JUNE 2013
DG ENER - DIRECTORATE B

CAPACITY MECHANISMS IN INDIVIDUAL MARKETS WITHIN THE IEM

THEMA
CONSULTING GROUP

ΕΠΙΣΕΥ ICCS
E^3M - Lab

COWI

ADDRESS COWI Belgium sprl
Av. de Tervueren 13-B
B-1040 Brussels
Belgium

TEL +32 (0)2 511 2383

FAX +32 (0)2 511 3881

WWW cowi.com

JUNE 2013
DG ENER - DIRECTORATE B

CAPACITY MECHANISMS IN INDIVIDUAL MARKETS WITHIN THE IEM

PROJECT NO.	ENER/B2/175/2012
DOCUMENT NO.	TE-2013-06
VERSION	Final Draft
DATE OF ISSUE	28 May 2013
TEAM LEADER	Dr. B. Tennbakk, THEMA Consulting Group
PROJECT MANAGER	J.-B. Lafitte, Cowi
PROJECT TEAM	Prof. P. Capros, C. Delkis, N. Tasios, M. Zabara, E3M-Lab
	C. H. Noreng, A. B. Skånlund, THEMA Consulting Group
Q. A.	Å. Jenssen, THEMA

CONTENTS

ABBREVATIONS

ACER: Agency for the Cooperation of Energy Regulators
ATC: Available Transmission Capacity
CCGT: Combined Cycle Gas Turbine
CHP: Combined Heat and Power
CRM: Capacity Remuneration Mechanism
DAM: Day-Ahead Market
DECC: Department of Energy and Climate Change
ENTSO-E: European Network of Transmission System Operators for Electricity
ETS: Emissions Trading Scheme
EUA: EU Allowance
FBMC: Flow Based Market Coupling
ID: Intraday (market)
IEM: Internal Energy Market
LoLP: Loss of Load Probability
LRMC: Long Run Marginal Cos
LSE: Load Serving Entity
MS: Member States
MW: Megawatt
NTC: Net Transmission Capacity
OCGT: Open Cycle Gas Turbine
PSO: Public Service Obligation
RES: Renewable Energy Sources
SFE: Supply Function Equilibrium
SMP: System Marginal Price
srmc: Short Run Marginal Cost
STOR: Short Term Operating Reserve
TSO: Transmission System Operator
TYNDP: Ten Year Network Development Plan
VOLL: Value of Lost Load
WACC: Weighted Average Cost of Capital

1 Executive Summary

1.1 The challenge

With the rapid increase in renewable electricity generation and the phase-out of conventional coal and nuclear generation there is a growing concern that energy-only electricity markets like the European target model will not be able to deliver sufficient capacity adequacy in the coming years.

The internal energy market (IEM) should increase the market's ability to dynamically provide the most cost-efficient development of the European electricity system. The rapid increase in renewable generation capacity (RES) throws the market out of equilibrium. At the same time, policy interventions and numerous uncertainties about future framework conditions challenge market dynamics:

1. Climate policy: The outcome of international climate policy negotiations and European climate policies in terms of carbon prices, renewables targets and energy efficiency.
2. Market development: The impact of the target model and the TYNDP, the development of fuel markets and particularly the gas market.
3. Market regulations and market design: Payments for flexibility and system (operation) services, demand side participation, design of renewables' support schemes.
4. Technology and costs: Changes in price structures and capacity needs due to new technology.
5. Economic environment: General economic and financial conditions which influence investors' decisions also in the power sector.

It is difficult on an empirical basis to determine whether the energy-only market design of the target model will yield adequate investment signals. Moreover, the academic literature is inconclusive too. Whereas some hold that energy-only markets are fundamentally flawed and that there is a need for permanent capacity remuneration mechanisms (CRM), others argue that the need for such mechanisms is mainly linked to temporary market interventions and uncertainties as the ones listed above.

1.2 Analysis

The empirical analysis shows that there is generally no urgent need for capacity mechanisms in Europe. Until 2020 the market needs to provide investments in new capacity constituting 10 % of the capacity installed in 2010. As old coal and nuclear capacity is phased out, the need for new capacity naturally increases after 2020. The new capacity needed until 2020 mainly concern balancing and reserve capacity due to increasing shares of variable RES capacity. This requirement further increases to the horizon of 2030.

The model based analysis reveals that the economics of new capacity, in particular in gas-fired open cycle and CCGT plants, may be challenging. The difficulty of capital cost recovery for new gas plants is related to the increasing penetration of variable RES capacity. With strict marginal cost pricing, the "missing money" represents 1-2% of the total turnover of dispatchable capacity. However, assuming more realistic price formation dynamics, the energy-only market may well be able to provide capital cost recovery for base load and most CCGT capacity. Peaking units are likely to require additional revenues in order to recover capital costs.

The “missing money” problem increases in scenarios with higher RES penetration. A hypothetical failure of the IEM leading to low XB trade possibilities would increase costs and prices at national level.

Individual (asymmetric) capacity mechanisms of all designs are prone to distort cross-border trade in two main ways:

- *By causing over-capacity:* Regulators are likely to overestimate the necessary domestic capacity reserve margin and to underestimate the contribution from cross-border trade.
- *By distorting allocation of investments:* Investments are likely to shift to markets with CRM, thereby increasing total costs and distorting cross-border trade.

Model simulations of individual CRM in France and Germany, respectively, confirm that unilateral mechanisms distort investments and trade and lead to higher system costs. The impacts on investments differ in the two cases due to differences in capacity mix and interconnectivity. Impacts are felt throughout Europe and total costs increase in both cases. Compared to the reference scenario (which also exhibits adequate capacity), EU generation costs are found to increase by 1,3-1,5%.

In theory, an optimally designed European market-wide reliability options market would not distort investments. Even for such a market however, the total capacity level must be set administratively, exposing the market to additional costs due to over-capacity. Capacity mechanisms targeted at specific capacity types, such as peaking units, are likely to distort incentives for investments in CCGT and base load capacity.

1.3 Advice

There is good reason to improve the investment environment in the European electricity market. Crucial steps include implementation of the target model, realization of the TYNDP and designing market compatible support mechanisms for RES-E capacity. Increased demand side participation in markets and development of more flexible technologies could provide valuable long-term contributions. New gas plants provide significant system services that should be appropriately remunerated. Remuneration possibilities through well-functioning real time balancing market, procurement of ancillary services and reserve services should be used in priority before capacity mechanisms are implemented.

Still, it cannot be ruled out that capacity mechanisms may be necessary to ensure sufficient peak and back-up capacity in the future low carbon European electricity system, or as a transitory precaution in some individual member states in the shorter term.

Design and implementation of a common European target capacity mechanism is premature. In addition to the general uncertainty of future framework conditions, there are numerous design issues associated with capacity mechanisms that need to be sorted. Simple designs tend to be imprecise, and more sophisticated mechanisms quickly become very complex. The market impacts may be difficult to grasp fully, and adverse investments incentives could easily be the result.

For security of supply reasons, individual Member States may opt for unilateral capacity mechanisms. As individual capacity mechanisms are likely to harm the efficiency of the IEM and adversely affect cross-border trade, the justification for such mechanisms should be documented. Common guidelines and a common methodology for such documentation should be developed.

A three-step approach is recommended:

1 Common approach to the capacity gap analyses:
    a) Reference gap analysis
    b) Cross-border contribution
    c) Options for closing the gap
2 Consideration of alternatives to capacity mechanisms, in order to demonstrate necessity, appropriateness and proportionality:
    a) Is demand response sufficiently stimulated?
    b) Is supply of system services appropriately compensated?
    c) Is interconnector capacity optimally utilized?
    d) Do the DAM and ID markets provide adequate price signals?
    e) Do other market failures, e.g. in the gas market or in financial markets, constitute investment barriers?
    f) Do market interventions in price formation create “missing money”?
3 Provisions for facilitation of cross-border capacity in the chosen mechanism should be required. Cross-border capacity can be remunerated directly, or indirectly via capacity remuneration for interconnections. This is important to preserve investment incentives for interconnections vis-à-vis domestic generation capacity.

It is difficult to recommend a standard model for individual capacity mechanisms within the IEM. In the transition period the challenges associated with capacity adequacy may differ substantially between markets. In cases where different capacity mechanism designs are chosen in interconnected markets, practical solutions to share cross-border resources and minimize adverse effects on trade have to be developed on a case-to-case basis.

2 Policy Maker's Summary

The objective of the study is to identify and analyse the issues which may arise as a result of individual capacity mechanisms by

1. Assessing current capacity mechanisms practices and initiatives within the member states (MS)
2. Assessing the need for action to ensure adequate generation capacity.
3. Assessing, if intervention is needed, how to ensure that the operation and efficiency of the internal energy market is not adversely affected.
    a) How should cross-border capacity be taken into account in the assessment of capacity adequacy?
    b) How may cross-border participation in capacity mechanisms be facilitated?

Although the main focus of the project is on the long term case for capacity mechanisms, we also discuss the case for capacity mechanisms in a somewhat shorter, transitional phase.

2.1 Policy and market context

With the rapid increase in renewable electricity generation and the phase-out of conventional coal and nuclear generation there is a growing concern that energy-only electricity markets like the European target model will not be able to deliver sufficient capacity adequacy in the coming years.

2.1.1 The European energy transition

Three aspects of the on-going transition of the European energy market are of particular relevance for the discussion of capacity mechanisms:

1. The completion of the internal energy market (IEM) and implementation of the target model for electricity.
2. The plans for increased interconnection capacity in Europe, cf. the Ten Year Network Development Plan of ENTSO-E.
3. The transition to a low-carbon energy system with increased shares of renewable electricity generation.

Completion of the IEM should increase the market's ability to dynamically provide the most cost-efficient development of the European electricity system by making optimal use of common resources, and efficiently adopting to changes in inter alia fuel and carbon prices, new technology solutions and demand. Currently, however, the market is thrown out of equilibrium and the market dynamic challenged by policy interventions and numerous uncertainties about future framework conditions:

1. Climate policy: The outcome of international climate policy negotiations and European climate policies in terms of carbon prices, renewables targets and energy efficiency.
2. Market development: The impact of the target model and the TYNDP, the development of fuel markets, the role of gas in power generation.

3 Market regulations and market design: Payments for flexibility and system (operation) services, demand side participation, design of renewables' support schemes.

4 Technology and costs: Changes in price structures and capacity needs due to new technology.

5 Economic environment: General economic and financial conditions which influence investors' decisions also in the power sector.

2.1.2 Missing investment incentives

"The missing money problem" is attributed to inadequate price dynamics in peak load hours due to market interventions. The culprit is however the lack of demand response, exposing the market to abuse of market power in scarcity situations:

› In most electricity markets consumers are currently exposed to average prices. Short term price response requires exposure to hourly prices, and that demand is able to respond to high prices on short notice. For many consumers, actual price response may also be mitigated by technological barriers or high transaction costs.

› The combination of a lack of short term demand response and simultaneity of generation and demand implies that generators may exhibit market power in scarcity situations.

› In order to mitigate market power, many markets are regulated through explicit and/or implicit price caps. The price caps protect consumers against high prices, but at the same time limit the opportunity for cost recovery by generation plant.

The "missing money problem" related to price caps is likely to be exacerbated by increased shares of intermittent renewable generation.

On the other hand, missing payments for balancing and system services contribute to the "missing money problem". Inadequate payment schemes for system services acquired by TSOs and missing balancing responsibility by renewable generation capacity are the main sources of such missing money. Whereas missing money due to capping of scarcity pricing affect the revenues of all generation capacity, missing payment for balancing and system services are likely to negatively impact flexible and peaking capacity the most.

2.1.3 Empirical and theoretical evidence

It is difficult on an empirical basis to determine whether the energy-only market design of the target model will yield adequate investment signals. Moreover, the academic literature is inconclusive too. Whereas some hold that energy-only markets are fundamentally flawed and that there is a need for permanent capacity mechanisms, others argue that the need for such mechanisms is mainly linked to temporary market interventions and uncertainties listed above.

There is however a clear consensus that it is necessary to improve the efficiency of the European electricity market by:

› Implementation of the target model including implicit (flow-based) market coupling in the day-ahead market and intraday markets, and increased cooperation between TSOs in balancing markets, would provide improved price signals and a better basis for long term financial markets and investments.

- Completion of the TYNDP would provide improved competition and liquidity in markets.
- Improving market based price signals for renewable generation and ensuring adequate pricing of system services should promote development and investments in new technologies and flexible solutions both in generation and consumption.

There are few academic contributions on the impact of individual or asymmetric capacity mechanisms. Meulman and Méray (2012) conclude that asymmetric capacity mechanisms may adversely affect cross-border trade whether cross-border participation is allowed or not. Capeda and Finon (2011) provide a model-based analysis of how asymmetric capacity regulations distort investment incentives.

2.2 The impact of capacity mechanisms

The purpose of capacity mechanisms is to strengthen the *incentives* for investments in generation capacity and demand side response in order to make the market more robust. Capacity mechanisms come in many different designs and represent new market interventions. We have analysed the characteristics of different designs and the impact of different designs if applied asymmetrically by individual countries.

2.2.1 Taxonomy of mechanisms

Capacity mechanisms can be designed in many different ways. Table 1 provides an overview of important design features of the main design categories; Capacity payment, Strategic reserve and Capacity markets.

- Capacity payments are direct subsidies aimed at directly strengthening investment incentives by providing (all or some) generators with a fixed payment in addition to market revenues.
- Strategic reserves remunerates capacity that is kept as reserves (may include load shedding) in case the market fails to provide balance between supply and demand.
- Capacity markets provide capacity payments via market based incentive schemes, i.e. auctions or certificates. Reliability options explicitly exchange an uncertain revenue (revenues above strike price) with a fixed revenue (option premium).

Table 1: Overview of capacity mechanisms

	Capacity payment	***Strategic reserve***	***Capacity markets***		
			Capacity obligation	**Capacity auction**	**Reliability option**
Market wide or targeted	Can be both Loads not included	Targeted. Loads may be included	Both, but typically market wide	Both, but typically market wide	Both, but typically market wide
Present or future obligation	May be both	May be both	May be both Incentives for long-term contracts	May be both	Future, specifically designed to strengthen investment incentives
Adequacy calculation	Not required	Required (reserve margin)	Required (reserve margin)	Required (total capacity)	Required (total capacity)
Reliability requirements	Not required	Required	Rules for approval / standard certificates	Rules for approval / standard certificates	Linked to market price (strike price)
Payment	Set by regulator May depend on peak reserve margin	By tender / auction	Market based: Bilateral contracts or certificate trade	Through centralized auction	Through centralized auction
Cost allocation	Fee on LSEs (uplift on energy charges)	System charges	Charge on energy sales by LSEs	Charge on energy sales, peak load or system charges	Charge on consumers (peak load)
Rules for activation	None. Generation sold in wholesale market	Activated on call Only loads bid in market	Expected to bid in wholesale markets	Expected to bid in wholesale markets	Required to bid in wholesale market when price exceeds strike price

Sources: Meulman & Mèray (2012), Cramton and Ockenfels (2011b), Brunekreeft et.al. (2011)

2.2.2 Existing and proposed mechanisms

Capacity mechanisms have been implemented in several European countries and are discussed or under implementation in others.

Finland, Norway, Poland, and Sweden currently operate strategic reserves, whereas Greece, Ireland, Italy, Portugal and Spain practice capacity payments. All mechanisms are targeted or differentiated to some extent. None are open to cross-border participation, although the power exchange between Ireland and the UK is based on prices including capacity charges.

France and the UK have decided to implement capacity mechanisms and discussions are on-going in Germany and Belgium. France has opted for a capacity obligation scheme supported by certification of capacity and demand response, where certificates can be traded. The obligation will be set for one year at the time. Cross-border participation is possible, but requires inter alia allocation of interconnector capacity and that the capacity is not counted as part of the host country's capacity availability. The UK has opted for a centralized, market-wide capacity auction. Inclusion of cross-border capacity by basing the exchange on prices including capacity charges is under discussion.

2.2.3 The impact of asymmetric capacity mechanisms

In the best case, capacity mechanisms merely corrects market failures of the energy-only market and improves market efficiency; in the worst case capacity mechanisms regard capacity adequacy per market area in isolation without taking cross-border capacity and trade into account, thereby introducing new market distortions.

Individual capacity mechanisms of all designs are prone to distort cross-border trade in two main ways:

- *By causing over-capacity:* Regulators are likely to overestimate the necessary domestic capacity reserve margin and to underestimate the contribution from cross-border trade.
- *By distorting allocation of investments:* Investments are likely to shift to markets with CRM, thereby increasing total costs and distorting cross-border trade.

Our theoretical analysis of asymmetric capacity mechanisms concludes that all capacity mechanism designs, if implemented asymmetrically, are prone to distort investments and trade. The value of interconnectors and trade is typically reduced. The allocation of capacity between markets is distorted, although the short term price formation still has an impact on the capacity mix.

Critical factors for the magnitude of the adverse effects on trade and interconnector revenues are 1) how capacity mechanisms impact price structures, and 2) the extent to which prices (and scarcity situations) in the countries are correlated. The adverse effects of not taking cross-border capacity into account are greater the more integrated the markets, and the lower the correlation between peak and off-peak hours (or high and low net demand).

Asymmetric approaches are likely to exhibit similar adverse effects as the combinations discussed above. Adverse effects may result even if markets implement the same capacity mechanism, but with different design parameters. Different capacity payment levels, different strike prices, and different reliability standards are examples of design parameters that would distort investment incentives, prices and trade.

Ideally, the potential cost of imperfect capacity mechanisms should be compared to the potential loss due to market failure in the energy-only market. It is obviously difficult to perform such quantitative cost-benefit analysis for concrete markets; the behavioural implications are complex and a number of simplifying assumptions have to be made.

2.3 Modelling results

2.3.1 Gap analysis

Simulation of the Reference scenario indicate that there is no urgent need for capacity mechanisms in most MS. Based on planned decommissioning and on-going investment, reserve margins are generally robust until 2015. Until 2020 the market needs to provide investments in new capacity constituting 9 % of the capacity installed in 2010, mainly concerning retrofitting and flexible open-cycle gas turbines. As old coal and nuclear capacity is phased out, the need for new capacity naturally increases in the decade after 2020. Needed investments are estimated at 28% of the dispatchable capacity in 2010. The structure of investments varies between MS with more base load and CCGT capacity needed in countries with nuclear phase-out and ageing coal capacity. The new capacity needed until 2020 mainly concern balancing and reserve capacity due to increasing shares of variable RES capacity. This requirement further increases to 2030.

2.3.2 Revenue prospects in the energy-only market

The gap analysis shows the need for market-induced investments in the coming two decades. The likelihood that the market will deliver these investments depends mainly on the expected market revenues, i.e., prices and the degree of uncertainty, in addition to revenues from supply of balancing and system services.

As the share of must-take generation increases, the number of hours per year with very low wholesale (DAM) prices increases and the annual average price level decreases. On the other hand, the number of hours with high prices is likely to increase as well. Price structures become less uniform than in the past. In addition, increased shares of intermittent generation imply higher system balancing and reserve needs. The change in price structure is more favourable to CCGT capacity than to base load capacity. However, the average annual utilization rates for CCGT capacity decline, making capital cost recovery more dependent on peak prices and flexibility payments. Hence, growing uncertainty may surround such investments. However, cross-border balancing services play a more important role as the implementation of the TYNDP and the IEM increase the capacity for cross-border trade, implying that flexible resources can be utilized for larger areas and in more hours than before.

We analyse revenue prospects by way of three different bidding regimes: Strict marginal cost bidding, Supply function equilibrium bidding and Cournot competition bidding. By assumption, open-cycle gas plants are not able to recover capital costs in the marginal cost bidding regime. The estimated “missing money” represents 1-2% of the total turnover of dispatchable plants in the wholesale market. Base load capacity is generally better off, with CCGT capacity struggling to recover capital costs in most markets.

Assuming more realistic price formation dynamics, represented by supply function equilibrium bidding, the energy-only market provides comfortable capital cost recovery rates for base load and most CCGT capacity. The “missing money” for peaking units is reduced to 0,5-0,7% of wholesale market turnover. Thus, peaking units are likely to require revenues from system services and balancing markets in addition. Comfortable capital cost recovery rates for base-load capacity indicate that there may be a market scope for more investments in base and CCGT capacity, if such capacity expansions are not limited by other constraints (e.g. nuclear and in the longer term CCS).

Increased RES penetration exacerbates the “missing money problem” for flexible plants, including CCGT plants. Possible barriers to cross-border trade were found to induce higher costs and prices at national level.

2.3.3 Impact of capacity mechanisms

The model results confirm that the completion of the IEM and the TYNDP is of utmost importance for capacity adequacy and for the costs to consumers. Control area operation following national reliability criteria implies significantly higher requirements for gas plants to provide balancing and reserve services to increasing volumes of must-take generation. Importing countries must invest more and exporting countries export less. Ramping and technical minimum constraints become more restrictive. Prices increase and diverge more. The capital cost recovery for CCGT increase, but is lower for base load capacity.

The average necessary capital remuneration fee implies additional annual costs for the consumer of about 2%.

Simulations of asymmetric capacity remuneration, in France and Germany respectively, also confirm adverse effects on investments. Investments increase in the country with CRM and decrease in other countries. On the other hand, adjacent markets are found to free-ride from the increased capacity in the CRM market in the short term. The long term effect is negative, however: Low investments aggravate the capacity adequacy level and yields increased costs. In the case of CRM in France only, total generation costs at the EU level increase by 1,5%. Similar, but smaller effects are obtained when Germany applies a unilateral CRM, but the increase in total costs is at the same level.

The intensity and the nature of the effects are found to depend on the structure of the energy systems in the affected countries. Overall, the asymmetric application of capacity remuneration significantly distorts the allocation of investments.

The results show distortion of cross-border trade. However, the effects on interconnector revenues has not been assessed or included. Interconnector capacities are constant.

2.4 A European approach to capacity mechanisms

A common European target capacity mechanism is premature

Our first advice is to not implement a capacity mechanism in the European target model, or a target capacity mechanism at this point in time. In addition to the inconclusive theoretical and empirical evidence, and the current relatively robust capacity adequacy in most European markets, our analysis shows that there are numerous design challenges associated with capacity mechanisms that need to be sorted. Both capacity payments and strategic reserves tend to be imprecise and more sophisticated capacity market designs quickly become very complex. In view of the significant uncertainties pertaining to policy and market developments, it is by no means clear that the benefits of sophisticated capacity market designs would merit the costs associated with their implementation and operation.

Exhausting the possibilities of real time balancing markets and of ancillary service and reserve procurement is important to address the capacity requirements related to increased penetration of variable RES. Such approaches should have priority compared to capacity mechanisms.

It is difficult to recommend a standard design for individual mechanisms

Member states may still opt for implementation of capacity mechanisms due to security of supply concerns. As implementation of asymmetric capacity mechanisms in interconnected markets could harm the IEM in several ways, a solution could be to identify a standard model for individual capacity mechanisms. However, in the transition period the challenges associated with capacity adequacy may differ substantially between markets. This is an area where a “one-size-fits-all" approach probably does not apply. In cases where different capacity mechanism designs are chosen in interconnected markets, practical solutions to share cross-border resources and minimize adverse effects on trade will rather have to be developed on a case-to-case basis.

Criteria for implementation of individual capacity mechanisms should be developed

Since capacity mechanisms are prone to introduce market distortions, the need for a capacity mechanism in a market area should be clearly demonstrated prior to adoption. The overall criteria for introduction of individual capacity mechanisms, as well as other market interventions adversely affecting trade, should be:

- Necessary: A thorough gap analysis is needed to demonstrate that intervention is needed. Common guidelines and a common methodology for such a gap analysis should be developed.
- Appropriate: Analysis of alternative measures is needed to determine the appropriate action. The appropriate action depends on the problem at hand. In principle, capacity mechanisms should only be implemented if it is clear that other means, which could remove or reduce weak investment incentives, are implemented first. Alternative measures include measures to improve demand side response, compensation for system services, utilization of interconnector capacity, price signals in DAM and ID markets, etc.
- Proportional: Implementation of a capacity mechanism should not unduly increase system costs and costs to end users. Common guidelines on the methodology for calculation of costs should be developed (cf. experience from e.g. UK).

When all of this is done, and if the conclusion is that a capacity mechanism is needed, the choice of mechanism and design features should be made on the basis of the analyses. The overarching goal should be to design the mechanism in a way that corrects the identified market failure(s) as precisely as possible – based on the identification of relevant market failures – and that distorts cross-border trade and competition in the IEM as little as possible.

Provisions for cross-border participation should be required, and given the uncertainty as to the need for capacity mechanisms in the long term, and the likelihood of adverse effects, a clear exit strategy should be provided.

Cross-border participation can and should be facilitated

In order to reduce the negative impacts of individual capacity mechanisms on cross-border trade, appropriate incentives are needed. How cross-border trade could participate in individual capacity mechanisms, depends on the choice of model.

Capacity payments: General capacity payments should apply to interconnector capacity on the same conditions as domestic generation and demand response.

Strategic reserves: Contracting of generation capacity in adjacent markets requires (guaranteed) access to interconnector capacity in times of stress. Interconnector capacity should however not be permanently reserved as back-up capacity. Instead, interconnector capacity could be treated as demand side resources in the strategic reserve, i.e. not permanently removed from the market, but as a guarantee of flow in the right direction in times of stress. In practice such agreements must be negotiated from case to case. If two adjacent markets opt for strategic reserves, the benefits of cooperation should be explored (cf. common stack of balancing reserves).

Capacity market: If capacity is secured through a centralized auction or, in the case of a decentralized capacity obligation, interconnector capacity could be eligible for certificates or capacity remuneration on the same conditions as generation or demand side response.

Cross-border capacity can be remunerated directly or compensated through prices reflecting a capacity charge

Capacity mechanisms undermine the profitability of cross-border trade through its effect on prices. The objective of the IEM is to provide efficient price signals to generators and consumers – including cross-border trade and investments in infrastructure. Hence, if there is a “missing money problem” affecting generation and demand response, there is also a “missing money problem” affecting trade and interconnectors. In principle, interconnectors can be included in the capacity market directly, i.e. offer reliability options or certificates. In a pure market-wide capacity auction with wide reliability standards and appropriate penalty provisions for non-compliance, interconnector owners could also opt to bid. Like for all other capacity, i.e. generation and demand response, interconnector bids would be based on the interconnector operator’s assessment of the availability of the connection and the risk of not being able to deliver in times of stress (which inter alia depends on the capacity adequacy and correlation with the market at the other end of the connection).

Both for capacity payments and capacity markets, the way in which capacity payments are collected allows for another possibility. Instead of including interconnector or cross-border directly in the capacity payment ex ante, cross-border trade may be exposed to capacity payments by reflecting capacity charges in the exchange prices. This is in line with the treatment of import and export in the Irish capacity mechanism. A similar design is proposed for the UK capacity mechanism. Such capacity charges are however set administratively and will not reflect the true capacity values hour by hour.

3 Policy and market context

The objective of the study is to analyse the need for capacity mechanisms in European electricity markets to ensure future capacity adequacy, to assess the effects of individual mechanisms in EU member states, and to discuss how adverse effects can be mitigated. The analysis is made against the background of the energy transition, i.e. the transition to a low-carbon energy system, implementation of the IEM and the TYNDP. As the incentives and security of supply provided by implementation of the target model for electricity is at the core of the discussion, the expected implications of the target model for electricity, currently under implementation, is presented in some detail.

3.1 Background

In several European countries there is a growing concern that under the current market design, electricity markets will not be able to deliver sufficient capacity to meet electricity demand at all times, i.e. provide *capacity adequacy*. This concern has compelled regulators to intervene to ensure that a required amount of capacity is available by way of implementing capacity mechanisms.

In the EU, capacity mechanisms have been implemented in Greece, Ireland, Italy, Portugal, Spain, and Sweden, and are under consideration in other MS, notably Belgium, France, Germany and the UK. Thus far however, countries are opting for different and nationally oriented approaches. These approaches do generally not take into account the opportunities presented by the internal electricity market and cross-border trade in the assessment of capacity adequacy and in the design of the capacity mechanisms.

The purpose of capacity mechanisms is to increase capacity and/or flexibility by incentivizing increased investments in generation capacity and postponed decommissioning of plant, and to promote demand side flexibility. With capacity mechanisms typically being geographically limited to national markets, asymmetric investment incentives may consequently distort the spatial configuration of generation capacity and demand response. Hence, the EU Commission is concerned that capacity mechanisms in individual MS may alter generation and investment decisions within the Internal Energy Market (IEM) and potentially act as a barrier to trade and investments in interconnector capacity. This may undermine the efficiency of the IEM both in the short and long term.

The objective of the study presented in this report is to identify and analyse the issues which may arise as a result of capacity mechanisms by

› Assessing current capacity mechanism practices and initiatives in MS

› Assessing the need for action to ensure adequate generation capacity

› Assessing, if intervention is needed, how to ensure that the operation and efficiency of the internal energy market is not adversely affected

The project focuses on the following issues:

1 How should cross-border capacity be taken into account in the assessment of capacity adequacy?

1 How may cross-border participation in capacity mechanisms be facilitated?

By cross-border capacity we mean contributions from other markets (in point 1), either directly in the form of generation capacity or demand side response, or indirectly through interconnector capacity. Although the main focus of the project is on the long term case for capacity mechanisms, we also discuss the case for capacity mechanisms in a somewhat shorter, transitional phase.

3.2 The energy transition

Capacity adequacy and the need for capacity mechanisms have to be analysed as a part of the overall market structure and design. Hence, in order to assess the need for and the impact of capacity mechanisms in individual markets, one should take the broader market context into account, e.g. interconnectivity and market integration, generation mix, demand side participation, etc.

Although the situation may vary from country to country or control area to control area, significant development trends and characteristics are shared across Europe. The European electricity system is currently in the process of being profoundly transformed. Three important aspects of this transition are particularly relevant for the issue of capacity mechanisms

1. The completion of the implementation of the IEM.
2. The increased physical integration of the electricity system, of which the Ten Year Network Development Plan (TYNDP) is instrumental.
3. The transition to a low-carbon power system in order to mitigate CO_2 emissions.

The analysis of capacity adequacy and interaction of capacity mechanisms with the IEM in this report is based on the assumption that the target model is implemented by 2020 and that the projects in the TYNDP are carried out according to plan. Moreover, it is assumed that the transition to a low-carbon power system towards 2050 will carry on with fulfilment of the renewables targets set by the National Renewable Action Plans (NRAP) by 2020, in addition to the other directives and actions contained in the Energy 2020 strategy.

The aim of the IEM is to provide the EU with "an internal energy market that is competitive, integrated and fluid".[1] The IEM implies making optimal use of Europe's energy resources across national borders and control areas through unbundling of monopoly and competitive activities in the energy market, and improved utilization of cross-border transmission capacity via market coupling (for market services) and TSO cooperation (for transmission and system services). The IEM should bring the European electricity system to a system developed from a European perspective, improve overall security of supply, and provide local and regional security of supply based on the optimal utilization of common resources.

Implementation of the IEM should see the development of more liquid markets across Europe, providing efficient price formation and improved risk management opportunities for market participants, hence improving the investment environment in the market. More efficient utilization of cross-border transmission capacity and increased TSO cooperation on balancing and reserve provision improves security of supply by making resources available for larger areas. The European Heads of State or Government have set 2014 as the deadline for completion of the IEM. Although the EU is not on track to meet this deadline today[2], implementation of the

---

[1] COM(2012) 663 final

[2] Op. cit.

IEM is progressing. For the purposes of this study we expect it to be fully implemented by 2020.

Another development that is important for capacity adequacy and for the gains achieved from implementation of the IEM is expansion and strengthening of the European transmission grid. In order for markets to take full advantage of the opportunities for efficiency gains and cost reductions offered by the IEM, the physical exchange capacity between control areas, countries and regions in Europe must be adapted to the new market situation.

The current European electricity transmission grid is largely developed from a national perspective, although electricity has been exchanged across borders for several decades. Historically, electricity was regarded as a national supply concern (sometimes across regions containing several countries such as the Baltic States and the former Yugoslav republics) and cross-border exchange mainly as a means of cooperation to offer mutual insurance in case of surplus or deficit situations.

In addition to domestic grid investments, ENTSO-E has developed a European Ten Year Network Development Plan (TYNDP). Realization of various internal infrastructure projects in addition to the TYNDP should provide for an electricity system that is better adapted to future needs and to a larger extent facilitates the utilization of common resources.

Last, but not least, the transition to a low-carbon power system implies profound changes in the configuration and characteristics of the electricity system. The share of renewable electricity generation is set to increase, while the share of fossil fuelled generation must be reduced, cf. the Energy Road Map 2050. While the renewables targets for 2020 are currently being realized by MS, targets and measures for 2030 are under development. Although it seems clear that the EU will continue to pursue ambitious climate policies, including expansion of renewable electricity generation, the actual design and mix of policy measures and targets beyond 2020 is still in the making.

Electricity generation based on renewable energy sources is largely capital intensive with low variable costs and weather dependent and intermittent generation patterns. Thus, increasing shares of such generation impact the system requirements for back-up and flexible capacity. At the same time, renewable generation impact market prices, and the profitability and generation in conventional generation plant. As renewable generation has been incentivized by (largely national) support schemes, investments in new power generation capacity are currently not driven by market prices. Moreover, in most markets, the short term operation of renewable generation is not driven by market prices either. In feed-in and certificate systems, and where RES generation is prioritized, RES generation will produce to its full ability even in hours with prices close to or below zero, and practically regardless of the associated system costs.

The rapid expansion of renewable generation based on subsidies implies general excess capacity in many markets and undermines the profitability of conventional capacity, while at the same time posing increased demand on system operation, notably the need for flexibility and back-up capacity. Although some of the current challenges may be attributed to the rapid changes necessary to comply with the 2020 targets, future electricity generation is also expected to be characterized by increased intermittency and weather dependency, reduced mid-merit flexible capacity, and phase-out of nuclear capacity. In the long term, the capacity mix and technology is likely to adapt as a response to the challenges posed by the new configuration. However, when it comes to technology development it is notoriously difficult to predict the result, both when it comes to what and when.

Other developments linked to the transition to a low-carbon electricity system are however significant as well. The need for increased system flexibility is likely to incentivize new solutions for demand side participation, while implementation of the IEM should facilitate such solutions. On the other hand, implementation of the energy efficiency directive is likely to reduce the need for investments in new capacity. In a transition period this may add to the challenges: Uncertainty about the impacts of energy efficiency measures on the growth in electricity demand may make investors even more reluctant to invest in new generation capacity.

The future electricity system is set to be better integrated, more competitive and increasingly based on renewable and low-carbon generation capacity. Substantial changes have occurred over the last decade, and further changes will come. The result of the changes in framework conditions is that the market is thrown far from a long term equilibrium solution in terms of adjustments of capacity mix and demand patterns. Investments are needed, but it is difficult to assess how much and what capacity will be in the money in the future. Uncertainties are linked to

- Global developments, notably climate policies and technology developments, but even fuel prices.
- EU policy developments, notably EU climate policies beyond 2020 and the impacts of goals and measures, including energy efficiency, renewable energy and the ETS.
- Electricity market developments, notably how implementation of the target model will affect markets and cross-border trade.

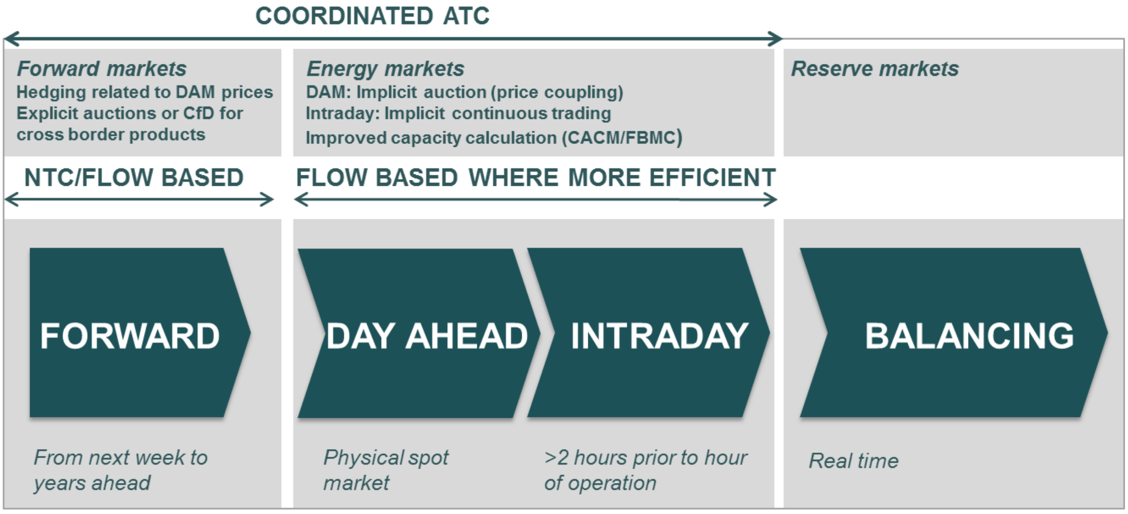
It is clear that the current challenging investment environment is not only linked to electricity market design. However, the ability of the IEM to deliver adequate and transparent prices and investment incentives within the future, more stable policy environment is an important element in the assessment of capacity mechanisms. In the next section we therefor describe the implementation of the IEM in terms of the target model for electricity in some more detail.

3.3 The European target model for electricity

The ability of the existing market design to produce capacity adequacy is at the heart of the discussion of the need for capacity mechanisms. Hence, it is a complicating feature of the capacity adequacy discussion that the internal energy market is not yet fully implemented across Europe. The IEM will be realized by implementing the target model market design. In order to assess the need for capacity mechanisms in the long term, it is useful to describe and discuss the implications of the target model in more detail.

The European target model describes a common, integrated marked framework for the EU single market in electricity. The model proposes a market design for each time frame, i.e. forward markets, day ahead and intraday markets, cf. Figure 1 (ENTSO-E, 2012). Guidelines for balancing (ACER, 2012) and a coordinated approach to cross-border interconnector capacity calculation (CACM) are integral parts of the implementation of the target model.

Figure 1: The EU Target Model



Source: ENTSO-E (2012)

According to the target model the markets will be integrated across country and system borders in all time frames.

Forward Market

In the forward market the market participants can enter into long term contracts for electricity trade. The main benefit of forward markets is to give market participants the opportunity to hedge uncertainties related to forward price risks. Within the target model, financial forwards mainly provide hedging related to prices in the DAM, with reference to the DAM price in a specified market area. Forward contracts may be traded between market players on derivatives exchanges or bilaterally.

Liquid forward markets referred to different market areas provide hedging opportunities for cross-border trades as well. Hence, the target model implies the provision of opportunities to manage forward cross-border price risks. The target model prescribes that physical transmission rights (PTRs) with use-it or sell-it clauses or financial transmission rights (FTRs) on cross-border interconnections are to be auctioned by TSOs if a relevant liquid forward derivatives market does not exists.

Day-ahead Market (DAM)

In the DAM supply (generation) and demand (customer serving entities and/or large consumers) provide bids and offers for every hour of the next day. The market solution for each hour is calculated so that marginal costs equal the marginal willingness to pay, subject to available transmission capacity (ATC) between market areas. Market areas may be defined by national borders, borders between control areas (area controlled by one transmission system operator, TSO) or according to grid bottlenecks within a country or control area. According to the target model, trade between market areas in the DAM are to be determined by implicit market coupling. Implicit market coupling implies that all order books from the power exchanges (all bid and offers) are aggregated and optimized in one algorithm that calculates prices and flows, subject to the available transmission capacity between market areas. Price differences occur subject to bottlenecks between market areas (congestion on interconnections).

In current implicit market coupling arrangements TSOs calculate ATC values ex ante based on expected flows. In the future Flow Based Market Coupling (FBMC) is expected to be implemented, implying that ATC values will be calculated as part of the market algorithm itself, i.e. simultaneously and not ex ante.

As the DAM solution is calculated several hours ahead of real-time generation and consumption, the DAM solution can be understood as a (short term) *plan* for generation and consumption during the next day. (Trading in the DAM is voluntary. Market players may also trade according to physical contracts agreed in the OTC market. All planned physical trades must however be submitted to the TSO – after clearing in the DAM – and the balance responsible parties are responsible for compliance with the plan.)

Intraday Market (IDM)

Balance responsible market participants are obliged to adhere to the plan determined in the DAM, or else pay a penalty (as a minimum equal to the cost of handling the imbalance). The bids and offers in the DAM are based on expectations of supply and demand for the next day (12-36 hours ahead). After gate closure (the deadline for submission of bids and offers) in the DAM circumstances may change in ways that leads to deviations from the plan. Wind power generation may deviate from forecasts, plants and lines may trip and consumption may deviate from expectations. The IDM offers market participants the opportunity to adjust the plan set in the DAM. In the IDM market participants can trade continuously up to one hour before real-time in order to reduce imbalances. Thus the outcome of IDM trading is a revision of the plan from the DAM. IDM trades may be cross-border as well. Transmission congestions are taken into account by updating ATC values according to each trade so that IDM transactions cannot be struck across congested lines unless they flow in the opposite direction of already planned flows.

Balancing Market

In real-time there will be deviations from the plan reached through trade in DAM and IDM. Plants may still trip on short notice and demand may deviate. Moreover generation and consumption is not constant through the hour. Deviations and variations in real-time must be handled by the TSO. The TSO maintains the balance by purchasing system services from the market players. Market players bid reserves for balancing purposes (up and down regulation) as tertiary reserves, secondary reserves or primary reserves depending on the defined speed and duration of the flexibility they provide. Balancing resources can also be shared cross-border and across regions as long as connections are not congested. Sharing of balancing resources requires cooperation between TSOs and is facilitated by harmonized definitions of balancing products in the target model. Due to system configurations and limited grid capacities, it is however important to have balancing and reserve resources available at different locations in the system.

Implications of the target model

By integrating control areas and national and regional markets across Europe in a common market coupling arrangement, including the “pooling” of balancing resources, cost efficient utilization of common resources is facilitated in the short term, and more efficient investment signals are provided for long term investments in generation and transmission capacity. Long term price expectations will affect investments and behaviour affecting long term demand for electricity as well.

Implementation of the IEM in terms of the target model is set to provide efficiency gains across the European electricity market. It is generally recognized that the success of the IEM, including the ability to accommodate increased shares of new renewable generation and activate demand side participation, rests on the improved functioning of short term markets.

Efficient short term price formation is crucial for investment decisions and risk management in futures markets. The target model improves price signals and the utilization of generation and transmission capacities, and as such, security of supply (and capacity adequacy) in the short and long term in the following ways:

1 The forward market implies that long term hedging may be done independently of physical transmission rights and the short term utilization of interconnector capacity. Price conversion and increased cross-border competition (liquidity) creates larger markets an possibilities for a limited number of more liquid forward products, improving the opportunities for risk management and ultimately limiting investment risks.

2 Implicit market coupling in DAM and improved capacity calculation (via implementation of coordinated CACM and/or FBMC) improves the short term utilization of interconnector capacity and is likely to improve locational price signals.

3 Cross-border IDM and Balancing trade improves the utilization of interconnector capacity further, it reduces the cost of imbalances for market participants and system operators, and it improves the payment for flexibility in the system.

The target model design is based on a so-called energy-only market approach (see next section), i.e. explicit payment for long term capacity availability is so far not included in the target model. Generators (and consumers) may however also receive revenues from services such as supply of ancillary services and balancing in real time. Hence, although the target model is basically an energy-only market design, important elements of capacity payments exist.

4 The role of capacity mechanisms in market design

Capacity mechanisms are discussed both as temporary measures to strengthen investment incentives and risk mitigation through the transition phase until framework conditions are stabilized and a sustainable equilibrium can be found, and as a necessary addition to energy markets in a long term efficient market design. Presently it is difficult to draw firm conclusions because markets are exposed to the "shock" of rapid expansion of RES generation, market solutions are not fully developed and integrated and future climate policy framework conditions and market impacts of climate policies are highly uncertain. Whether capacity mechanisms are needed in the long run or not, improved functioning of short term markets via implementation of the target model is beneficial. In addition, clarification of policy uncertainties and clear rules for market interventions would improve the investment climate.

4.1 Introduction

Capacity adequacy (and inherently the need for capacity mechanisms) is a question of the ability of energy-only market designs like the European target model to deliver investment signals that are sufficient to secure adequate market-based investments over time. The question is whether additional measures in the form of capacity mechanisms are needed to provide investments and ensure the long term capacity adequacy.

In this chapter we will present the discussion of the role of and need for capacity mechanisms in theory and practice in more detail. In chapter 3 we describe different capacity mechanism designs.

4.2 Capacity adequacy

Generation capacity adequacy in power markets is generally understood as the ability of the system to meet any level of power demand, and peak demand in particular, at all times.[3] In practice this means that the generation system must dispose sufficient amounts of ready-to-operate power capacity, taking into account predicted peak load power demand, price elasticity of demand, the reliability of different sources of capacity and the likelihood of trips of (large) capacity units and lines.

If capacity adequacy is poor, the probability of brownouts (drop of voltage) and loss of load due to centrally managed or accidental power cuts increase and occur more frequently. In wholesale electricity markets, extreme price spikes may be symptoms of inadequacy.

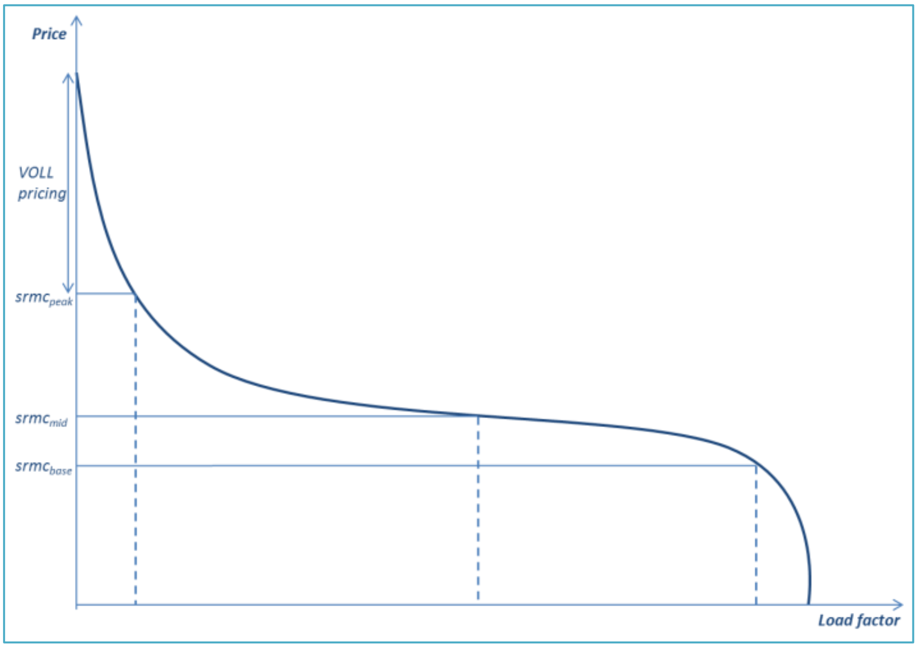
---

[3] In addition to the need for sufficient capacity to cover hourly demand in peak load hours, the electricity system needs availability of ancillary services, such as voltage, frequency control and reserve power as well, and system operators or balance responsible parties offer payments for such services as well. Ancillary services are supplied by power generators provided that sufficient incentives or obligations are in place. Reserve power is typically capacity that is available beyond the half hour.

4.3 Are investment incentives inadequate in energy-only markets?

Regardless of the market design, the (theoretically) optimal electricity market is a market where costs are minimized and all generation earn the market rate of return on invested capital. In the short term generation is dispatched according to least costs (merit order), flexibility requirements, (residual) demand fluctuations and grid capacity. As such the location of capacity in the optimal solution takes into account security of supply and value of lost load (VOLL) in different locations (including variations in demand flexibility).

Figure 2: Price duration curve in long term equilibrium



The theoretically optimal solution is illustrated in a simplified way in Figure 2, showing the price duration curve and the load factor for different types of capacity assuming that demand is covered at least total cost, and taking the marginal willingness to pay into account (marginal VOLL). Base load capacity has a high load factor and low short term variable costs ($srmc_{base}$), whereas mid merit generation has a lower load factor and higher variable costs ($srmc_{mid}$). Peak capacity has the highest variable costs ($srmc_{peak}$). In the optimal solution, the value of the area between the price duration curve and the respective srmc is expected to cover normal returns on the invested capital for each power plant. The welfare economic optimal volume of peak capacity is determined by VOLL. We note that if the area between $srmc_{mid}$ and the price curve is larger than the capital cost of mid merit capacity, the volume of mid merit capacity is too small. Moreover, increased investments in mid merit capacity affects the price curve – it shifts down in the hours when mid merit generation is producing, hence affecting the value and optimal volume of both peak and base load capacity.

Market design is a question of providing the market agents with the proper incentives and risk management tools in order to realize the optimal solution.

4.3.1 Energy-only markets versus markets with capacity mechanisms

In energy-only market designs, the (only) traded commodity is electricity (MWh/h). In such markets, the supplying companies get revenues only by selling electricity, either in organized wholesale markets and/or through bilateral contracts with customers.[4] The companies recover capital and fixed costs of power generation because the selling prices or the wholesale market prices turn out to be higher than the variable costs (mostly fuel costs) of power generation, either continuously or periodically, but in a sufficient number of hours. Generation capacity adequacy is supposed to be derived from the resulting market dynamics. In well-functioning markets generators bid their marginal cost to the market and the demand side bids according to the marginal VOLL. (Hourly) prices are determined according to marginal bids, i.e. prices are set so that supply equals demand. If there is excess capacity, prices are set equal to the highest supply-side bid. In scarcity situations prices should increase and compel supply to increase according to marginal costs and demand to retract at price levels corresponding to the marginal VOLL until the market balance is restored. According to this dynamic, demand and supply responses to prices in the energy-only markets can be relied upon to secure the balance between supply and demand. Moreover, scarcity pricing ensures revenues to cover capital cost of peak (and other) generation capacity.

By contrast, market designs with explicit capacity mechanisms recognize two market commodities, namely electricity (the output) and generation capacity (the means). Introducing capacity mechanisms imply that generators receive payments for the mere availability of capacity *in addition to* revenues obtained from the energy market. One might say that in a market with an explicit capacity mechanism the energy market is still the main instrument for short term optimization of resources, while the capacity mechanisms is the main instrument for long term development of generation capacity.

4.3.2 The "missing money problem"

In practice, various market and regulatory failures may mute investment signals in energy-only market designs. The main challenge is that demand response is missing or limited in most electricity markets, exposing consumers to market power abuse in scarcity situations. This risk compels regulators and system operators to intervene in the market to suppress scarcity prices. The revenue reduction due to intervention in peak prices is commonly referred to as the "Missing money problem":

1 *Absence or lack of short term demand response.* In most electricity markets consumers are currently exposed to average prices. Short term price response requires that demand is exposed to hourly prices and able to respond to high prices on short notice. For many consumers, actual price response may also be mitigated by technical barriers and/or high transaction costs.

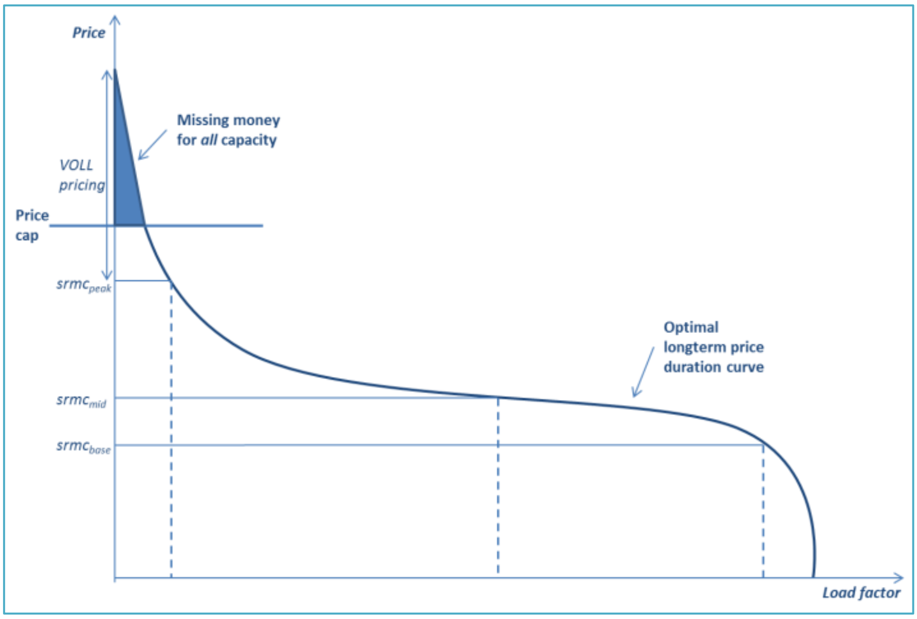
---

[4] Within the target model bilateral contracts are likely to be financial in the sense that contracted prices are linked to prices realized in the organized wholesale markets (spot exchanges). Bilateral contracts may however also be physical, in which case they may implicitly contain an element of capacity payment.

2. *Market power in scarcity situations.* The combination of a lack of short term demand response and simultaneity of generation and demand implies that generators may exhibit market power in scarcity situations.
3. *Capping of prices in scarcity situations.* In order to mitigate market power, many markets are regulated through explicit and/or implicit price caps.[5] The price caps are there to protect consumers, but may at the same time limit the opportunity for cost recovery for peaking plants.

A simplified illustration of the "missing money problem" is provided in Figure 3. Since prices are not allowed to increase above the price cap, the generators do not realize the full welfare economic value of generation in peak load. We note that the price cap reduces the revenues of all generation capacity. Peak load capacity suffer the largest revenue loss in relative terms, but the revenue loss in absolute terms is the same for all generation capacity that is generating in peak load hours. As the number of full load hours for traditional mid merit generation declines, peak prices become relatively more important for the revenue margin of these plants as well.

Figure 3: The "missing money problem"



The "missing money problem" is likely to be exacerbated when the share of intermittent generation increases, as illustrated by Figure 4. The curves depict price duration curves for Germany for different assumptions about the share of RES generation. Please note that the simulations are purely illustrative and do not depict long term equilibrium situations.

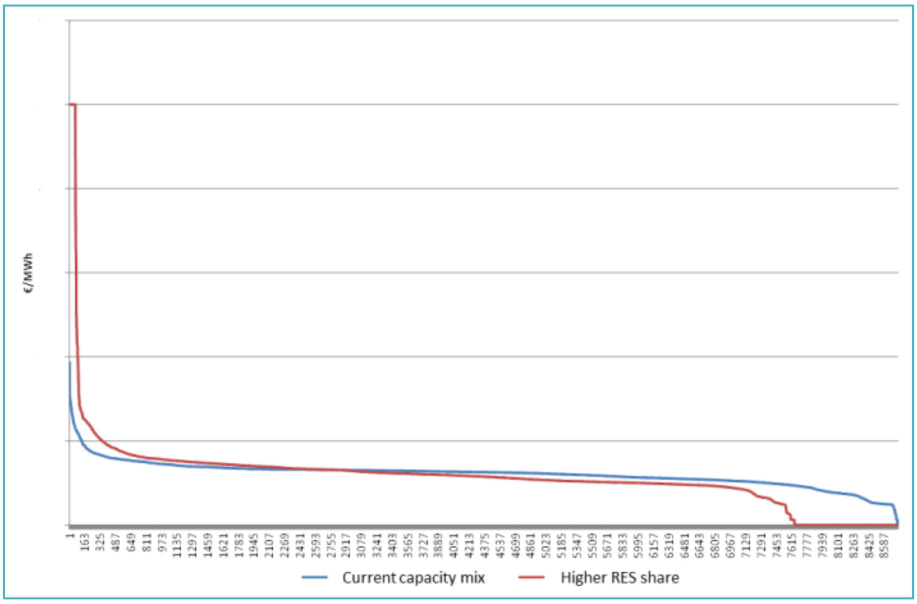
Intuitively, the answer to the "missing money problem" is to remove the identified imperfections, i.e. to expose demand to hourly prices and thereby increase demand response. If demand is price elastic, prices may be allowed to increase in scarcity situations until demand is sufficiently reduced so that the market clears. Hence, the market can always be relied upon to balance supply. If consumers can be exposed to short term price signals and demand side participation in the market can be

---

[5] Even in markets where the official price cap is not binding, system operators may activate several measures in times of scarcity that may affect prices and thus generators' revenues and scarcity signals (cf. Roques, 2007).

enhanced, regulatory intervention in the price formation in scarcity situations could be minimized and the “missing money problem” reduced. If scarcity prices can form more freely, incentives for optimal investments in generation capacity and demand response should result. Hence, it is essential to provide efficient price formation, to expose end-users to hourly prices and to facilitate demand-side participation in energy markets.

Figure 4: Change in duration curve with increased RES generation



Source: The-MA model runs[6]

Proponents of capacity mechanisms may be divided into two camps: Those who hold that energy-only markets are fundamentally not sufficient to induce the right investments, and those who hold that capacity mechanisms are primarily needed in the transition phase until the target model is fully implemented, markets are fully integrated and the framework conditions for the market are stabilized.

Proponents of the *permanent* need for capacity mechanisms argue that energy-only markets exhibit inherent market failures implying that energy-only markets cannot be relied upon to secure capacity adequacy at all times (e.g., Cramton and Ockenfels, 2011a; de Vries and Heijnen, 2008; Batlle, 2012) without running into market power problems in scarcity situations. In addition to missing short term demand response, demand and supply has to be balanced in real-time. On the other hand it takes several years to increase capacity. (The arguments are more formally presented in Appendix 1.) They argue that since investors are risk-averse, investments in new capacity tend to be realized too late, and consequently short term security of supply requirements will be compromised. Security of supply is a common good: If generation and consumption does not balance in real-time, voltage drops and power is lost for all consumers in a smaller or larger area. Hence, the market design should include additional provisions for long term capacity adequacy.

Proponents of capacity mechanisms as a *temporary* measure (such as Roques, 2007) argue that the energy-only market may be able to produce adequate

---

[6] The-MA is a power market model covering the Nordic and NWE markets.

investment signals, provided that a number of other barriers for investments are removed.

As pointed out by Meulman and Méray (2012) it is also difficult to draw firm conclusions about the need for capacity mechanisms based on the existing academic literature. Various desk studies yield different results: "Some, favouring energy-only markets or a Strategic reserve focus on the draw-backs of Capacity Markets. Others, favouring Capacity Markets (particularly Reliability Options,) focus primarily on the efficiency benefits and tend to gloss over the implementation and application risks from regulatory measures."

4.4 What capacity mechanisms can and cannot do

I the following we discuss the reasons why capacity adequacy is currently a concern in some European markets, to what extent this concern may be alleviated by implementation of capacity mechanisms, and how capacity mechanisms may introduce new challenges and market inefficiencies.

4.4.1 Current and future investment environment

As explained in chapter 1, the European electricity market is undergoing a profound transformation when it comes to market design, market integration and generation mix. These changes provide a whole new investment environment for electricity companies. In addition to these general trends, the growth in electricity demand is reduced, and old nuclear and coal power capacity built in the 70ies and 80ies needs to be replaced in the coming decade. Moreover, the outcome of international climate policy negotiations and the development in European climate polices beyond 2020 remain largely undetermined. All this means that investors need to decide what to invest in and how much investment is needed in a period characterized by huge uncertainty about future market and policy framework.

As investment decisions depend on business expectations by power generators, investments may be hindered by a number of market and non-market barriers. The *current* investment environment is challenging due to a variety of uncertainties linked to the energy transition:

1. *Climate policy uncertainty:* The processes of climate policy negotiations and future climate policy design are slowly proceeding and the long term outcome in terms of targets and measures is uncertain, including framework conditions for renewable generation, carbon pricing and regional vs. global policies.
2. *Market uncertainty:* Market integration is evolving, but the long term implications are still uncertain. This is linked to the impact of system challenges, the impact and implementation of flow-based market coupling and the degree of physical market integration. Market uncertainties also include the developments in gas markets generally, the role of gas in the low carbon energy system, and the impacts of implementation of IEM on European gas prices.
3. *Regulatory uncertainty:* Market design, where the outcome of changes in mechanisms such as flexibility payments, increased demand side participation, improved TSO payment mechanisms for system (operation) services, etc., is not known.

4 *Technology and cost development:* Development and introduction of technologies may change price structures and capacity needs and payment, cf. the rapid introduction and cost reductions seen in solar power in recent years.

5 *Economic situation in Europe:* General economic and financial conditions which influence investors' decisions also in the power sector.

Notably, the energy-only target model has not yet been implemented to its full extent (cf. the description of the target model above), generation capacity is rapidly changing due to climate policies in general and expansion of renewable generation capacity in particular, whereas other system characteristics such as demand response, locational price signals, transmission capacity and markets for system services and balancing are not yet adequately developed. The current out-of-equilibrium market prices combined with extensive uncertainty about future climate policies are the main reasons for lack of investments in new generation capacity.

In this situation, it is not possible on an empirical basis to determine whether the energy-only market design of the target model is going to yield adequate investment incentives. In addition, existing capacity mechanisms vary substantially between systems and have not been in existence very long.

Although the target model is likely to improve the short term market efficiency and the long term investment signals compared to the current situation, the transition of the energy system to a low-carbon state, and the associated market interventions and uncertainty, may affect the market for a long time to come. Hence, although capacity mechanisms may not be needed to optimize capacity and operation in the long term energy-only market, it cannot be ruled out that capacity mechanisms may be useful and necessary in the transition phase, even after the target model has been successfully implemented. (The long term is very long in the electricity market.)

4.4.2 Missing money compensation

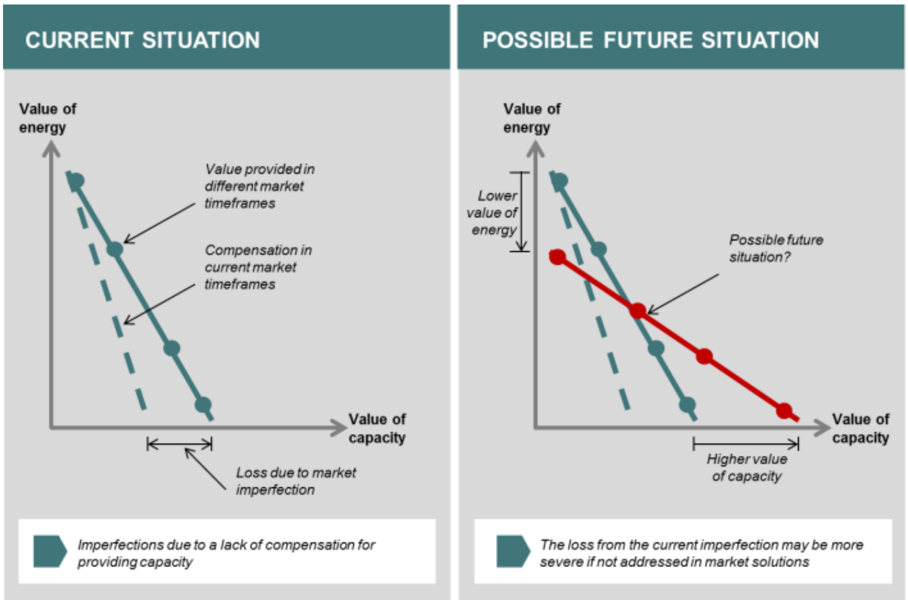
It is difficult to accurately determine the optimal solution in an integrated electricity system for a number of reasons: it is difficult to accurately forecast demand and supply, in addition to policy concerns and measures, including such factors as fuel prices, demand profiles and response, climate policies, security of supply challenges, etc. The target model implies that the European electricity system should be developed as an integrated system across national borders and control zones. The system is however large and complex, and there are long lead-times in the development of new infrastructure and market solutions. The role of TSOs and operation and planning procedures, including security margins, differ between countries and market areas. Whereas market coupling and the target model provide increased coordination and harmonization between market participants, which also implies improved price signals and tools for operation and development of the grid, there are still cooperation challenges that need to be addressed when it comes to more integrated operation and development of the European grid.

Whereas capacity mechanisms are generally introduced as a means to ensure sufficient peak capacity, the reasons why TSOs and authorities fear that the market will not provide adequate capacity differ. As discussed above, the concerns may be related to short term "shocks" for which the markets need time to adjust, both when it comes to investments in generation capacity and infrastructure, as well as adjustments in market design and incentive schemes.

However, the transition to a low-carbon electricity system also exposes the electricity system to new challenges. The increasing shares of intermittent and weather-dependent generation capacity mean that capacity adequacy concerns are increasingly associated with the supply of adequate flexibility and reliability of capacity. The system needs to be able to handle rapid changes in wind power generation on short notice and longer periods with low wind and solar generation as well, in addition to the "traditional" peak load provision. Roques (2007) argues that inadequate payments for system services is part of the "missing money problem". If this is the case, then the increase in intermittency is set to amplify this problem as the value of such services increase, while the value of energy may decrease.

Figure 5 illustrates that capacity payment elements (flexibility, back-up reserves, balancing resources and ancillary services) may become more important in the future market with larger shares of intermittent and "non-controllable" capacity like wind and solar generation. The panel to the left also illustrates that not all the capacity-related values of capacity is remunerated in current market designs. The implications of this are likely to become more critical in the future system when capacity-related services become more valuable.

Figure 5: Discrepancy between the value and the revenues from supply of energy and capacity in the current and future market (illustrative)



Hence, it can be argued that a growing part of the "missing money problem" does not stem from interventions in peak load pricing – that capacity mechanisms aim to compensate – but from inadequate or lacking payments for system services. A lack of such payments distorts the investments in capacity with different characteristics. The resulting regulatory failure will not be corrected by general capacity mechanisms, and should be targeted directly.

4.4.3 Impact of asymmetric capacity mechanisms

Capacity mechanisms affect the market via their impact on short term pricing and via their impact on long term investments. In an integrated market, trade is affected and impacts in one market spill over to adjacent market as well. Whether capacity mechanisms adversely affect the IEM however, depends on whether capacity mechanisms merely correct external effects, i.e. bring the market closer to the optimal solution, or represents a market intervention or distortion that brings the market further away from (or beyond) the optimal solution. Do we go from "too little, too late" to "too much, too early"? The answer to this question depends on the actual design and coordination of capacity mechanisms.

In the literature, there is little discussion of the impact of capacity mechanisms on cross-border trade. Meulman and Méray (2012) points out several ways in which capacity mechanisms in individual markets can negatively affect the IEM and cross-border trade, with or without cross-border participation. According to their view capacity mechanisms may adversely affect cross-border trade whether they allow cross-border participation or not:

Capacity mechanisms that do not allow for cross-border participation may yield:

1. Reduced cross-border competition and efficiency. Domestic capacity will be put at a competitive advantage compared to non-domestic capacity.
2. Over-capacity in a larger area. If all or several countries implement capacity mechanisms without considering the overall capacity situation, the result may be a much higher total capacity margin than what is need from a total capacity adequacy perspective. Hence, total system costs increase.
3. Spill-over (external) effect in terms of prices and supply availability. Increased capacity in one market due to domestic capacity mechanisms impacts prices and thereby trade with adjacent market areas.
4. Reduced value of cross border interconnections.

Capacity mechanisms that do allow for cross-border participation may yield:

1. Reduced available interconnector capacity (ATC) in the energy market as non-domestic capacity may need to book interconnection capacity to be eligible to participate in the capacity mechanism.
2. Reduced capacity adequacy in the home market if non-domestic capacity is reserved for the market with a capacity mechanism (or a more favourable capacity payment).

Cepeda and Finon (2011) analyse the impacts of a capacity mechanism on cross-border trade and long term investments in a two-country model simulating market developments for a 30-year period. The electricity systems of the two countries are linked by physical interconnection capacity and trade is determined by implicit market coupling in the DAM. The electricity systems in the two countries are equal at the outset. The model is used to analyse how implementation of a price cap and a capacity mechanism in one market affect price developments and investment cycles in both markets. The benchmark for the analysis is the symmetric development if energy-only markets apply in both markets.

The results show that the implementation of a price cap in one market shifts some of the investments to the other market which in turn yields consistently higher prices and lower reserve margins in the first market. If the market with the price cap implements a capacity mechanism (capacity obligation)[7] to compensate the loss associated with the price cap, however, investments are shifted from the country with a pure energy-only market to the country with capacity regulations. The market without capacity regulations is found to free ride on the capacity

---

[7] The suppliers are obliged to commit to a capacity level covering their peak demand, plus a reserve margin of 10-15 per cent.

mechanism in the neighbouring market: Reserve margins decline, but the loss of load expectation is marginally improved.

Asymmetric implementation of capacity regulations distorts investment incentives, and impacts prices and trade. An interesting result is that the distortion is increased if the interconnector capacity between the two markets is increased, i.e. in the presence of asymmetric capacity mechanisms, the total social efficiency of the integrated markets decrease when the market integration increases.

Capacity mechanisms, if not carefully designed, may introduce new market distortions when it comes to the overall capacity level and the incentives for investments in different types of capacity and location of capacity within a market. Additional distortions may occur in an integrated market, especially if asymmetric capacity mechanisms are implemented. Hence, there is a trade-off between the possible market failures of the energy-only market and the possible failures of energy-only markets.

The effects of asymmetric capacity mechanisms depend on what kind of capacity mechanism is implemented. We discuss this further in chapter 5.

4.5 Concluding remarks: Policy considerations?

The combination of uncertainties regarding policies, market integration, market regulations and technology mean that it is challenging for both market actors and authorities to determine the optimal future level and mix of capacity. It is difficult from both a theoretical and empirical point of view to accurately determine the optimal development in electricity generation in an integrated electricity system since it is difficult to accurately forecast demand and supply given the uncertainties related to policies, measures, fuel prices, demand profiles, levels of demand response, security of supply challenges, etc. On the one hand, the market is superior when it comes to adjusting and adapting to changes in market fundamentals such as fuel prices and technology break-through. On the other hand, however, the market may be crippled by over-whelming regulatory and policy uncertainty.

The target model implies that the European electricity system should be developed as an integrated system across national borders and control zones. The system is however large and complex, there are long lead-times in the development of new infrastructure and market solutions. The role of TSOs and the operational and planning procedures, including security margins, differ between countries and market areas.

Scholars and policy makers disagree on the need for capacity mechanisms in the long term. There is however no disagreement on the need to improve the functioning of short term markets and cross-border trade. Even proponents of permanent capacity mechanisms argue that short term or temporary barriers to investments should be removed before capacity mechanisms are introduced. Indeed, the capacity mechanisms preferred by academics, rely on well-functioning short term markets. On the other hand, proponents of temporary solutions admit that the energy-only market may not be able to provide capacity adequacy in the future system.

In order to reduce investment barriers, capacity mechanisms are not likely to be the answer to all challenges. In addition, it is crucial to make short term markets work well, to reduce political uncertainties to the extent possible, and to carefully develop rules for when interventions in the market for the sake of capacity adequacy are acceptable, and how such interventions should be carried out.

5 Different capacity mechanisms

This chapter gives an overview of different kinds of capacity mechanisms and existing and proposed capacity mechanisms in Europe. Capacity mechanisms may be divided into Capacity Payments, Strategic Reserves, and Capacity Markets. Existing capacity mechanisms are to a large extent tailored to the specific market situation, and there is a large variation in the design features of existing schemes. The experience with cross-border participation is limited at best.

5.1 Brief taxonomy of capacity mechanisms

Capacity regulations, which aim at attenuating the intensity of investment cycles, consider that the electricity market is implicitly split in two markets for two relatively distinct commodities: the "energy" market which regards the electricity commodity and the "capacity" market which concerns availability of generation capacity. Capacity regulations aim at increasing the availability of generation capacity, particularly in scarcity and peak situations, i.e. the capacity adequacy in the system.

In the overview below we distinguish between three main models of capacity mechanisms:

1. Capacity payments, in which capacity receives a fixed payment to be available in the market
2. Strategic reserves, in which targeted capacity is compensated to be kept in reserve and is not bid into the market
3. Capacity markets, in which a capacity requirement for the market is defined and the compensation paid is determined by supply and demand of capacity

All main types may be designed in many different fashions (cf. section 3.2). The specific design may be crucial for the market effects of the mechanism. Important characteristics include:

1. Whether mechanisms are market wide or targeted: Differentiation between different kinds of capacity, and demand side participation.
2. Whether obligations refer to the present or the future, or both.
3. How the level of (adequate) capacity is determined.
4. How availability is documented or certified.
5. How the capacity payment is determined: Whether prices are set administratively, according to auctions or in the market.
6. How the costs are allocated: Whether the capacity obligation is imposed on the TSO (centralized) or on load serving entities (LSE) (decentralized).
7. The rules for operation and activation of the capacity, including participation in energy markets.

5.1.1 Capacity payments

The simplest type of capacity mechanism is to provide direct, fixed capacity payments in addition to revenues accruing from energy sales in the market. The direct capacity payment strengthens the incentives to invest in new capacity and to maintain old capacity.[8]

The capacity payment is defined and controlled by a regulatory body and offers great flexibility in terms of differentiation of payments and targeting of payments. The capacity payment may apply to all capacity or to specific plant types. Alternatively it can be differentiated between capacity suppliers, e.g. between base-load and peak capacity, existing and new capacity, etc. Demand side resources are typically not eligible for capacity payments.

Capacity payments may refer only to the present, but may also apply (exclusively) to new capacity. In the latter case, the payment is explicitly aimed at amplifying the investment incentives for new capacity.

Capacity payments do not require definition of a specific reliability margin. The level of payment may however be made subject to the actual reserve margin (dynamic capacity payments), in which case one must define the range of reserve margin that the payment applies for. As the capacity payment level is typically defined by a regulatory body, an explicit reliability standard or reserve obligation is not imposed on the TSO or on LSEs. The costs of capacity payments are covered by levies collected by LSEs. The fee is typically proportional to the amount of electricity supplied, usually in the form of an uplift charge on energy purchased. The uplift charge may be dynamic or fixed.

The generation from the capacity that receives capacity payments is sold in the wholesale market, i.e. it on the power exchange or through bilateral contracts. Capacity payments are often combined with price caps in the wholesale markets in order to avoid extreme price spikes.

According to Brunekreeft et.al. (2012) capacity payments have several drawbacks: It is difficult to determine the right level of payment and to determine the effect of the payments, and the mechanism provides no guarantee against price spikes or market power. Another important drawback is that capacity payments are very inaccurate, it is not clear what consumers pay for and what they get in return.

5.1.2 Strategic reserves

Another simple capacity mechanism is to make contracts for long term reserve capacity to ensure access to sufficient reserve capacity, so-called strategic reserves. Generation capacity in the strategic reserve is held as back-up, ready to generate when called upon, and is not bid into the market. The strategic reserve is generally activated only if the (day-ahead) market is not able to cover demand.

Capacity for strategic reserve is procured through a tendering procedure for a specified amount of capacity (in MW). Hence, a strategic reserve is limited to the procured capacity and the capacity or demand response procured must be able to respond when called upon. The strategic reserve may consist of existing or new generation built for the purpose of reserve capacity, and may include demand resources.[9]

---

[8] The first real-world example of this market design was the initial UK liberalized market which lasted for approximately ten years. Examples of currently operating capacity payments are found in Spain, Greece, Ireland, Chile, Colombia and Peru.

[9] The Swedish strategic reserve has a provision to gradually increase the share of demand side participation to 100 per cent in 2020.

Strategic reserves may be procured on a year to year basis or contracted for longer-term maintenance.

The strategic reserve is implemented by imposing an obligation on a reliability ensuring body, usually the TSO, much in the same way as the TSO is obliged to obtain ancillary services. The specification of the amount and type of capacity (e.g. peak units) may be based on a so-called reliability study. The strategic reserve may also contain capacity that is owned by the TSO.

The compensation schemes are specified in the tendering documents and may vary from case to case. Strategic reserve schemes may involve direct payments, payments in the form of an option or mixed forms. The cost of strategic reserve schemes are typically covered through system charges included in the transmission tariff.

Typically, the TSO reserves the right to call upon the strategic reserve capacity when required. The generation capacity included in the strategic reserve cannot be bid into the wholesale market. Demand side resources are bid into the market, but obliged to reduce consumption to a specified level when called upon. Strategic reserve contracts contain provisions for notification time, duration of activation, compensation during activation, etc.

The market impacts of the strategic reserve depend on the rules for activation: When is it activated and, when it is activated, how does it affect market prices? Typically the activation of the reserve is linked to a predetermined threshold price or trigger price. This threshold or trigger price acts as a price cap in the market. Ideally the threshold price should be set at the level of VOLL (Brunekreeft et.al., 2011). Alternatively, the activation of the strategic reserve could be made dependent on the physical balance in the market, i.e. only be activated when a market balance cannot be found. In that case, the resulting market price must be administratively determined, e.g. as the highest market bid plus an uplift. This market price will impact interconnector revenues.

Strategic reserves may incentivize early retirement of capacity (into the strategic reserve). Although strategic reserves may be very accurately targeted (type, location, duration, etc.), there is a risk that one pays for capacity and interruptible load that would even be available without the mechanism.

5.1.3 Capacity markets

Capacity markets are schemes in which capacity adequacy is secured by various market based measures. Within this category it is useful to distinguish between capacity obligations, typically imposed on LSEs, centralized capacity auctions, and reliability options.

Capacity obligations

A capacity obligation is a decentralized measure that normally places reserve obligations on LSEs. The obligations specifically require that LSEs contract for generation capacity corresponding to a certain percentage above the volume of their contracted or expected supply obligations.

Capacity obligations may be met by holding a volume of capacity certificates or through ownership of generation plant and/or long term contracts with generators. Capacity market designs without any form of capacity certificate are however rather old market designs which have been applied, but subsequently abandoned, in the power pools of the eastern states of USA.

Capacity obligation schemes may apply to the present volume of load served or to load volumes expected to be served (or declared to be served) at some time in the future. In the former case contracting for capacity may be done on a "spot" basis, whereas in the latter case the capacity market is similar to a forward market. It is not clear how a forward obligation can be compatible with a competitive retail market.

Even if the obligation is imposed for present supply volumes, it may be in the LSEs' interest to conclude long term contracts with generators for some parts of their expected future volume of sales; however, they may conclude "spot" contracts with generators to adjust their position and fulfil the present time obligations.[10]

Capacity obligation schemes imply centralized calculation or determination of a required reliability margin by a regulatory authority, usually set at a certain percentage above peak supply obligations. Hence, capacity obligations do not require a central prediction of future demand. Different rules for calculation of the capacity obligation may apply, however.

The LSEs can document fulfilment of the obligation through ownership of power plants or bilateral contracting with power generators. The format of the required documentation may be standardized, e.g. as a capacity certificate. In this case, the LSEs are required to deposit a sufficient amount of capacity certificates to a centrally managed register, usually annually.

Controlling the obligation of suppliers for holding capacities is more difficult in capacity markets with explicit forward obligations. In this case, the LSEs have to demonstrate that they have acquired sufficient power capacities several years in advance. If the certificates are tradable, however, the LSEs can adjust their position in terms of certificate holding when expectations about future sales change.

Rules may apply for the approval of capacity in terms of reliability, etc., or there may be a system of standardized certificates. Standardized certificates specify the required availability of the power plant or part of a power plant (duration, notification time, etc.). Demand side resources may be included as interruptible load contracts.

In return for the capacity certificate payment, the generator is required to make the contracted capacity available to the market in shortage periods (shortage periods may be defined in terms of a threshold price). Failure to make capacity available results in a fine.

Capacity providers are paid for the issued capacity certificates (or bilateral contract) and the LSEs pass on the costs of the buying certificates to end users.

Standardized capacity certificates allow for flexibility in the way customer serving entities comply with their capacity obligations. For flexibility purposes the capacity certificates are tradable in some market designs. Trade may take place among the customer serving entities on a bilateral basis or in a centrally organized market for capacity certificates. Hence, the price for capacity certificates is determined by supply and demand in the market.

Such a centralized capacity certificate market can be either organized on a voluntary basis (similarly to private power exchanges) or by the body ensuring reliability (e.g. the TSO). Hybrid systems are also possible. If centrally organized,

---

[10] To control that the share of spot contracting remains marginal, regulators in some eastern USA markets have moved from present only capacity obligations to include future time obligations.

the aim is to ensure price disclosure and transparency in order to facilitate new entry.

The generator accepts to certify capacity availability in exchange for a current or future payment; so he receives an extra fee for capacity availability in present or future time. In decentralized systems of capacity regulations, the payment contract can take any form agreed bilaterally between the generator and the customer serving entity; for example as an option (call option or other form of option) or a contract for differences (a two-way option).

Capacity contracted under capacity obligations is expected to bid the generation into the wholesale market or sell generation on bilateral contracts, and in particular, to offer capacity to the market in scarcity situations.

Capacity obligations are implemented and have been adapted several times in the PJM market. Some of the experiences are that capacity prices may be volatile and sensitive to gaming, that locational signals should be included and that the mechanism may become very complex, resulting in a substantial bureaucracy.

Capacity auctions

Another form of capacity mechanism which relies on capacity certificates, but does not require capacity obligations on LSEs, is centrally organized capacity auctions. The main difference from capacity obligations is that the procurement process is centralized and the reliability body acts on behalf of total load. Centralized capacity auctions make it easier to standardize the capacity contracts and to get one common, transparent price for capacity obligations. When the capacity market is centralized, the clearing prices are disclosed to market participants, contrary to the decentralized capacity market models in which capacity prices are not necessarily disclosed.

Capacity auctions may be conducted year-by-year, but also for future capacity. Centralized capacity auctions require reliability assessments, i.e. estimates of the total need for capacity including forecasts of peak demand and reserve margins.

In this design, the reliability body auctions standard capacity payment options to generators who receive payment contracts for capacity availability certificates. In principle, interruptible loads may also participate. The regulation includes a procedure for allocation of the reliability costs to LSEs. Usually this allocation is based on administratively set rules (e.g. prorate basis depending on peak load of customers by entity), but it can also be based on auctioning procedures among customer serving entities. In this case a centralised reliability product market is established, and certificates may subsequently be tradable among LSEs.

The auctioning among generators is thus an alternative way of determining the capacity payment price. The auctions can be complex and repetitive in order to ensure cost-effectiveness and market power mitigation.

Reliability options

A reliability option scheme is a variety of centralized capacity auctions. The main difference is the design of the capacity contract. The capacity contracts offered to generators in such auctions typically have the form of a one-way call option which refers to a strike price, usually with reference to the system marginal price of a wholesale market. In this market design, the capacity providers forego the potential (but uncertain) revenues in hours in which the market price in the wholesale market is above the strike price, in exchange for the certain revenues of the option. The consumers on the other hand, pay the option premium and in return avoid prices above the strike price.

The reliability option is designed to provide incentives for generators to invest in the right capacity for the market as the hours with high prices are an important part of all generators' revenues, and all generators may be eligible to participate in the market. In principle reliability options do not require any provisions as to the kind of capacity or general reliability of capacity that can participate in the market. The reliability option is a financial instrument and penalties only apply if the contracted capacity cannot provide generation in hours when the market price exceeds the strike price. The penalty may be equal to or higher than the market price.

Reliability options require a well-functioning wholesale market and a market-wide system price. Actually, the reliability is directly associated with bidding in the wholesale market. Well-functioning reliability option schemes do however depend on the existence of a wholesale market producing a reliable reference price as the strike price of the reliability options are linked to market prices.

Design challenges include eligibility requirements in terms of availability of contracted plant, setting the future capacity margin right, defining the right strike price, defining the duration of the scheme, and auction design. Advocates of reliability options argue that market wide reliability option schemes, even if the reliability margin is set too high, yields incentives that provide an optimal long term capacity mix.

5.1.4 Summary

Table 1 gives an overview of the different capacity mechanism designs and their main features.

Real-life capacity regulations can combine various elements of the above classification, and often do, see next section.

The different capacity mechanism designs partly reflect that there are different motivations for implementation of capacity mechanisms in different cases, and partly that the thinking around the market design has developed in order to address various adverse incentive and cost effects of capacity mechanisms. Capacity payments may be regarded as subsidies aimed at directly fixing the "missing money problem", i.e. increasing investment incentives by increasing the expected revenues for generators. Strategic reserves on the other hand may be regarded as an answer to need to secure and control a certain volume of reserve capacity in case the market is not able to find a solution (equalize demand and supply). Capacity markets can be seen as refinements of capacity payments. In capacity obligation schemes regulators determine the reserve margin, whereas the market agents, in a decentralized manner, find the least cost way of fulfilling the requirement. Central auctions may ensure greater transparency and standardization of capacity, i.e. greater cost-efficiency than decentralized markets. Neither capacity obligations nor capacity auctions mitigate market power in scarcity situations, however.

Reliability options are explicitly aimed at creating optimal long term investment incentives that correct for the alleged market failures of (optimal) energy-only market designs. By their very nature, reliability options would be implemented for the long term as integrated elements of optimal electricity market design, and are not aimed at fixing temporary challenges in the market.

The more sophisticated the capacity mechanisms are, the more accurate they may be, but at the same time, the more complex they become.

Table 2: Summary table of capacity mechanisms

	Capacity payment	Strategic reserve	Capacity markets		
			Capacity obligation	Capacity auction	Reliability option
Market wide or targeted	Can be both Loads not included	Targeted. Loads may be included	Both, but typically market wide	Both, but typically market wide	Both, but typically market wide
Present or future obligation	May be both	May be both	May be both Incentives for long term contracts	May be both	Future, specifically designed to strengthen investment incentives
Adequacy calculation	Not required	Required (reserve margin)	Required (reserve margin)	Required (total capacity)	Required (total capacity)
Reliability requirements	Not required	Required	Rules for approval / standard certificates	Rules for approval / standard certificates	Linked to market price (strike price)
Payment	Set by regulator May depend on peak reserve margin	By tender / auction	Market based: Bilateral contracts or certificate trade	Through centralized auction	Through centralized auction
Cost allocation	Fee on LSEs (uplift on energy charges)	System charges	Charge on energy sales by LSEs	Charge on energy sales, peak load or system charges	Charge on consumers (peak load)
Rules for activation	None. Generation sold in wholesale market	Activated on call Only loads bid in market	Expected to bid in wholesale markets	Expected to bid in wholesale markets	Required to bid in wholesale market when price exceeds strike price

5.2 Existing capacity mechanisms

The energy-only market design is a common model in Europe (UK, France, Germany, Belgium, the Netherlands) and in some US states. However, regulatory provisions about reliability of power supply are often implemented even in these markets, although these provisions often refer only to ancillary services. Capacity mechanisms in various forms and of varying scope have been implemented in several European states. Table 3 shows an overview over the existing capacity mechanisms in Europe.

Table 3: Existing capacity mechanism in Europe

	Design	Country (name)	Market wide/Targeted	Cross-border participation
Quantity based	Strategic reserve	Sweden/Finland (Peak load reserve11)	Targeted	No
		Poland (Operated by TSO)	Targeted	No
		Norway (Operated by TSO)	Targeted	No
Price based	Capacity payments	Ireland/Northern Ireland (Capacity Payment Mechanism)	Targeted	Collaboration
		Spain/Portugal (Pagos por capacidad)	Targeted	No
		Italy	Targeted	No
		Greece	Targeted	No

Sources: Süßenbacher et.al. (2011), Cramton and Ockenfels (2011b), project analysis

5.2.1 Greece

In 2005 Greece adopted a capacity obligation scheme based on tradable certificates and contracts for differences. The capacity obligation was to ensure long term capacity availability and imposed an obligation on customer supplying entities[12] to present sufficient guarantees for long term investments in capacity.

However, the capacity obligation system was never implemented in practice, as a less complex, temporary capacity payment mechanism was seen as more attractive (especially to the producers) and was introduced in parallel to the capacity obligation scheme in 2006. The capacity payment is flat on all capacities at a level determined by a Ministerial decree, based on a proposal by the regulator, and the total available capacity (UCAP) of all fossil fuel and hydro power plants.[13] At present the capacity payment is calculated at around 41.000 €/MW-year and is distributed to the power plants irrespective of their actual operation, but under the provision of being available at all times.

---

[11] Reserves are not available for the market on ordinary terms. The TSOs control the peak load reserves and decide when they should be activated.

[12] Each supplier and self-supplying customer

[13] Customer supplying entities are requested to pay a capacity obligation fee of 45.000 € per year, determined by the Ministerial decree, multiplied by the average energy consumed during peak demand periods and adjusted by a capacity reserve margin factor. The total amount gathered is evenly distributed among all available capacity participating in this scheme.

In 2013 a reform of the capacity payment system was proposed by the regulator. According to the draft proposal, currently under consultation, the future level of the capacity payment will be differentiated by plant depending on plant efficiency, age and degree of operation in the wholesale market.

5.2.2 Ireland

Ireland first introduced a capacity payment scheme in 2003. The purpose of the scheme was to ensure security of electricity supply in view of expected rapid electricity demand growth and weak interconnection capacity to other markets. Generators that would undertake the construction of new generation capacity received capacity payments based on their capacity availability according to up to ten year long Capacity and Differences Agreements (CADA) (EU, 2003). The CADA scheme applies to two gas generation plants with a combined capacity of 560 MW.

The Single Electricity Market (SEM) went live in 2007 with an explicit capacity payment mechanism (CPM), also including Northern Ireland. The main rationale for its establishment was to encourage provision of adequate capacity. Each year a total capacity payment called the Annual Capacity Payment Sum (ACPS) is made available to generators. The ACPS pot is calculated by the regulator and consists of two elements:

- Annual cost per kW of a best new entrant peaking generator
- A measure of the total kW of capacity required to meet generation security standard

For 2013 the Commission for Energy Regulation in Ireland has calculated an ACPS of €529 million. The annual pot is divided into monthly pots weighted by peak to trough demand and with a larger pot for months with higher levels of demand. Each monthly pot is in turn divided into several pots which are allocated to generators. 30 % of the ACPS is allocated as a fixed payment based on the year ahead forecasted demand, 40 % is based on ex ante month ahead forecasts for load, security margins and availability, and 30 % ex post based on actual load, security margins and availability. In order to mitigate high price volatility, a flattening factor is applied (Pöyry, 2011).

Within the SEM Committee there is continued support for the appropriateness of a capacity mechanism in Ireland. However there are some concerns over whether the current design has been meeting the objectives efficiently and how robust it will be to changing market structures. In a review of the current design, Pöyry (2011) finds that the overall performance is acceptable, but points out several areas for concern such as;

- There is significant uncertainty in future payments due to annual changes in total capacity payment available to generators, which increases the risks for new entrants
- The payment over-reward intermittent generators and therefore does not provide the right incentives to plants available during peak.
- There are concerns over the level of exit inefficiencies, particularly plants with low load factors.
- The level of payments is not always highest when capacity is scare.

The analysis does not expect any significant changes in the performance of the current design if the share of renewable energy increases.

5.2.3 Italy

After the black-out of June 2003, the Italian Government was concerned about scarcity of reserve generation capacity in Italy. In October 2003 legislation empowered the Italian Government to take measures to guarantee the adequacy of the national electricity system. In April 2004 a temporary capacity payment was implemented. This scheme is still running. The mechanism provides compensation to producers who make back-up generation capacity available during critical days. The remuneration level is determined by the TSO depending on tightness of supply for each hour of the day; the compensation is established in advance, relying on forecasts rather than the actual supply/demand balance.

There are on-going discussions about maintaining the temporary mechanism until 2017 (depending on Ministerial decree) or introducing a capacity mechanism based on reliability options between generators and the transmission system operator. There seems to be a consensus estimate of a total annual cost of the new capacity payment of €1.0bn, given an option price of € 24,200/MW/year" (A2A group, 2012). The new resolution requires that the TSO, Terna, prepares a proposal to regulate the remuneration of production capacity availability, which is subsequently to be approved by the Authority of Electricity and Gas (Aeeg) and the Ministry for Economic Development. The detailed proposal by Terna was under public consultation until February 2013.

5.2.4 Spain and Portugal

Spain has had a *capacity payment* since the Spanish market was liberalized in 1996. The motivation for capacity payment was the applied price cap and stranded cost compensation for generators.

In 2007 a new system for capacity payments was introduced. The new system introduced *availability services as contracts* between TSO and plants selected for reserve purposes with one year duration and remuneration to new investment (capacity payment) for 10 years operation. The level of remuneration depends on reserve margin requirements estimated by the TSO. The remuneration is a capacity charge for *new* plants, which is a contracted price per MW for each plant. New plants receive a maximum of 28,000 €/MW per year for the first ten years after entry. The payment is decided by the regulator based on a capacity price curve, as a function of the reserve margin, in the year of entry (Cramton and Ockenfels, 2011b). This means that the regulator sets the price of capacity and the market chooses its amount by entry.

Portugal introduced the same system for capacity payments in 2010.

5.2.5 Sweden and Finland

Finland and Sweden apply capacity mechanisms based on strategic reserves. The respective system operators (or the agency responsible for ensuring security of supply) procure capacity contracts through auctions. The auctions are open for domestic generation and demand. Power plants partly or completely dedicated to the strategic reserve are only bid into the DAM or IDM markets in curtailment situations, i.e. when the market is unable to equal demand and supply. Then the plants are called to generate by the system operator. The plants are remunerated through the capacity contracts. Contracted demand resources can be bid into the DAM in normal market situations.

The Swedish reserve is contracted annually for the coming winter months and includes demand side resources. The reserve for 2012 will be a maximum of 1 759 MW, and will gradually be reduced to 750 MW and phased out in 2020.[14] The share of demand side participation is set to gradually increase. When the strategic resource is called upon, the market price is set equal to the bid of the highest commercial bidder plus an uplift of 0.1 Euro per MWh.

The Finnish reserve is contracted biannually and in 2012 contained 600 MW in peak load reserve, consisting of (old) oil and coal plant units. Three power plants were selected for the peak load capacity reserve for the period of 1 October 2011 to 30 June 2013.[15]

5.2.6 Poland

Poland currently has a reserve service that resembles a strategic reserve. The arrangement includes 1700 MW of pumped storage power plants contracted by the TSO. This reserve is however not expected to be sufficient in coming years.

The Polish market redesign includes implementation of a capacity mechanism, most probably in the form of a capacity market. The adequacy situation is expected to become challenging in the near future and the discussion of capacity remuneration has high priority. A full-fledged, long-term capacity market is an option under consideration. The exact scope and details are under discussion, but the final decisions are yet to be made.

5.2.7 International experience

Capacity mechanisms have been more widely used in the US than in Europe. In Eastern USA markets (PJM, MUISO, ISO-NE) the capacity obligations are calculated for selected peak load demands expected to be served by each customer serving entity; the generating units issue capacity certificates depending on available capacity which is determined taking into account forced and unforced outages according to statistics collected in a TSO registry; each customer serving entity has to demonstrate every year the holding of sufficient amount of capacity certificates compared against its obligation; to hold such certificates, the customer serving entity is supposed to conclude a contract (free, not regulated) with generators; capacity certificates are tradable.

PJM is a regional transmission organization administering the electricity market in an area that comprises 13 states in the eastern USA. The PJM market incorporates various regulatory policies, including price caps, which directly affect peak load pricing and revenues during scarcity. This leads to the classic “missing money problem” issue for investors and consequently an explicit capacity remuneration

---

[14] http://www.svk.se/Energimarknaden/El/Effektreserv/

[15] http://www.fingrid.fi/en/customers/additional%20services/peakloadcapacity/Pages/default.aspx

mechanism has always been in place (Cramton and Ockenfels, 2011b). The current PJM capacity mechanism is called the Reliability Pricing Model (RPM), established in 2007. RPM is a market wide capacity obligation. All retailers have a capacity obligation and can meet this through self-supply, bilateral contracts or auction. All generators can qualify for the capacity market, and the contract duration for new plant is three years and one year for existing plants. The contract price is set in a centralized auction.

Colombia (obligación de energía firme) has a capacity market (options). The motivation for the capacity market in Colombia was energy scarcity due to the seasonal variation in a hydro dominated electricity market. The Colombian product is a firm energy obligation that fixes a price for 20 years. Generators have to supply the market with an amount of energy to cover demand when the market price exceeds the strike price set administratively (Cramton and Ockenfels, 2011b). the regulator or the TSO organises auctions of capacity contracts to conclude with generators (current and potentially new); the auctions are organised on behalf of all customer serving entities, who reimburse the costs on prorate basis (depending on the shares of serving load in peak load for example); the auctions may have complex rules, for example with auctioning rounds along an administratively-set decreasing demand curve; the capacity contracts have the form of a one-way option (reliability option) which defines a strike price according to a market-based underlying price (for example the system marginal price of the wholesale market); in time periods with market prices exceeding the strike price, contracted generators are then remunerated at strike price provided that they are available to operate; such generators do not get revenues at the level of the high spot price, which are surrounded by uncertainty, but instead get certain revenues based on the lower strike price; the auctions include time-related provisions for accommodating both existing and new plants.

Chile has applied capacity payments since 1982. Capacity payments are an extra payment to all available capacities; availability estimated using contribution of plant availability to system reliability.

Argentina (since 1995) with different payments for operating plants (using loss of load probability but applied only to operating plants) and for reserve plants (plants operating rarely but estimated essential for system reserves); reformed after 2005 to unify remuneration to plants operating and plants available during peak demand.

ISO-New England (US) has a new capacity regulation in place, that follows a scheme similar to that applied in Colombia; demand participation is expected (demand curtailment) to take part in the reliability auctions; locational price signals were also introduced.

In Brazil the system operator auctions reliability contracts on an ad hoc basis depending on forecasts about possible energy scarcity; the auctions are separated for existing and for new plants and differ in terms of duration length.

Western Australia: demand serving entities are obliged to buy capacity credits to cover their share in total system reserve requirements which are determined by the TSO annually.

Guatemala: obligation of retailers to hold capacity credits in sufficient amount compared to expected future sales; capacity credits are determine by the regulator for each plant type.

Other countries applying direct capacity payments: South Korea, Colombia (replaced by reliability charges), Peru, Dominican Republic. Several other Latin

American countries are introducing reliability option auctioning in their capacity regulation designs.

5.2.8 Cost of existing mechanisms

There are several methods to measure the cost of a capacity mechanism. Generally the cost associated with a mechanism should be reviewed in relation to the overall cost of the electricity system, i.e. energy payments, transmission tariffs, balancing costs, value of lost load plus the capacity payments. A general objective is to implement mechanisms at minimum cost to consumers. It is not the objective for this study to make a comprehensive cost impact assessment of exiting capacity mechanisms.

Due to the differences in design and scope, available figures are not directly comparable across countries. However, Table 4 gives a general overview of cost estimates in terms of total annual capacity remuneration, total annual capacity remuneration compared to gross electricity generation and remuneration per committed capacity unit. The numbers in the table are based on recent figures (2011-2013), drawn from several sources and do not include costs associated with ancillary services or balancing markets.

Ireland has the highest capacity cost per gross electricity generation. This reflects that a substantial share of generators' revenues accrue from the capacity payment scheme.

Table 4: Annual capacity cost of existing mechanisms

		Annual cost of capacity remuneration			
	Market design	Total cost Mill. €	Per gross electricity gen. €/MWh	Per committed capacity €/MW/year	Committed capacity MW
Greece	Capacity payment	451	9.18[16]	41,030[17]	11,008[18]
Ireland	Capacity payment	529	14.9	78,000	6,778
Italy	Capacity payment	100 – 160	0.5	-	-
Spain	Capacity payment	758	2.7	30,506	24,847
Sweden	Strategic reserve	12	0.1	6,981	1,726

---

[16] http://www.admie.gr/fileadmin/groups/EDRETH/Monthly_Energy_Reports/energy_201212_GR.pdf

[17] http://www.admie.gr/fileadmin/groups/EDRETH/CAM/Data_CAM_2012-2013_v1.pdf

[18] http://www.admie.gr/fileadmin/groups/EDRETH/CAM/UCAP_12_13.pdf

Finland	Strategic reserve	19	0.3	31,216	600
Norway	Strategic reserve	25	0.2	82,753	300
PJM	Capacity market	4,275	5.5	31,401	136,144

Sources: TSOs, Regulators, Eurostat.[19]

Norway has the highest estimated cost per committed capacity. Norway keeps two gas-fired units specifically built for that purpose (completed in 2008/2009) as strategic reserve in scarcity situations, which are owned by the TSO. The annual cost in 2012, including capital cost and depreciation, is estimated at € 25 million per year.

In 2010 Greece increased the annual capacity payment unit price from 35,000 €/MW to 45,000 €/MW. The Italian payment scheme is divided into following two components; a specific capacity remuneration component calculated by TSO based on available capacity and an additional payment if the revenues from energy sold are lower than revenues that it would have obtained on the basis of the administrated tariffs.

5.2.9 Cross-border participation

Some of the capacity mechanisms mentioned above provide for the possibility of cross-border participation. Examples are mainly found in the eastern USA systems. In the PJM reliability auctions cross-border bidding from other systems (MISO) is allowed. Special provisions, decided commonly by the system operators, apply to avoid double payments to such capacities.

There are two possible ways to include locational price signals in the capacity auctions: whenever capacity firmness depends on transmission capacity bottlenecks, either the capacity auctions are split into non congested areas (in other words special auctions are organised for capacity procurement from distant areas with probably congested links) or financial transmission options (rights) are used to compensate financially non firmness of remote capacities because of congestion.

Despite these mechanisms, the bulk of capacity mechanism as applied until today lie within the jurisdiction of a single system operator. The capacity regulations applied or discussed in the EU have not included provisions for cross-border participation. The only exception is Ireland where it is possible to remunerate cross border flows under certain firmness conditions through the direct payment mechanism which is in place. Discussions are on-going regarding the conditions for such remuneration.

---

[19] Greece: *HTSO Capacity Assurance market Reliability year 2011 to 2012;* Ireland: *Decision Paper SEM AIP/Sem/12/078*; Italy: *Terna Annual report 2008 – 2011*; Spain: *CNE: CONSULTA PÚBLICA SOBRE EL MECANISMO DE PAGOS POR CAPACIDAD*; Sweden: *SvK Annual report 2011*; Finland; *Fingrid website*; Norway; *Statnett website and THEMA calculation*; PJM: *Monitoring Analytics, LLC: 2011 State of the Market Report for PJM.*

5.3 Suggested and planned capacity mechanisms in Europe

In this section we briefly describe the status of currently discussed capacity mechanisms in major European countries, their status of implementation and design features.

5.3.1 France

In France capacity adequacy concerns appeared in 2005. The existing excess in capacity began to decline and few new investments were planned. Concerns over the rise in peak demand, the need to replace coal-and oil-fired units that do not meet environmental standards, and the need for a more appropriate mechanism for the valuation of demand reductions have lead French authorities to introduce a capacity mechanism. The new French energy act, the NOME law, was adopted in December 2010.[20] A capacity market (obligation) is incorporated in the NOME[21] law, although further detailing is pending. The draft declaration was elaborated after the conclusion of a wide consultation process lasting from March 2011 to April 2012. The draft declaration sets up a framework and layout of the mechanism (Directorate General for Energy and Climate, 2012)[22]: On 19th of December 2012, Delphine Batho, Minister for Ecology, Sustainable Development and Energy signed a decree which should guarantee long term security of electricity supply:

- Every customer serving entity has an obligation to contribute to supply security
- Eligible capacity includes power plants and demand response
- All capacity must be certified
- If availability commitments are not fulfilled, the capacity operator must pay a penalty
- The obligation of suppliers and the certification of capacity operators leads to the emergence of a capacity certificate market
- Capacity certificates are completely set apart from the energy market
- The mechanism has no impact on interconnection capacity reservation nor cross-border energy flows
- The mechanism does not interfere (in the short term) with the energy market

Fine-tuning of the mechanism is however still pending as the decree has to be complemented by more detailed secondary regulations in the second half of 2013. RTE (Transmission System Operator) is to launch a new consultation on the

---

[20] The NOME law of 2012 is questioned by the new French government which is planning a new energy bill for June 2013. Following an 'information phase' between November and December 2012, a public participation phase will take place between January and April 2013. This phase - supported by a dedicated website and regional conferences - will lead to recommendations being made in May 2013. The results of the debate will be used to formulate an energy policy bill in June 2013.

[21] NOME (Nouvelle Organisation du marché de l'Électricité)

[22] Directorate General for Energy and Climate (Silvano Domergue, August 2012, DENA conference on Capacity Mechanism).

specific «set of rules» of the capacity mechanism. Another wide consultation process will take place before additional regulations are implemented. Important “details” regarding the capacity mechanism include the duration of the contracts, calculation of the capacity requirement and the distribution of the obligation.

In principle, foreign capacity may participate in the French capacity mechanism. However, capacity certification abroad would require at least:

- Allocation of interconnector capacity to the facilities concerned (which is not consistent with EU directives on internal market)
- That the foreign TSOs commit to not take this capacity into account in their local S&D balance assessment
- If a neighboring country sets up a similar capacity mechanism (market), it would be possible to connect it with the French one.

5.3.2 UK

The Electricity Market Reform White Paper set out the UK Government’s view of the security of supply challenges facing the GB market, and concludes that a capacity mechanism is required to ensure future security of supply.

DECC (Department of Energy and Climate Change) points out two main factors for the requirement of a capacity mechanism as stated in the White Paper (DECC, 2011);

- Around a quarter of existing generation is closing down
- A significant proportion of new generation is likely to be more intermittent and less flexible

Although the central scenario in DECC's modelling indicates that a capacity challenge is not likely to occur until the 2020s, its "stress test" (i.e. worst case scenario) suggests that a capacity challenge could occur in the second half of this decade.

The Government’s decision is to introduce a capacity mechanism in the form of a market-wide capacity market. The primary legislation was adopted in 2012, and the detailing of design features is currently under development with the help of an expert group. The draft bill would give the Secretary of State authority to introduce a capacity market, but only if and when Ministers decide that a market is needed. This decision will be based on capacity adequacy analyses provided by the system operator, National Grid.

There is still some uncertainty about the design and details of the capacity mechanism. After completion of the consultation period the favoured option was a market-wide volume-setting capacity market with a central buyer. The Government will run the first auction in 2014, if the capacity adequacy analysis identifies a need for additional capacity. The first auction will be for delivery of capacity in the winter of 2018/2019. A final decision will be made subject to evidence of need (DECC, 2012a).

Other possible approaches considered were strategic reserve or extension of the Short Term Operating Reserve (STOR), used by the National Grid to fulfil the responsibility of market balancing. The STOR currently consists of about 4 GW made available on demand by National Grid (DECC, 2011).

DECC has completed an impact assessment for a capacity market in the UK (DECC, 2012b). The total impact on energy system costs is estimated at a total net present value of £1.7bn. for the preferred option. Distributional analyses show that this cost is largely borne by consumers through electricity bills.

5.3.3 Germany

In 2012 Germany introduced a temporary measure to prevent operators from closing unprofitable power plants that are deemed to be system-relevant, as their permanent closure could risk power supply security. At the same time the discussion for a more long-term mechanism is on-going.

Several key studies set the agenda for the on-going discussion on a capacity mechanism in Germany (Elberg et. al., 2012; Cramton and Ockenfels, 2011a; b).

A study commissioned by the economy ministry (EWI, 2012) concludes that the introduction of a capacity market or security-of-supply contracts (a version of the reliability option) could ensure adequate supply in the absence of sufficient price signals for new investments in the wholesale power market. The study favours the security-of-supply contracts rather than establishment of a strategic reserve, as security-of-supply contracts are seen as more suited to guarantee the prescribed level of security of supply in an efficient manner and in conformity with the electricity market. At the same time, the report argues that security-of-supply contracts reduce the incentives to exercise market power in scarcity situations.

The adequacy analysis assumed that domestic capacity must be able to cover peak load demand with a probability of 99 per cent. This results in a large overall amount of installed capacity in Germany. The increase in interconnector capacity, as envisaged in the ENTSO-E Ten Year Network Development Plan (TYNDP), is taken into account. Other European countries are included, so that the simulation can adequately reflect the dispatch in Germany and thus the marginal cost of the system.

According to Cramton and Ockenfels (2011a) several issues urge caution in pursuing a capacity market such as regulatory imperfections, temporary resource adequacy challenge in the current transition from nuclear towards renewable generation, interference with a sound wholesale market and that Germany faces challenges with market integration of renewable sources that are currently out-of-market, supported by subsidies that are largely inconsistent with an efficient capacity market. The study recommends Germany to build a stable and reliable political and sound market framework. The contribution from building a stable and more flexible market environment will likely exceed any contribution to reliability from well-designed capacity market.

Another study prepared for RWE (Frontier Economics, 2011b) concludes that the current and previously forecasted reserve situation in Germany is not critical. Germany may need to rely on some degree of imports in extreme situations. Even if capacity is adequate in the near future, it would be inappropriate to conclude that the current energy-only market delivers sufficient capacity. Some overcapacity from the pre-liberalisation period still remains, which is different to the situation in liberalised US-markets, which do use capacity mechanisms. Such markets in the US emerged with a much tighter capacity balance than that recently observed in Germany. Political stability is needed and priority should be given to the creation of a stable political environment (without ad hoc policy shifts). The study conclusion is that a capacity market is not acutely needed. The benefit of a capacity market for Germany would probably not outweigh its cost. This is because there currently is no imminent capacity issue, but the introduction of a capacity market at this stage may create certain transaction cost and bears the risk of creating distortions if the capacity market is imperfectly designed.

A BMWi study "Clearing-Studie kapazitätsmärkte", released in May 2013 (Growitsch et. al., 2013), further discusses security-of-supply contracts and a targeted mechanism as a long-term solution for capacity adequacy in Germany.

5.3.4 Other EU countries

In Belgium the State Secretary *plans* a guaranteed return for new built gas-fired production based on auction results motivated by nuclear phase-out and low investments appetite. The government are expected to launch a tender for new gas-fired power production to replace the nuclear capacity from 2015, through which successful bidders would receive a guaranteed power price (Platts, 2012)[23]. In October 2012 the Regulatory Commission for Electricity and Gas (CREG) released a study that examines the generation capacity remuneration mechanisms implemented or under consideration in different countries and from which the Belgian electricity market can draw lessons.

---

[23] http://www.platts.com/RSSFeedDetailedNews/RSSFeed/ElectricPower/8470625

6 Impact of individual capacity mechanisms

In this chapter we discuss how implementation of different capacity mechanisms – capacity payments, strategic reserves, and capacity markets – in individual markets affect the efficiency of the IEM. We find that the effect depends on the interconnection between the markets, the correlation of scarcity situations and the design details of the capacity mechanism. It is difficult to imagine a capacity mechanism that would not affect cross-border trade. Some of the adverse effects are attributed to the tendency of capacity mechanisms to yield "too much" capacity, others to the distortion of short term prices and long term investment incentives.

6.1 Introduction

We discuss the possible implications of different capacity mechanisms on the efficiency of cross-border trade based on the taxonomy of capacity mechanisms presented in section 5.1. As we have seen, there is currently a patch-work of different capacity mechanisms implemented in different EU states. All are nationally oriented and do not facilitate cross-border participation.

As explained in chapter 4, capacity mechanisms can be perceived as a means of correcting temporary or inherent market failures in energy-only markets. If a capacity mechanism merely corrects market failures, i.e. the "missing money problem", one might say that they complement and improve the market solution as compared with the outcome of the target model and the IEM. Capacity mechanisms then improve the efficiency of market signals and reduce the overall cost of the electricity system.

However, as capacity regulations represent imperfect interventions in the energy-only market, they are prone to induce new market distortions. The additional costs must ultimately be borne by final consumers.

Important challenges associated with the implementation of capacity mechanisms are:

1. How to accurately determine the proper level (and distribution) of capacity adequacy.
2. How to take cross-border capacity (and bottlenecks in general) into account.

When setting the capacity adequacy level, i.e. the reserve capacity margin, regulators may err on the positive or the negative side. However, regulators are more likely to overestimate the capacity adequacy requirement than to underestimate it. As the capacity mechanism may be regarded as an insurance policy, it is likely that regulators will set reliability margins "on the safe side", and hence overestimate the need for capacity. Uncertainty about market developments such as economic growth, fuel prices, technology developments, etc. is likely to further exacerbate this tendency.

Overestimation of the capacity requirement is also likely to reduce the significance of power exchange (implicit market coupling). Hence, there is a real risk that capacity mechanisms introduce new distortions in the market which undermine the potential benefits of the IEM:

1. General overcapacity implies excessive costs of power supply (investments in generation capacity).
2. Failure to take cross-border capacity and benefits of market integration into account implies lower value of cross-border trade (and other coordination measures) and reduce the value of interconnectors.

In the best case the capacity mechanism merely corrects the market failure of the energy-only market, in the worst case capacity mechanisms regard capacity adequacy per market area in isolation without taking cross-border capacity and trade into account.

6.2 Analytical framework

The core issue in this project is whether implementation of capacity mechanisms in individual markets adversely affects cross-border trade and coordination. *The benchmark for the assessment of the impact of individual capacity mechanisms is the optimal solution*: *What solution would the social planner recommend?* According to the working assumptions introduced in chapter 1, we assume that the target model implies that transmission capacity can be utilized more efficiently (implicit market coupling), and that the TYNDP implies that the cross-border exchange capacity is developed according to expected long term price differences between markets (congestion rent and welfare economic effects). The focus of the analysis in this chapter is how implementation of a capacity mechanism changes the market situation for any given initial situation, i.e. not whether capacity mechanisms are needed or not.

In chapter 8 we discuss the properties of different choices for a European approach to capacity mechanisms further.

We consider the following simplified situation:

There are two countries (or control areas), country A and country B, which are connected by an interconnector with capacity X MW, see Figure 6. The interconnector capacity is limited compared to the total size of the markets, i.e. the interconnector is congested in some hours. In the future both markets need investments in new generation capacity due to a combination of decommissioning of old generation capacity and demand growth.

The optimal solution depends on the options for (future) generation capacity in A and B, the development of demand (e.g., industry structure) and RES targets. We assume that country B has higher wind resources than country A, and is phasing out old capacity more rapidly. In order to ensure future capacity adequacy, a capacity mechanism is introduced. This mechanism may take the form of a strategic reserve, a capacity payment or a capacity market. Country A does not implement a capacity mechanism. The market situation is illustrated in Figure 6.

Figure 6: Analytical framework

According to the optimal long term solution new generation is distributed between the two markets so that all capacity is profitable and demand is covered at all times. Due to differences in domestic energy resources, consumption profile, and shares of wind/solar generation, the price structure and average price level is not the same in both markets. The prices are more volatile in market B than in market A due to the higher shares of intermittent generation. The number of full load hours for different types of generation capacity will also differ between the markets. Hence, the equilibrium generation mix will also differ. The short term power exchange between A and B is determined on the basis of implicit market coupling (cf. the target model). Hence, prices in the two areas are linked through trade, and the interconnector capacity should reduce the differences between the markets in terms of both price structure and average prices.

In the optimal solution there are bottlenecks between the two areas in periods of high demand/low wind in B (full imports from A to B) and low demand/high wind in B (full exports from B to A) even if the interconnector capacity is optimal.[24]

We discuss the implications of each type of capacity mechanism in terms of short and long term effects. The short term effects are price effects prior to long term adjustments in terms of investments, whereas long term effects take impacts on investments into account. We analyse the impacts in three steps:

1. What are the effects in the market that implements the capacity mechanism?
2. What are the effects on trade with the other market?
3. What are the effects in the other market?

The effects are naturally more complex than what can be captured by a simplified theoretical approach. Section 7.6 provides a model-based analysis of the impacts of asymmetric capacity remuneration in France and Germany.

6.3 Capacity payments

Capacity payments are typically a fixed payment for availability paid to all generators. The level of payment is set by a central body. The payment could be paid when the plant runs (per energy unit generated) or also when it does not run, in which case some kind of availability (firmness) criteria have to be met. Capacity payment schemes may be implemented for a year at the time, for a certain number of years or indefinitely (open-ended). It may apply to all capacity independent of a capacity adequacy assessment or dynamically depend on a capacity adequacy assessment.

The market effects depend on the design of the capacity payment. Below we distinguish between the following designs:

1. Fixed (annual) capacity payment
2. Dynamic capacity payment
3. Long term fixed capacity payment (subsidy)

---

[24] It is generally not optimal to invest in interconnectors that remove price differences in all hours. The reason is that the welfare economic benefits of increased transmission capacity are declining as the transmission capacity increases and price differences are evened out.

Fixed (annual) capacity payment

If the capacity payment is designed as a fixed (annual) payment to *all* capacity, the short term effect is merely to increase revenues for existing capacity in B (cf. the Spanish scheme to contribute to the recovery of stranded costs). The payment may however disincentivize or postpone decommissioning of some old capacity, thus some capacity that would otherwise be phased out is kept available in the market. This capacity will then be bid into the market at short term marginal cost and will be dispatched when market prices in B are above their marginal costs. Since this capacity is old, it is likely to have relatively low energy efficiency and high marginal costs; hence, any the main short term effect, if any, is to lower peak load prices.

Lower peak load prices do not affect trade directly in peak hours with (already) full imports to market B (most probable scenario). In hours without full imports to B, i.e. if some peak prices in A are at the same level as in B and the interconnector capacity is not fully utilized, trade flows are altered and the prices decrease in both markets. Some hours that would otherwise be congested, may see the congestion lifted because more capacity is available in B. The congestion revenue on the interconnector is likely decrease.

If the capacity payment applies to both existing and new generation, it should provide an extra investment incentive (as long as the (certain) capacity payment is not offset by the (uncertain) negative price effect of increased capacity). This requires a longer-term commitment to capacity payments by regulators. If the capacity payment is *not* market wide and only applies to existing or peak load capacity, the lower (average and peak) prices tend to reduce the incentives to invest in new base and medium load capacity. Then the capacity payment may improve capacity adequacy in B in the short term, but the longer term effect on capacity adequacy may be negative.

The short term market effects will (partly) spill over to market A as well, to the extent that prices in peak hours without congestion are reduced. This may worsen the capacity adequacy situation in A in the longer term: Decommissioning may be expedited and investments postponed. In scarcity situations with congestion (flow from B to A) the reserve margin in A will hence be lower than in a situation without capacity payment in B.

It is clear from the discussion that the spill-over effects depend on the interconnection capacity between A and B and the correlation of prices in the two markets. (The higher the correlation, the less are the benefits of trade and the lower is the optimal interconnector capacity likely to be. And the more is capacity adequacy to be regarded as a private good.)

A fixed capacity payment does not per se require a specific capacity target. Hence, how cross-border capacity is taken into account is not an explicit issue. Theoretically, capacity in A may also be eligible to the capacity payment, but this is not very likely unless capacity is simultaneously reserved on the interconnector (or the interconnector capacity is increased). This is equivalent to the TSO in A guaranteeing that there will be full flow from A to B in scarcity situations – regardless of the capacity adequacy situation in A. Note that if the capacity situation in A is such that there are full exports from A to B when capacity is scarce in B anyway, B has no interest in paying for such a guarantee.

Dynamic capacity payment

Instead of a fixed payment, the capacity payment may depend on the actual reserve situation, e.g. it falls to zero if the reserve margin drops below some specified percentage (threshold).

The capacity payment is only paid to generation located in B, and we assume that it is paid as an uplift charge on the market price. The immediate effect is that peak load prices (whenever the reserve margin falls below the threshold) increase in B. This benefits all generators supplying the market in peak load hours.

In peak hours with full imports from A (congestion), the uplift charge does not affect prices in A. In peak hours without congestion, however, the uplift spills over to market A and change trade in favour of increased exports to B. Thus peak prices increase in A as well. Hence, the uplift strengthens the incentives to postpone decommissioning (and increased demand response) even in A, but to a lesser extent than in B. Via the implicit price coupling, consumers in A pay for increased capacity adequacy in B. This may provide some benefits for A as well, depending on the capacity adequacy situation. If A has ample capacity anyway, there will normally be full exports from A to B in scarcity situations, and the more muted is the short term price effect in A.

The result is reduced or postponed decommissioning of capacity and (longer-term) increased or accelerated investments in (all kinds of) new capacity in market B. Higher peak load prices should also incentivize demand response. Since the price effect at least partly increases prices in A as well, investments become more profitable there too. But in relative terms, a larger share of the investments is likely to take place in B (compared to the symmetric energy-only market).

A dynamic capacity payment implies that a reserve margin and the uplift charges have to be estimated by authorities. Depending on the determination of the reserve margin and the design and level of the uplift factor, cross-border capacity may explicitly or implicitly be taken into account. Since the uplift is reflected in the wholesale price, the congestion revenue increases in hours where the uplift is applied and A exports to B. This strengthens the incentives to expand interconnector capacity. On the other hand, the attractiveness of cross-border trade may be reduced since incentives to invest in generation capacity are stronger in B than in A.

Long term fixed capacity payment (subsidy)

New capacity in market B is paid a (targeted) investment subsidy in order to incentivize investments. The short term effect may be increased decommissioning of existing capacity in market B. Obviously a capacity subsidy in one market will attract more generation to that market than to markets without such a subsidy, cf. also the findings of Cepeda and Finon (2011).

One might envisage a procurement process involving an (annual) auction for a certain amount of capacity to be put in operation within a specified number of years. The basis for the volume of capacity procured would have to be some kind of capacity adequacy assessment and also, some assessment of what kind of capacity to procure (assessment of firmness, flexibility, etc.).

A capacity payment to all new capacity in B would increase generation, reduce imports and increase exports. Average prices and the general price level are likely to be reduced. Generation in A would be reduced correspondingly, and prices suppressed there as well. In the long term investments would shift from A to B compared to the symmetric solution.

If the capacity payment is targeted at peak capacity, incentives for investments in base load and mid merit capacity would be reduced in B, as the peak capacity marginal cost would in effect constitute a price cap in the market. Hence, in the long term the need for a capacity payment in B could increase. (In addition, incentives for demand side response would be weakened.)

More peak load and less base load and mid merit capacity in B would change the price structure in B by lowering peak prices and increasing mid-merit prices. The demand for imports from A would be reduced in peak load, and so would interconnector revenues. The effect on mid-merit prices is more uncertain and depends on the specific prices structure in A and the correlation between market. Hence, the overall impact on investment incentives for generation in A and in interconnector capacity is not clear. The overall market efficiency would however be weakened.

6.4 Strategic reserves

The impact of strategic reserves depends on their purpose and rules of procurement and activation. Contrary to capacity payments, generation capacity in the strategic reserves is kept outside the market and called upon by the TSO according to specified rules. As explained above (see 5.1.2 and 5.2), strategic reserves may be motivated by a wide range of situations and their design is typically tailor-made for the specific challenge at hand. In that sense, strategic reserves may be regarded as *local* measures.

The level of payment is usually set through a competitive tendering process. The capacity is in principle only operated in extreme conditions. In such situations they enter the market at the market price plus a (usually small) premium.[25]

We will distinguish between strategic reserves consisting of

1. Mothballed generation capacity,
2. Investment in dedicated new reserve capacity and/or
3. Contracts with load (demand shedding)

Mothball reserve (existing generation)

A mothball reserve consists of generation capacity that is otherwise likely to be decommissioned, and is paid to be available for activation under specific rules (e.g. notification time, duration of service, etc.). Strategic reserves are often procured through an auction or through bilaterally negotiated contracts (between the TSO and the owner of the capacity). Activation of the reserve may be contingent on an actual shortage situation (market supply is not sufficient to cover demand), or on a threshold market price. In both cases rules must be established that specify the impact of activation on the market price. The capacity may be used as part of the market solution, as the mothballed reserve capacity, or only after the market is suspended (for TSO purposes explicitly).

Whenever the reserve is activated to secure a market solution, the market price (area price) is usually set according to the marginal (fuel) cost of the reserve

---

[25] The Swedish strategic reserve is only activated when the market fails to find balance between demand and supply. When the reserve is activated the market price is set marginally above the highest market bid, alternatively at the variable cost of the activated generation capacity including start-up costs.

capacity plus a mark-up. As such, the strategic reserve activation rule constitutes a price cap in market B whether activation is due to a physical gap or a price threshold. There is also a risk that capacity in the strategic reserve would not have been decommissioned, but is offered to the strategic reserve because the terms are deemed more favourable than with normal market exposure. (Instead of uncertain operation and revenues from the market, the capacity receives an up-front payment and a certain price plus mark-up if activated.)

The short term impact on peak prices in B depends on the capacity situation without the reserve, and on the activation rule.

If the activation rule is linked to the supply-demand gap, import capacity is implicitly taken into account. The reserve would only be activated if the interconnector capacity fully exploited or there is a capacity deficit in A as well. If the interconnector is congested, prices in A would not be affected. If the supply-demand gap affects market A as well, activation of the reserve may or may not spill over to A: The strategic reserve helps achieve supply-demand balance in both markets, but in the long term the price cap may negatively affect decommissioning and investment incentives in market A.

It may be an alternative for country B to procure capacity in A as part of the strategic reserve. Procurement of capacity in A for the strategic reserve in B is more likely if there is ample interconnector capacity between the markets, if the capacity situation in A is comfortable and the correlation between the markets is low.

Limiting the strategic reserve to existing capacity makes it possible to determine the magnitude and composition of the strategic reserves, including activation rules, for one year at the time, and adjust to market developments.

Investments in new reserve capacity

The impact of investments in new capacity dedicated for a strategic reserve would basically have the same impact on the market as a mothball reserve. The market impact depends more on the rules for activation than on what capacity is kept in reserve. Compared to a mothball reserve there is no risk that capacity is removed from the market in order to be offered in the reserve. New investments indicate a longer time horizon for the mechanism, however, and the activation rules may affect general investment incentives.

The investment in reserve capacity may however explicitly be taken as a temporary measure to increase security of supply until capacity adequacy is restored by investments in market based generation capacity, stronger grid connections or increased demand response. [26]

In the short term such reserve investments should not impact market prices in B. If the reserve is permanent however, it may reduce the value of increased interconnector capacity to A. This may in turn reduce investment incentives in A,

---

[26] In Norway the TSO invested in (mobile) gas turbines as temporary reserve capacity in the Northwest Norway market area in 2009. This is a relatively small market area that depends strongly on imports, particularly in periods with low inflow to the hydro power reservoirs, as the grid is fairly weak in the area. (This is an example of a market area where capacity adequacy was rapidly reduced due to rapid demand growth, particularly in the power intensive industry, which in turn created a situation of reduced capacity adequacy – foremost related to the interconnector capacity to adjacent market areas.)

and on the whole, reduce the incentives for trade. If A has access to cheaper balancing and peak load capacity potentials, the value of this capacity is reduced if B opts to take care of its capacity adequacy internally.

Demand side reserve (energy options)

The advantage of demand side participation in the strategic reserve is that the demand may be allowed to bid into the regular wholesale market and is free to respond to market prices. The reserve is ensured by an obligation to keep demand below a certain capacity level when called upon, and not to *reduce* demand by a certain amount. Thus, the question of baseline demand is not an issue. It does not matter for the capacity adequacy situation if consumption is permanently or temporary reduced, incentivized by market prices or explicitly activated by the TSO. (Although there may be a risk that e.g. large industrial consumers are paid to consume at a level which they would not – in practice – exceed anyway, particularly in periods with high prices. This would particularly apply to industries with spare production capacity.)

Again, the effect on market prices in B and A depends on the activation rules and the general market situation. Contrary to the marginal cost plus uplift rule for generation capacity, one might envisage that activation of demand side resources would be priced at the VOLL for the activated consumption. (One might however wonder why the demand response would not be activated via the normal market dynamics if that is the case.) In Norway, however, the demand side reserve is activated within a longer notification period than the day-ahead time frame (minimum of two weeks). The option obliges demand reduction for a 2-4 week period and the measure is mainly used as a precaution against water scarcity in dry (and cold) years.

Whatever the rules, activation of the demand side response at price levels below VOLL, would effectively suppress scarcity pricing in market B. This might reduce the import incentives and the general investment incentives.

6.5 Capacity markets

Capacity markets are by nature more long term and usually less targeted than capacity payments and strategic reserves.

As explained in chapter 3, we may distinguish between three different types of capacity markets:

1. Capacity obligation
2. Capacity auction
3. Reliability option

Capacity obligation

Suppliers have an obligation to contract with generators (or load) for a certain level of capacity, usually determined as a percentage (> 100 %) of their average (or peak) supply obligations. If the obligation is not met, the supplier must pay a penalty. The price for capacity is set in a decentralized manner, i.e. the suppliers are free to fulfil the obligation through own capacity, bilateral contracts and/or via the market. The mechanism could include a certification body, an organized market for trade in certificates, and penalties for non-availability of certified capacity in scarcity situations. Such a scheme requires administrative determination of the proper capacity margin, but not necessarily a long term demand forecast.

The actual electricity generation from the capacity under obligation is bid into the market (or sold on bilateral contracts), independent of the capacity obligation contract.[27] The market price is set according to the marginal hourly bid. The cost of the capacity obligation is passed on to end-users.

As the scheme incentivizes investments in generation capacity, the long term expected market prices in B drop. Since the contract is not targeted towards peak-load capacity specifically, the obligation is likely to impact prices in all hours. Ex ante it is difficult to determine what kind of capacity will constitute the extra capacity, but the effect is likely to be similar to the one with a general (fixed) capacity payment. The longer-term reduction in prices will spill over to market A as reduced export demand. Incentives to invest in new capacity in A are reduced, and so are the value of interconnection and the benefits of trade.

Capacity auction

The total required (firm) capacity volume is centrally determined a (sufficient) number of years in advance. The price is determined in an auction and paid to both new and existing capacity.

The main difference from the capacity obligation is that a central body decides the capacity level by forecasting future demand-capacity gap, in addition to the security margin. As such, there is a risk that a capacity auction will incentivize more capacity than a capacity obligation, since demand growth may be overestimated. However, the capacity auction does not imply issuing of tradable certificates, and it may be easier for authorities to adjust the future capacity level if and when demand forecasts change. (The capacity obligation percentage on the other hand, should be set several years ahead.) If load is to be included, baseline issues arise.

The main effect of the auction is to strengthen the investment incentives in B, and the impact on trade with A and the profitability of interconnectors will be similar to the ones discussed under capacity payments above. As a matter of fact, the capacity auctions are similar to direct capacity payments, the main difference being that the capacity prices are determined through auctions.

Reliability option

In a reliability option scheme, the total required (firm) capacity volume is set centrally a number of years in advance. The suppliers do however not bid for a capacity payment but rather for an option contract defined by an activation or strike price. Whenever the market price exceeds the strike price, the generators are required to generate (or bid their capacity into the market), however they only receive the strike price for their generation. If a generator with a reliability option is not available when the market price exceeds the strike price, he must pay a penalty specified by the reliability option contract.

Reliability options are promoted by many academics on the grounds that they provide a more efficient market solution than alternative (long term) capacity mechanisms. There are however several complex regulatory issues associated with reliability options, one of which is the administrative determination of the total

---

[27] Although the capacity may be obliged to bid whenever it is available, there are generally no provisions as to how and when the capacity is bid into the market – apart from the penalty for non-availability in scarcity situations.

capacity. As with the other two varieties of capacity markets, and capacity auctions, the main adverse effect of implementing an RO scheme in B is likely to attract more investments to B as investors in B receive a fixed option revenue as opposed to a more risky peak price revenue in A. Well-designed, market-wide reliability options should provide the market with the optimal mix of generation capacity – according to Cramton and Ockenfels (2011a)[28] – excess capacity would come in the form of peak load capacity. If this is the case, reliability options – assuming that too much capacity is incentivized – should mainly affect peak load prices (in B).

6.6 Summary of market impacts

The discussion above reveals that all individual capacity mechanisms are likely to adversely affect the efficiency of the IEM. A summary of implications are provided inTable 5.

The introduction of a capacity mechanism (either directly or indirectly) is likely to affect the investment behaviour of current and future generators. Taking the optimal investment behaviour as the starting point, we have argued that capacity mechanisms are likely to yield overinvestment. However, as has also been pointed out by some observers, the mere *discussion* of capacity mechanisms may negatively impact investments and capacity adequacy: Investors are prone to prefer certain revenues to uncertain revenues and thus might postpone investments in the expectation that a capacity mechanism will be introduced. Moreover, the implementation of a capacity regulation scheme is exposed to additional costs due to principal-agent situations, where the principal is the regulatory or system body and the agents are the capacity providers.

In all the cases examined above we find that the value of interconnectors and trade is affected and typically reduced. Generally we might say that if interconnector capacity is not taken into account the implementation of capacity mechanisms separates the long term development of the markets and reduces the value of market integration. The market coupling becomes mainly a short term coordination mechanism, and not the main basis for allocation of investments. Although the price formation, including trade, will still have an impact on the generation mix in the market areas, the total capacity level in each market will be determined by the capacity mechanism.

---

[28] Cramton and Ockenfels argue that:

1) Interaction of different markets in different zones and for different products such as electricity and reliability options does not necessarily hamper (inter-market) efficiency. Implementing a well-designed capacity market in one country does not threaten the functioning of the European cross-border market. (It has to be understood that a well-designed CM restores the optimal investment signals in the market, including the ability of capacity in adjacent zones to participate in the CM.)

2) If two markets are fully integrated reliability is a public good. Hence, in fully integrated market they strongly recommend to align the design and implementation of a capacity market. (If the CM is only implemented in one market, the reliability should be the same – in both markets, but the distribution of costs will not be fair.)

3) If markets are not fully integrated, such that transmission constraints bind during periods of scarcity in one market, reliability in that market becomes a private good. Then cross-border trade does not require a joint capacity market.

Table 5: Summary of short and long term market effects of individual capacity mechanisms

EFFECTS		SHORT TERM EFFECTS ON:			LONG TERM EFFECTS ON:	
MEASURES		Price in B	XB trade	Price in A	Investments in B	Investments in A
CAPACITY PAYMENTS	Fixed	*Down in peak hours (reduced decomm.)*	*Down in peak hours (no congestion)*	*None (congestion)* *Less (no congestion)*	*Market-wide: Increased*	*Reduced*
	Dynamic	*Up in peak hours*	*Up in peak hours (no congestion)*	*Up in peak (no congestion)*	*Increased*	*Increased, but less than in B*
	Long-term fixed (subsidy)	*Limited. Up if increased decommissioning*	*Limited effect, depends on solution*	*Limited. Up if increased decommissioning in B.*	*Increased*	*Reduced*
STRATEGIC RESERVES	Mothball reserve	*Down (caps peak prices)*	*Limited. Depends on rules for activation*	*Limited. Down if no congestion*	*Reduced*	*Reduced*
	New reserve capacity	*Down – if anything (rules for activation)*	*Limited. Depends on rules for activation*	*Down if no congestion*	*Possibly reduced.*	*Possibly reduced.*
	Contract with load	*Down in peak hours*	*Limited. Depends on rules for activation*	*Down if no congestion*	*Less incentive to invest in both A and B*	*Limits incentives*
CAPACITY MARKETS	Capacity obligation	*Down*	*Down in peak hours (no congestion)*	*None (congestion)* *Less (no congestion)*	*Increased*	*Reduced*
	Capacity auction (as subsidy)	*Down (but may lead to decommissioning). Will depend on solution*	*Limited effect, but will depend on solution*	*Down due to spill-over from B if no congestion. Will depend on solution.*	*Increased*	*Reduced*
	Reliability option	*Peak-load prices down*	*Limited effect*	*Down at peak load ad no congestion*	*Increased*	*Reduced*

The potential additional costs of imperfect capacity mechanisms should ideally be compared to the potential value of loss of power supply due to market failure in the energy-only market. It is obviously difficult to perform such a quantitative cost-benefit analysis for concrete markets, because of complexity and also because the analysis has to make assumptions (which are difficult to prove) about the distortions induced by capacity regulations and the market failures that explain generation inadequacy in the absence of capacity regulations. The difficulty involved in quantitative evaluation of the costs and benefits of asymmetric capacity regulations in integrated markets is even larger. There are no examples in the literature of detailed quantitative calculations of such costs and benefits for concrete markets; the literature includes many studies on costs and benefits which however rely on theoretical analysis and few stylised examples.

6.7 Impact on cross-border trade and interconnector revenues

From the above discussion we may draw some general conclusions about critical factors for the adverse impact of unilateral capacity mechanisms.

On the impact on trade

The analysis has revealed that one critical factor for the magnitude of the adverse effect of individual capacity mechanism is the impact on the price curve. Figure 7 provides a simplified illustration of spill-over effects by use of annual price duration curves for market A and B.[29] Prices in both markets are sorted according to prices in B, ranked from high prices to low prices.

---

[29] Annual price duration curves depict all hourly prices during a year, sorted from the highest to the lowest price.

As we have assumed that the capacity situation in B is more constrained than in A, thus peak load prices are higher in B than in A. The higher share of weather-dependent RES generation in B implies that B has more hours with low prices as well. Hence, the price duration curve is steeper in B than in A. In the figure, high prices in B correspond with high prices in A, thus prices and scarcity situations are highly correlated between the two markets.

As trade between the markets is determined by hourly price differences, the price curves indicate that initially there are full exports from A to B in peak load (peak prices in A are well below peak prices in B, even with trade), and full imports to A from B when prices are low.

Introduction of a capacity mechanism in B impacts the price duration curve in B, either by primarily reducing peak load prices, illustrated by the shift **a)** in Figure 7, or by reducing overall market prices, illustrated by the shift **b)**.

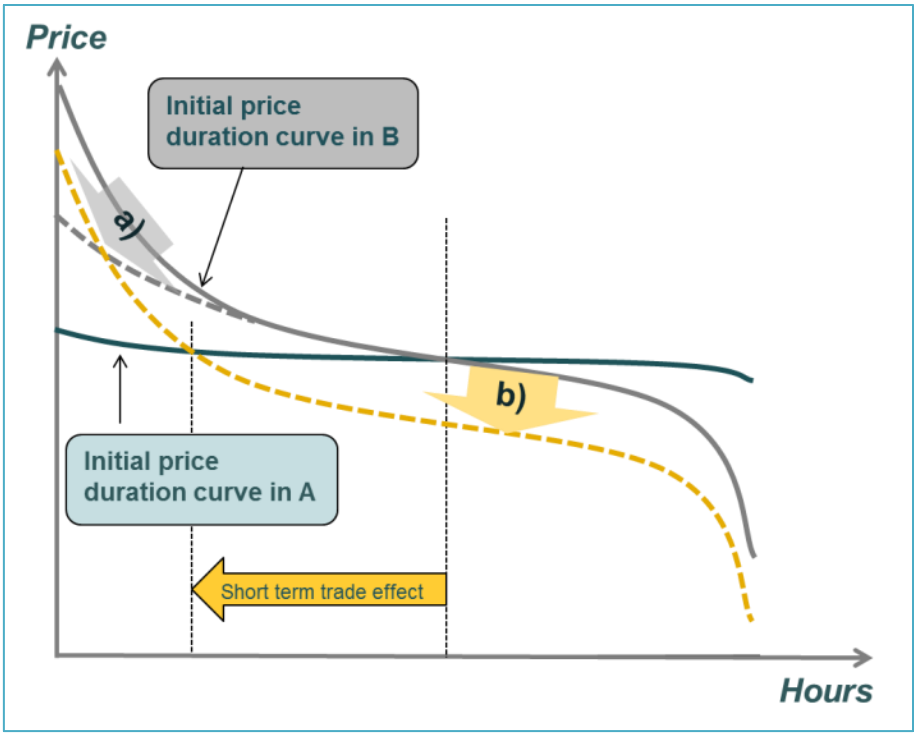
Changes in price duration curves affect trade flows and interconnector revenues:

1 Capacity mechanisms that primarily lower peak load prices will not have an immediate effect on traded volumes. Peak prices in B are still higher than peak prices in A and B still imports in full from A in these hours. The interconnector revenue (congestion rent) is equal to the hour-by-hour price difference between A and B. The reduced peak prices in B thus reduce the congestion rent.

2 Capacity mechanisms that reduce the general price level in B, distort trade flows as illustrated by the “short term trade effect” arrow in the figure. Here trade flows are reversed in a number of (mid-merit) hours and the congestion rent is affected in all hours. We note that although the congestion rent is reduced in peak hours, it increases in low load hours. However, in this case the price duration curve in A is likely to be affected by the shift in trade. As flows shift from exports from A to imports to A in these hours, the price duration curve in A is likely to shift downwards. The effect on the total interconnector revenue is undetermined.

General remuneration schemes increase revenues for all capacity. This is true for general capacity payments and dynamic capacity payments, and even for strategic reserves which induce higher peak load prices. Mechanisms targeted at peak load capacity may however have the opposite effect: Peak load prices are suppressed, reducing peak load revenues for all (controllable) capacity, and hence weakening investment incentives for mid-merit and base load capacity. This illustrates that, depending on the design, capacity mechanisms do not only affect total investments, but even the investment mix, and hence, the price structure as well as the price level in a market.

Figure 7: Price duration curve effects with high price correlation between markets

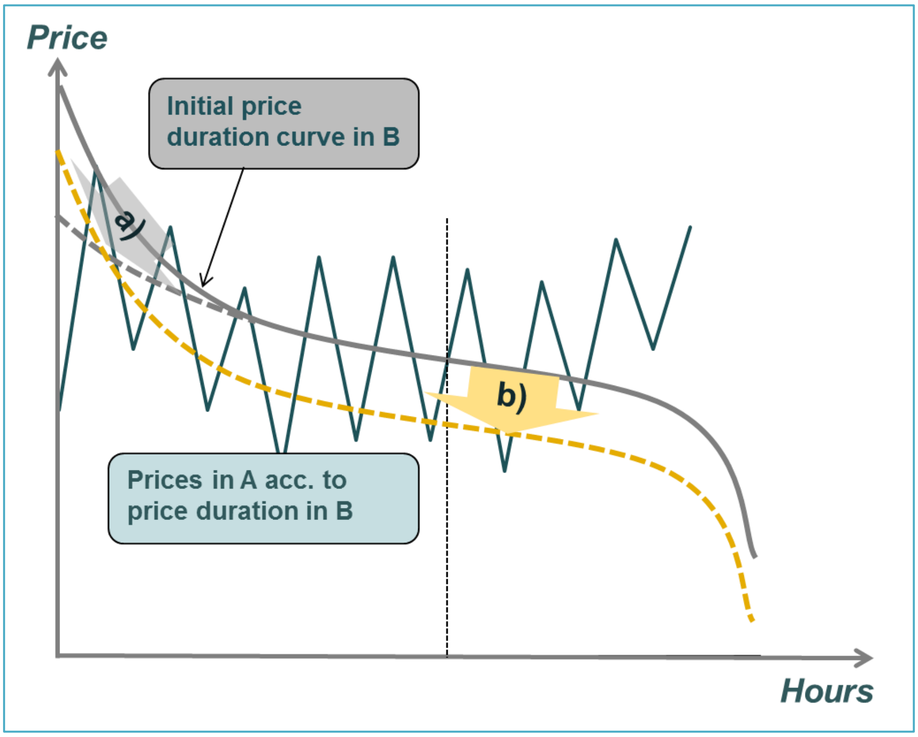


Short and long term changes in price structures impact the investment incentives for interconnector capacity. To the extent that capacity mechanisms correct market failures, the incentives for interconnector investments are corrected as well. Similarly, inoptimal capacity mechanisms are likely adversely affected interconnectors. The exact effect depends on the capacity mix of the affected markets, the interconnector capacity, and a number of other market features. However, even interconnector revenues, and indeed the benefit of interconnectors, are highly dependent on differences in peak prices between markets.

The relevance of correlation between the markets

If prices between A and B are not correlated, or less correlated than implicitly assumed by the price duration curves depicted in Figure 7, the shift in peak prices, **a),** will have a greater short term impact on trade as flows are reversed in some hours. In Figure 8, prices in A are sorted according to the price duration curve in B. Since prices are not correlated, high prices in B are in some hours associated with low prices in A and sometimes with low prices in A. Now a unilateral capacity mechanism in B that mainly affects peak prices in B, will impact trade directly. In some hours the price difference, and hence, flows are reversed between A and B.

Figure 8: Price duration curve effects with low price correlation between markets



The impact of asymmetric capacity mechanisms

The analysis presented in this chapter assumes that a capacity mechanism is only introduced in one market. However, as we have seen in chapter 3, capacity mechanisms have been implemented in several countries and all exhibit different design characteristics. It would be too elaborate to analyze the implications of all possible combinations of capacity mechanisms in this context. However, it is clear that asymmetric approaches are likely to exhibit similar adverse effects as the asymmetric cases discussed above.

Obviously, the impacts on cross-border trade, short term price formation and, subsequently, investment incentives, depend on design parameters, for example the capacity requirement and whether (or to what extent) cross-border capacity is taken into account. The results from Cepeda and Finon (2011) and the analysis above indicate that the adverse effects of not taking cross-border capacity into account are greater the more integrated the markets are, and the lower is the correlation between peak and off-peak hours (or high and low net demand). In other words, if markets are not highly integrated and prices highly correlated, the smaller is the efficiency loss associated with asymmetric capacity mechanisms.

Adverse effects may result even if markets implement the same capacity mechanism, but with different design parameters. Different capacity payment levels, different strike prices and different reliability standards are examples of design parameters that would distort investment incentives, prices and trade.

7 Assessment of capacity adequacy in the IEM[30]

This section presents a model-based analysis aiming at assessing future capacity adequacy from a system planning (section 7.1) and from a market perspective (section 7.2). Analysis of capacity situation is conducted by individual markets and for the EU as a whole. Appendix 1 summarises the modelling approach. Appendix 2 presents the main projections under the Reference scenario assumptions. Appendix 3 includes tables with detailed numerical results by country. Appendix 4 provides a theoretical justification of the missing money issue and the dependence on bidding behaviour in a wholesale market.

7.1 EU capacity investment requirements to 2020 and 2030

The aim of this section is to present a model-based quantification of the power generation investment requirements in the EU member-states until 2020 and 2030 so as to ensure capacity adequacy. The analysis would identify possible investment gaps in the current planning of investments, and it will do so separately for merchant plants and for plants that primarily will address system reserve needs. The results of the analysis will be used further (section 7.2) to assess the likelihood of energy-only markets delivering the required level of investments and to identify the possible scope for capacity regulations by MS as a way of complementing the market forces.

7.1.1 The Reference scenario

The model-based projection is based on the draft Reference scenario quantified using the PRIMES energy system model as delivered to the Commission at the end of 2012.[31] The Reference scenario is a policy-rich scenario, as it assumes that all adopted policies and measures will be successfully implemented in the MS, including the ETS, the Renewables Directive and a series of energy efficiency policies among which the recently adopted Energy Efficiency Directive. The implementation of these policies has consequences for the evolution of energy demand in the future (influenced by energy efficiency measures) and for the penetration of renewable energies in power generation. The Reference scenario assumes strong RES supporting policies, possibly even beyond today's feed-in tariff levels in order to ensure that the RES obligations are met in all MS. The Reference scenario also assumes that the TYNDP is successfully developed and flow-based allocation of interconnector capacities. Thus, cross-border trade is projected to develop beyond current levels following undistorted economic optimality to the extent future interconnecting capacities will allow. A more

---

[30] Model-based analysis conducted by E^3Mlab (Prof. P. Capros, C. Delkis and N. Tasios).

[31] The Reference scenario projection will possibly change after the end of the on-going consultation process with the MS

detailed description of the assumptions in the Reference scenario is found in Appendix 2.

In following, we use the Reference scenario projection as a benchmark situation to which conclusions deduced from analyses of different scenarios on the operation of the market will be assessed (sections 7.2, 7.5 and 7.6), as well as from the analyses of sensitivity cases regarding the implementation of the aforementioned policies (section 7.3 and 7.4).

7.1.2 Historical outlook of capacity margins in the EU

Based on the PRIMES database of generation, capacities, load and availability, it is possible to calculate aggregate reserve margin indicators by member-state (see Appendix 3). A simple reserve margin indicator is obtained by dividing total dispatchable net capacities (thermal, nuclear, hydro with reservoir and part of hydro run of river) by peak load including net exports.[32] As this calculation does not consider the contribution of net imports it corresponds to a pure "national" perspective on capacity margins (capacity to adequately meet domestic load and net exports where applicable).

As a rule of thumb, reserve margins need to be higher than a threshold value (e.g. 15%) to take into account plant outages and the demand for system serving capacities. The 15% threshold constitutes a simplistic approximation of a variety of technical considerations regarding the exact calculation of power capacity availability of plants for covering peak load.[33]

Figure 9 depicts the values of the reserve margin indicator per MS. The EU member-states have disposed sufficient capacity reserve margins since 2000 and the EU as a whole had a reserve margin of 33% in 2010 (left panel). The projection to year 2015 includes new investment which is known to be under construction and is planned to be commissioned before 2015 as well as planned decommissioning (right panel).

Although 2010 was a very comfortable year in terms of reserve margins in almost all EU countries, MS fall below the reserve margin threshold[34] of 15% in the short term. In Belgium and Germany the short-fall is explained by nuclear phase out, while the delays in nuclear commissioning explain the poor reserve margins in

---

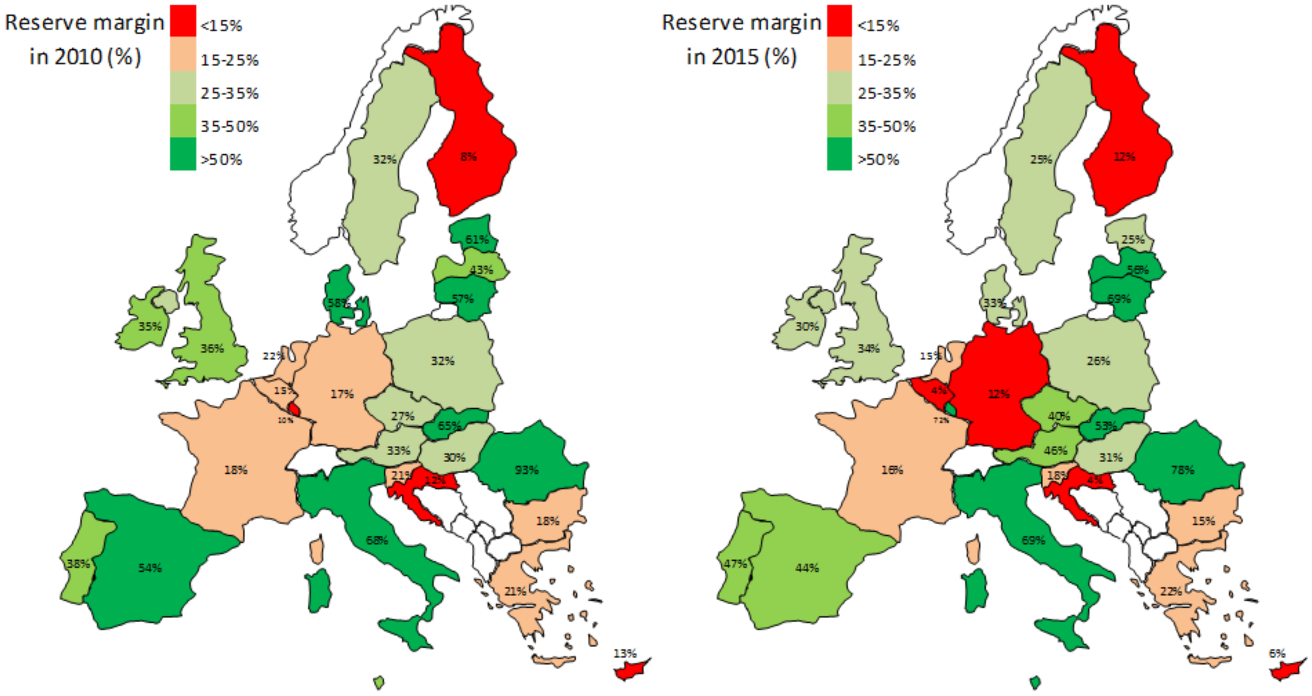
[32] The ENTSO-E capacity adequacy report calculates remaining capacity as the difference of reliable capacity and load (at specified time and day). To estimate reliable capacity the ENTSO-E report subtracts from total installed capacities the unavailable capacities which include large part of non dispatchable renewables, thermal capacities in maintenance or in forced outage and capacities retained for system services. So, the remaining capacity is net of capacities that serve system reserve and reliability purposes.

[33] In capacity adequacy reports ENTSO-E follows a more detailed methodology which depends on declarations by the TSOs about total capacity which is unavailable in peak hours. In regulatory codes applied to support capacity obligation mechanisms the calculation of capacity availability by plant is based on statistical estimation of forced and unforced outages.

[34] In our simple estimation of reserve margins we require that the reserve margin must be higher than a certain threshold, which is set at 15%; this percentage corresponds to dispatchable capacities which are in forced or planned outage and also capacities retained for system service purposes (e.g. spinning reserve and regulation control).

Finland. The reserve situation is more comfortable in countries, such as Greece and Ireland, which have experienced critical margins in the beginning of the decade of 2000. Taking import capacities into account the EU market is likely to exhibit robust reserve margins in 2015.

Figure 9: Reserve margin trends in the short term



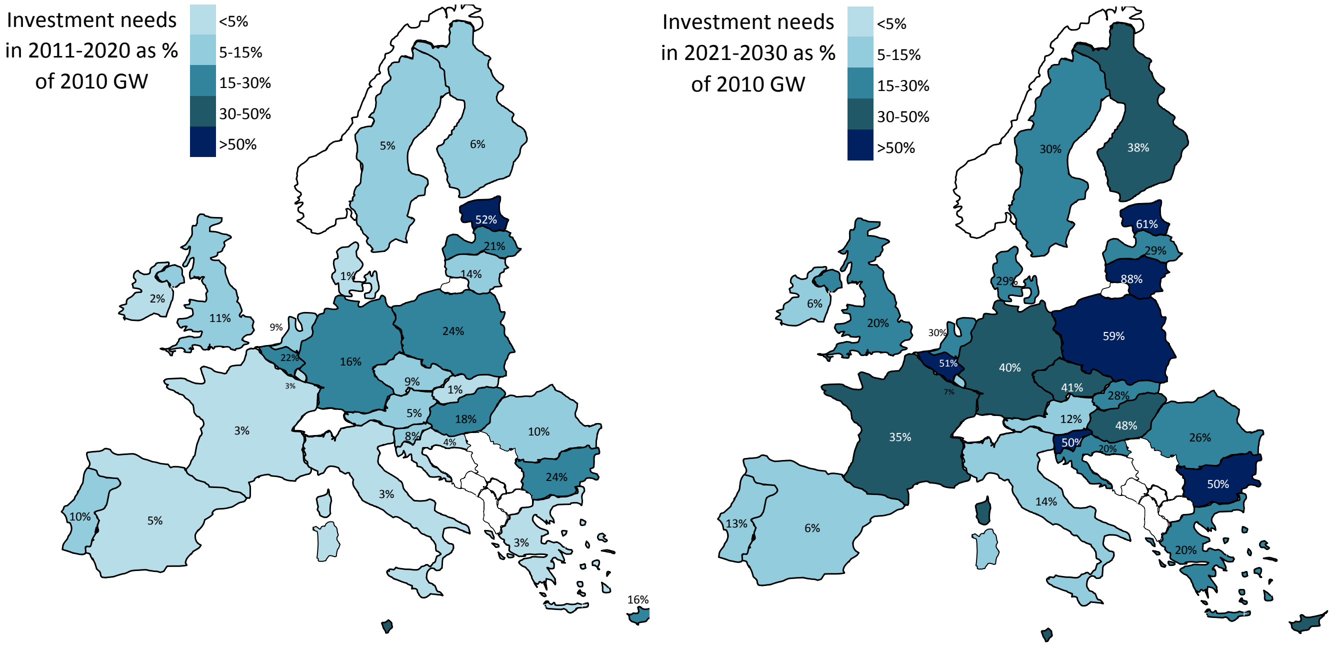
7.1.3 Capacity margins with currently known investments

The investment requirements to 2020 and 2030, shown in Figure 10, is an estimation of the amount of new capacities in dispatchable plants that the market will have to deliver to replace decommissioned capacity and cover peak demand. This estimation subtracts the remaining dispatchable capacities (capacities in 2010 minus decommissioning and plus known commissioning) from total dispatchable capacities projected in the Reference scenario. This projection takes into account some degree of capacity credits from non dispatchable RES[35], contribution from cross border trade, probable outages of dispatchable plants and system services to calculate total required dispatchable capacities to meet peak load under strict reliability criteria by country.

---

[35] Studies have calculated that non-dispatchable RES may provide between 5% and 10% of capacity credits to the system relative to their nominal capacity depending on the dispersion of renewable resources in the country. In southern European countries which may have peak load in the summer, solar energy provides higher capacity credits in peak hours than in northern countries which have peak load in the evening of winter days. Wind blowing patterns around British Isles justify higher capacity credit ratios for wind power in these areas, contrasting other countries including Germany which have rather concentrated wind blowing patterns.

Figure 10: Requirements in new dispatchable plants according to an extrapolation of decommissioning



The results show that 14 EU countries are likely to have a reserve margin below 15% in 2020 if no new investment in dispatchable plants takes place, and that all countries except three will be below 15% by 2030 (cf. Figure 11). The countries that phase-out nuclear or consider decommissioning of ageing nuclear plants are among those that see reserve margins below 15% already in 2020. Countries that have old coal plants not complying with the LCPD are also in this group.

The calculations show that the decade after 2020 demands far more new investments than the current decade. However, a number of countries would be in critical capacity adequacy situation also up to 2020 in case the market fails delivering the required investment. *Error! Reference source not found.*Table 6 groups investment requirements by region (including only EU countries).[36] The largest investment requirements are identified for Eastern Europe followed by central-western Europe and Nordic-Baltic EU. Figure 12 depicts the development in reserve margins per country if no new investments are realized.

---

[36] Central-Western EU: Belgium, Netherlands, Luxembourg, Germany and France; Central-south EU: Italy, Austria, Slovenia, Croatia, Malta; Eastern EU: Poland, Czech, Slovakia, Hungary; Iberian EU: Spain, Portugal; British isles: UK, Ireland; Nordic and Baltic EU: Denmark, Sweden, Finland, Lithuania, Latvia, Estonia; South-east EU: Greece, Bulgaria, Romania

Figure 11: Sorting of countries according to reserve margins values w/o projected investment (excl. RES) in the period 2010 to 2030, in Reference scenario

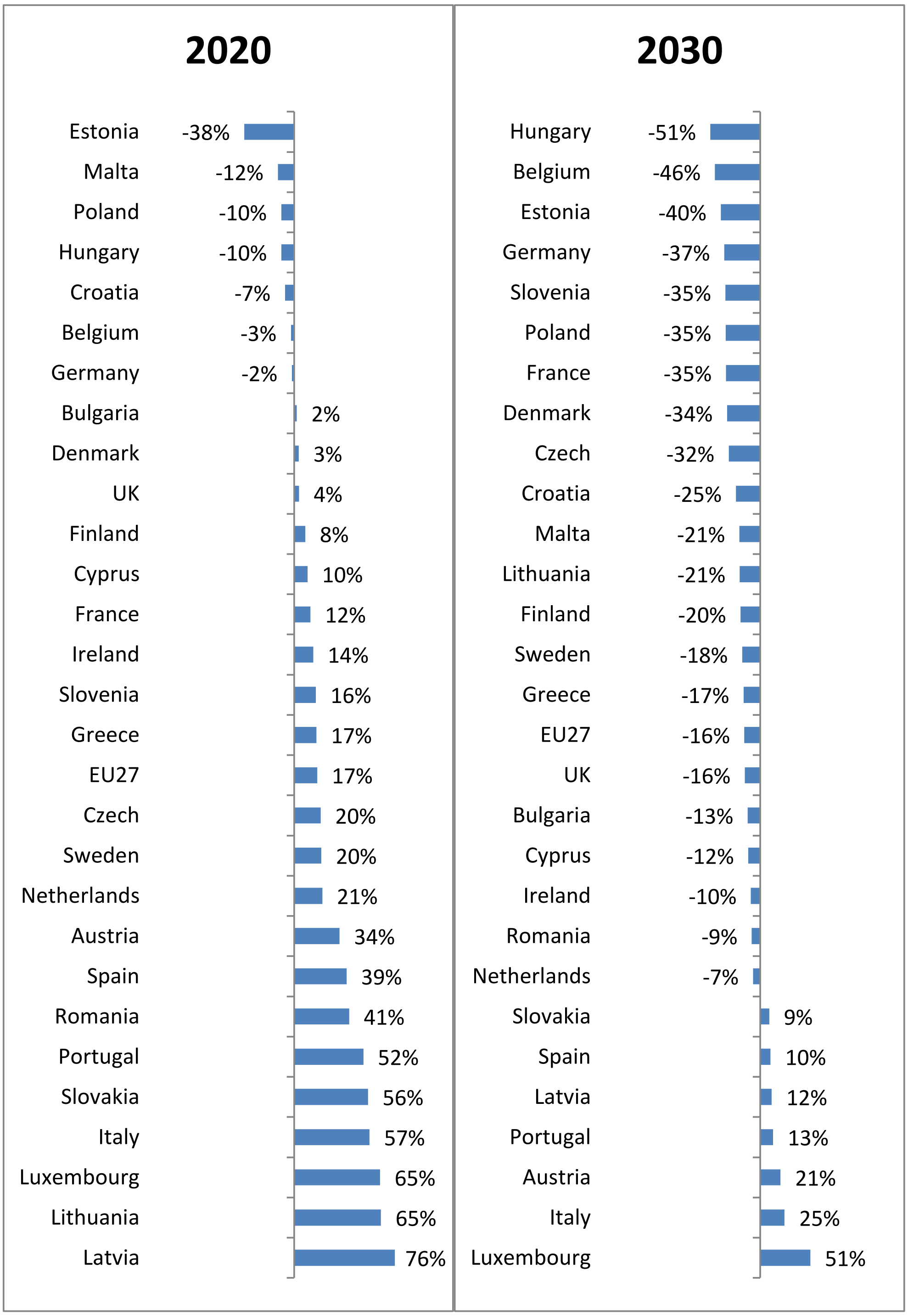
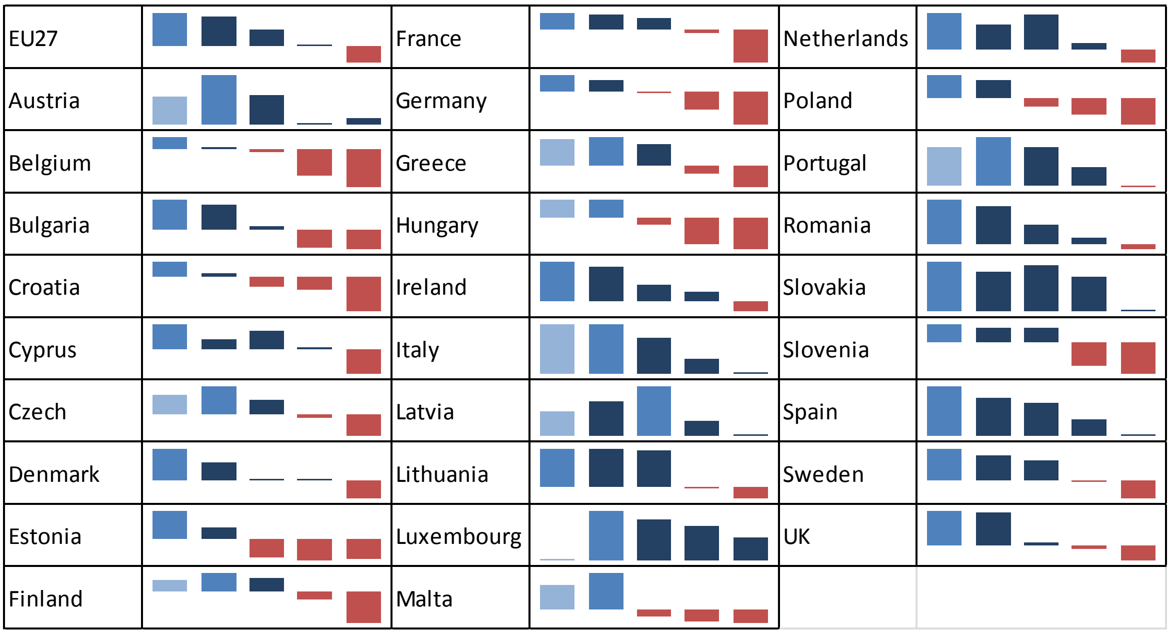


Table 6: Investment requirements in dispatchable plant by region

	Remaining capacities in GW			Investment requirements in GW		as % of 2010 capacities	
	2010	2020	2030	2011-2020	2021-2030	2011-2020	2021-2030
Central-western EU	263.1	238.1	158.8	26.4	99.1	*10.0*	*37.7*
Central-south EU	121.5	113.8	103.1	4.2	18.3	*3.5*	*15.1*
Eastern EU	63.9	58.4	43.0	10.5	31.5	*16.4*	*49.2*
Iberian EU	89.5	87.5	81.8	5.2	6.7	*5.8*	*7.5*
British isles	95.8	71.0	60.1	9.8	18.2	*10.2*	*18.9*
Nordic and Baltic EU	69.0	98.2	73.8	5.3	24.3	*7.6*	*35.2*
South-east EU	46.3	46.2	35.4	4.7	13.3	*10.2*	*28.7*

Figure 12: Reserve margins w/o projected investment (excl. RES) in the period 2010 to 2030



7.1.4 Projection of new investments in the Reference scenario

The projection of new (not known today) investment in power plants is endogenous in the PRIMES model and is based on least long-term cost capacity expansion and system operation over the European interconnected system. The projection simulates economic conditions without uncertainties and perfect foresight of future demand, future fuel and technology costs and carbon prices. Investment in renewables is explicitly modelled by applying feed-in tariffs and other supporting measures. Additional RES supporting measures are included in the modelling to allow all countries reaching their individual overall RES obligations in 2020. In addition, the model-based projection of the power sector includes least-cost capacity expansion of cogeneration (in competition against boilers for industrial uses and district heating) which is also driven by heat supply optimisation and is influenced by carbon prices.

Total electricity generation and electricity system costs, including the costs of RES supporting measures and the payments for carbon auctioning, are modelled to be passed through to consumer prices without super-normal profits. Investment economics in power generation are not modelled individually by plant (except for RES under feed-in tariffs) but collectively as if they belonged to a single generation portfolio. So, revenues from generation are modelled to cover all variable cost payments and all annual capital cost payments for the entire generation fleet taken as a whole. For example new power plants that the model finds necessary to build for reserve purposes and for supporting non dispatchable RES do not recover capital costs on an individual basis but collectively within total generation revenues.

The model does not represent any specific market regulation which would allow for the above mentioned recovery of capital costs but only assumes that whatever regulations are in place they lead to a perfect market functioning which delivers required investment according to a least cost mix and is applying charges to consumers exactly so as to recover total optimal cost. This optimal and perfect market functioning applies not only by country but also at the level of the entire EU IEM, as the model simulates least cost cross-border trade and flow-based allocation of interconnecting capacities.

Generation adequacy is ensured in the model-based projection as part of the least-cost capacity expansion projection taking into account reliability standards and system requirements for supporting non dispatchable RES. The model-based projection corresponds to an ideal market success and is used as a benchmark for analyses of projections assuming for example market failures.

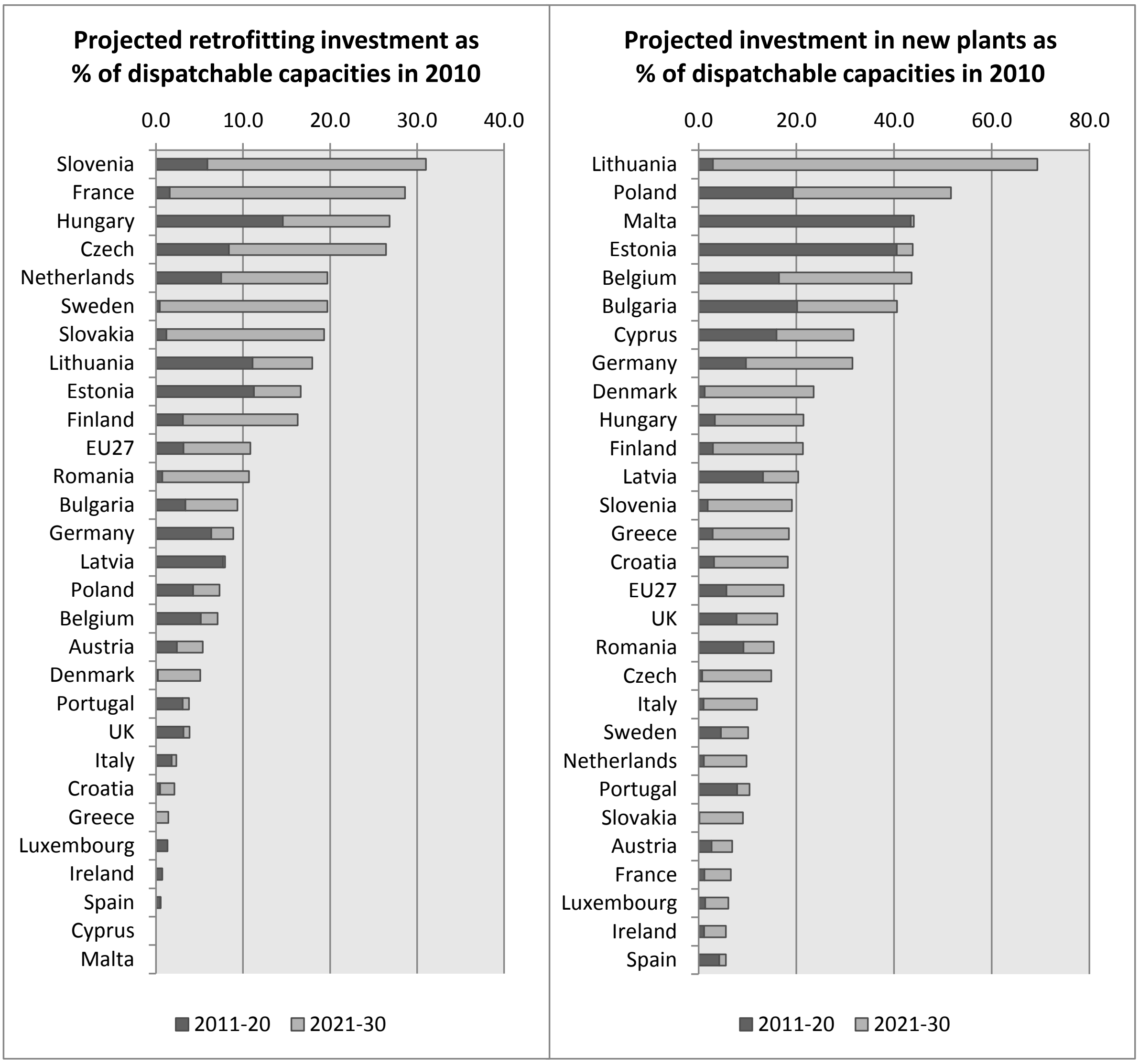
Table 7 provides an outlook of the volume and mix in new projected investment at the EU level in the Reference scenario.

Table 7: Outlook of projected investment in Reference scenario

	Total	Base-load plants	CCGT plants	peak units and CHP plants	dispatchable RES plants
2011-21	**65.9**	**11.0**	**7.1**	**39.0**	**8.7**
%		***17%***	***11%***	***59%***	***13%***
2021-30	**144.7**	**72.5**	**34.7**	**30.2**	**7.2**
%		***50%***	***24%***	***21%***	***5%***
	retrofitting investment		new plants		
2011-21	**23.5**	***36%***	**42.4**	***64%***	
2021-30	**57.4**	***40%***	**87.3**	***60%***	

As explained above the volume of projected investment is per assumption sufficient to cover the investment requirements (shown in section 7.1.3) and comply with the reliability criteria at system level. Total projected investment in dispatchable plants, excluding investment under construction, amount to 211 GW for the entire EU28 until 2030, of which 69% is projected to be commissioned in the decade after 2020.

Figure 13: Investment in retrofitting and in new plants by country relative to 2010



The model-based projection finds economic to extend the lifetime of old plants: retrofitting investment represents between 35% and 40% of total projected investment both in the period until 2020 and in the decade after 2020 (cf. Figure 13). Retrofitting investment generally has low capital costs but the extension of the lifetime is generally short (between 10 and 20 years depending on plant type). The remaining roughly 60% of projected new investment are new plants, most of which are developed on existing plant sites.

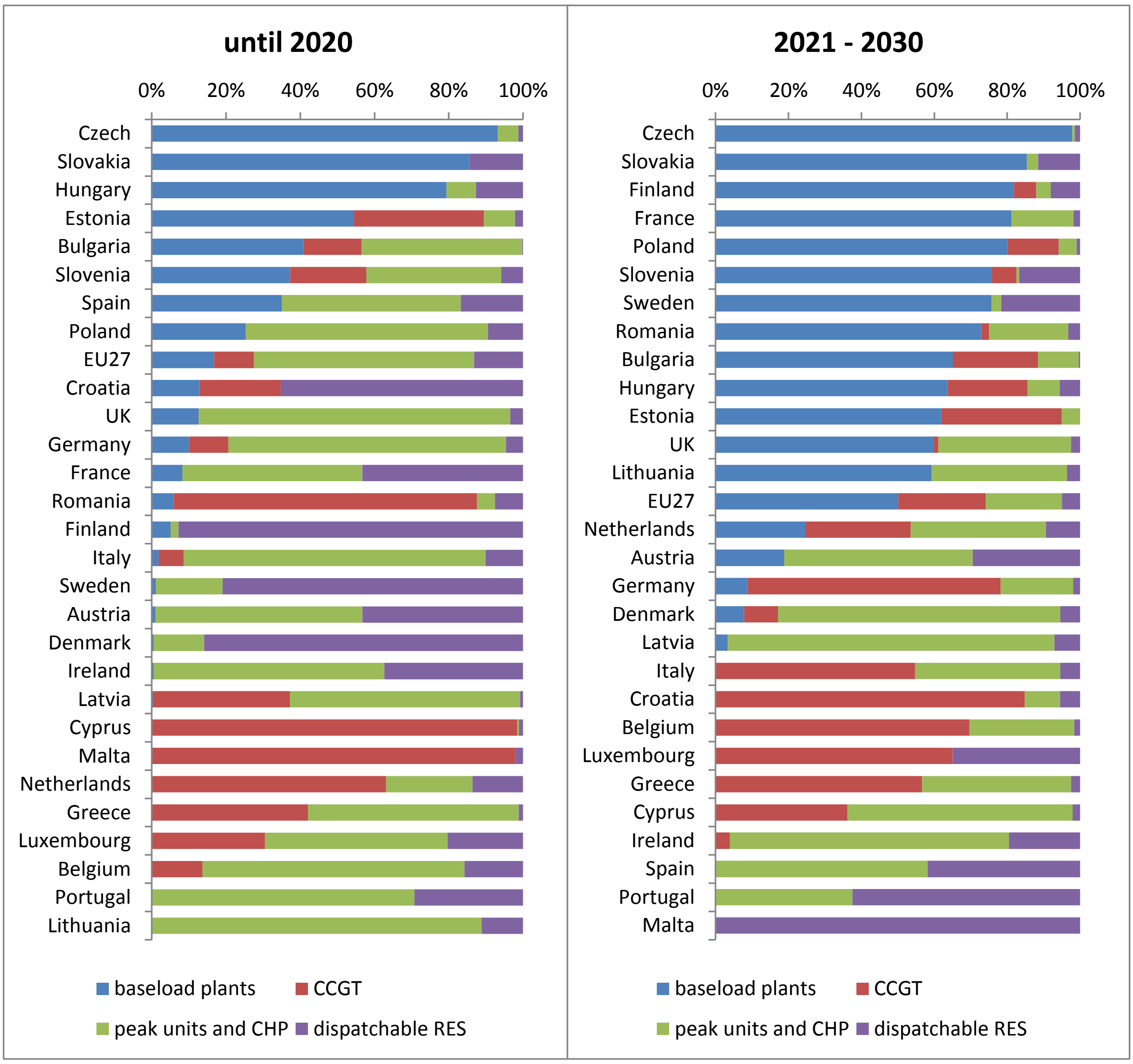
The retrofitting opportunities differ by country depending on the age of old thermal plants and on licensing and technical constraints for old nuclear plants. For example the retrofitting program for French nuclear plants is projected to be pursued, contrasting nuclear in the UK which is gradually decommissioned rather than retrofitted. The countries which pursue nuclear phase-out require relatively high investment in new plants and also have limited retrofitting possibilities. The extension of lifetime of open cycle gas plants, industrial units and CHP is among the preferred choices according to the model-based projection mainly in the time period until 2020 (half of total retrofitting) because this represents a non-expensive solution for meeting the high reserve and flexibility system requirements in 2020 when increasing capacities of non dispatchable RES gets into the system. The extension of lifetime of these open cycle plants is more limited after 2020. Nuclear plant retrofitting, mainly in France, takes place after 2020.

The structure of total projected investment is different before and after 2020 (cf. Table 7 and Figure 14). The obligation to reach the RES targets by 2020 drive investments in open cycle gas plants. Investments in CHP dedicated plants (which are cogeneration plants and their operation is driven by heat demand and heat load fluctuations) are driven by policies promoting efficiency and CHP. Investment in new peak units and CHP plants represents above 60% of total new plants in the period before 2020 and 30% of total new plants in the decade after 2020. For the decade after 2020, the model finds it economic to invest more in base-load plants and CCGT plants rather than in open cycle gas plants in order to replace part of decommissioning of old capacities. Investment in new pure merchant plants (base-load and CCGT) is projected to represent less than 20% of total new plants in the period before 2020 and above 60% in the period after 2020. Within the group of pure merchant plants, investment in new CCGT plants is higher than investment in new base-load plants throughout the period. Investment in dispatchable RES plants has a rather small share in total projected investment because of small untapped hydro potentials and also because biomass has a rather small share among total RES investment. The pace of RES penetration slows down after 2020 as the Reference scenario does not assume significant additional policies for RES beyond the targets set for 2020.

Investment in new plants is projected to be higher in countries which phase out nuclear (Germany, Belgium) or have limited possibilities to refurbish older plants (e.g. UK, Poland). For some small countries specific investment cases are included in the projection the success of which is critical for their generation adequacy (e.g. Lithuania for nuclear, Malta and Cyprus for new gas plants, Estonia for replacing old oil shale plants, and others). The structure of total projected investment are visualised in Figure 14. The countries are sorted in descending order of the share of base-load plants in total projected investment. The figure depicts very different structures by country. A common feature is the high share of peak and CHP units until 2020 except in few countries which dispose high potential of hydro and biomass (e.g. Austria, Sweden, Denmark and Finland). The bulk of projected investment in new pure merchant plants is concentrated in eastern European countries, in central-western Europe and in the UK. New investment in merchant plants in southern countries is significantly lower. CCGT has a higher share than base-load plants among new pure merchant plants, but retrofitting is projected far more for base-load plants than for CCGT. Retrofitting is the preferred option for open cycle gas plants and CHP until 2020, but also a significant volume of peak units is projected to develop until 2020.

Overall, we conclude that the issue about whether the market can deliver adequate investment (taking least cost expansion projection as a benchmark) is different for the period until 2020 and after 2020 and also differs by country.

Figure 14: Structure of projected investment (excl. investment under construction)



7.2 Investment economics from a market perspective

In section 7.1, we presented the model-based projection of investments in the EU in respect to least-cost capacity expansion and so as to ensure capacity adequacy. The projection using PRIMES determines consumer prices so as to make sure that all investments achieve capital cost recovery; without defining any particular market arrangement or regulation to enable such recovery.

In this section, we follow a backward approach, taking as given that the level of investments is as projected in the Reference scenario and simulating the operation of a wholesale market (energy-only market) under various assumptions about bidding behaviours. The simulation will cast light as to which of those investments will have the ability to recover their capital costs and ultimately as to the likelihood that energy-only markets can deliver those investments in the first place. The results of the simulation are discussed in section 7.2.4.

7.2.1 Methodology

The investment in dispatchable plants as projected by the model in the Reference scenario corresponds to an ideal market with perfect foresight and where capital cost recovery is ensured at a system-wide level. Capital budgeting is accounted for using a 9% WACC[37] in real terms.

In real markets, investments are usually based on revenue and cost projections for each plant. In a free energy-only market there is no obligation to invest, unless a supplier is bound by contractual obligations to customers. Plant revenues can be collected from wholesale markets and from bilateral contracts concluded with supply serving entities or directly with consumers. In most European countries the wholesale markets operate on a voluntary basis, except in Greece and Ireland. Hybrid market designs operate in Spain and in Italy. All of these countries apply some form of direct capacity payments (cf. section 5.2).

The aim of this section is to investigate whether investment economics applied individually for each plant would justify investment as projected in the Reference scenario. We seek to answer the question: "can an energy-only market ensure that the optimal mix of investments (as projected in the Reference scenario) will be delivered, or is there a need for regulatory interventions such as capacity remuneration mechanisms (CRMs)?" For this purpose, we assume that investments occur as projected in the Reference scenario and we simulate the operation of a virtual wholesale market by country to estimate future revenues of the plants at wholesale marginal prices. If revenues suffice to recover capital costs we can infer that the investment would be delivered without the need for a CRM.

The calculation of present values of revenues and costs, by plant, is made by simulating virtual wholesale markets by country from 2010 until 2050. For this purpose we have developed a power market oligopoly model which runs over the entire European interconnected system (see Appendix 1). The oligopoly model includes electricity demand through price depending demand functions by country, represents explicit electricity companies which own plants and perform sales to customers and also models traders (arbitragers) who perform trading transactions across system control areas to profit from price differences. The oligopoly model is much more detailed than PRIMES regarding the time resolution of the load curves and includes ramping constraints. Implicitly the oligopoly model simulates pan-European market coupling and flow-based allocation of interconnecting capacities. The oligopoly model assumes EU-wide market coupling and in a sense simulates a successful implementation of the target model.

In the simulation we consider renewables and CHP plants as must-take plants, meaning that generation from these plants should be absorbed by the system in order to meet system load requirements; hence these plants cannot be price-makers and merely shift the supply curve to the right. The remaining plants (nuclear, coal, CCGT and other conventional plants[38]) are dispatched according to merit order, i.e. according to their economic bidding.[39] Hydro capacities and pumping are assumed

---

[37] Weighted Average Capital Cost

[38] Parts of these conventional plants are also considered to be must-take plants when they serve specific industrial demand (e.g. refineries, blast furnace), when they are primarily cogeneration plants and when they serve autonomous systems (e.g. islands).

[39] It is assumed that withholding of capacities or mothballing is not permitted.

to be operated at system level to shave peak load and maximise the value of water resources on a yearly basis.

We consider that must-take generation bids zero priced offers (except for hydro storage and pumping). The PRIMES model simulates cases of RES curtailment whenever available RES exceeds demand and net exports (where applicable) taking into account technically minimum dispatchable capacity required for system reliability purposes. In real wholesale markets such potential curtailment could manifest as negatively priced offers by dispatchable plants. This possibility is taken into account in the simulation through the ramping constraints. Therefore, assuming zero bidding by must-take in the wholesale market simulations is a sufficient approximation.

Imports are assumed to influence but cannot determine marginal prices (they are assumed not to be price makers in wholesale markets but they are remunerated at system marginal prices), and are fully endogenous in the simulations, including in the projections for the Reference scenario[40]. Exports influence wholesale market prices as they are part of demand. The degree of price elasticity of demand also influences wholesale market prices.

In order to span the range of possibilities in relation to real market contexts, we perform the economic analysis for three economic bidding regimes:

- *Marginal cost bidding:* the plants bid at their (short run) marginal cost, in order to cover their variable cost. This corresponds to a perfect competition market or to a perfectly regulated monopoly grouping the generators; obviously this bidding cannot ensure that the plants collect sufficient revenues to cover total generation costs including capital costs.
- *Supply function equilibrium:* the plants can bid above their marginal costs according to supply function equilibrium (SFE) logic with the aim to obtain total revenues from wholesale marginal prices so as to collectively cover total costs, including annual capital costs.[41]
- *Cournot competition:* the plants can bid above their marginal costs according to supply function equilibrium logic with the aim to individually cover total costs, including annual capital costs.

For all the bidding regimes it is assumed that plant offers have to stay above plant variable costs.

The above regimes are simulated using the oligopoly model by varying the values of parameters expressing conjectural variation from the perspective of the competing generation companies (see Appendix 2).

The simulation of supply function equilibrium and of Cournot competition is performed empirically as follows:

---

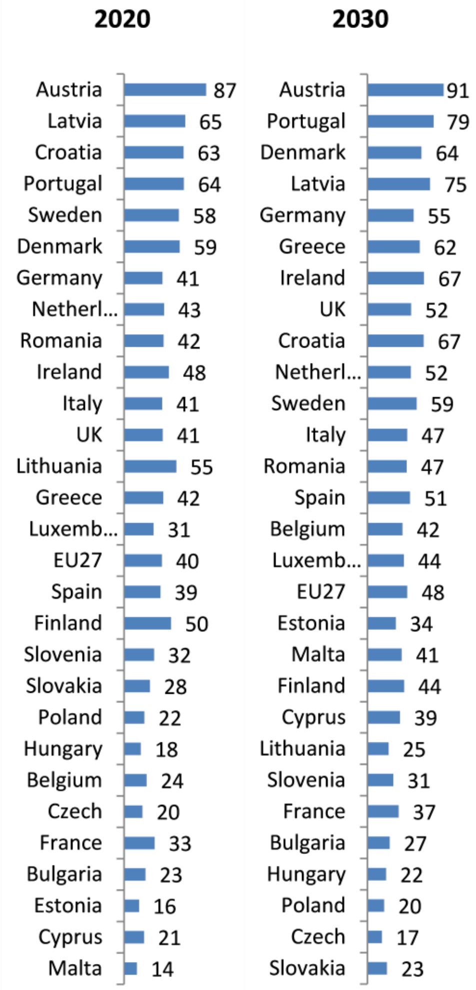
[40] This is a usual arrangement in mandatory wholesale markets. Cross-border flows determined through implicit auctions is ensured in the modeling as cross-border flows are determined as optimal power flows simultaneously with optimal unit commitment in the projection of the Reference scenario; these cross-border flows are taken as given in the simulation of virtual wholesale markets.

[41] Annual capital costs are estimated as annual fixed payments for principal and interests with the principal equal to overnight capital investment cost of the plant (for new plants) and not yet amortized capital cost for old plants (commissioned before 2011). For annuity calculations we use a WACC of 9% in real terms (without inflation).

- In the supply function equilibrium case each plant may bid above its unit variable cost and below the unit variable cost of the next more expensive plant; peak plant is free to bid above variable cost; total bids are determined so that all plants together recover the sum of their total generation costs, including capital costs;
- In the Cournot competition case each plant bids above unit variable costs but below the bidding of the next more expensive plant; the bidding is not allowed to alter the merit order compared to the supply function equilibrium case; the bids are determined so that each plant individually recover total generation costs, including capital costs.

The method of estimating market revenues from a simulation of a virtual wholesale market is a common technique which can provide a good approximation of market revenues based on a mix of bilateral contracting and a power exchange market. The approximation is good if the bilateral contracting market presents no rigidities and has sufficient flexibility in concluding contracts. Obviously the system marginal prices that are estimated for the virtual wholesale markets correspond to mandatory pool system marginal prices. These generally differ from marginal prices of non-mandatory power exchanges where generators can arbitrate between revenues from wholesale and from bilateral contracting. For example, to hedge against uncertainty, often generators seek stable long term capital revenues from bilateral contracting and get opportunistic revenues from power exchanges where they offer spare capacities.

Figure 15: Shares of must-take generation in total generation (%)



Uncertainties, transaction costs and rigidities are not considered as possible market failures for the purposes of the current simulation of capital cost recovery through wholesale markets. Such imperfections may be captured by increasing the risk premium factor which accounts in the assumed WACC[42] formula entering capital cost recovery formulas.

7.2.2 The impact of must-take generation

As mentioned in section 7.2.1, the market simulation considers all RES, including biomass, as well as cogeneration plants, as must-take plants. Hydro storage and pumping influence marginal wholesale prices as they are dispatched on a yearly basis to maximise the value of water resources (thus in a peak shaving way).

The projection of future must-take generation is based on the results of the Reference scenario (cf. Figure 15). The importance of must-take generation increases in all countries in

---

[42] A 9% WACC before inflation may be considered as a result of a scheme involving 60% borrowing at 5% real and 40% equity at 14% real. These interest rates obviously include sufficiently high risk premium factors. Sensitivity analysis with respect to the value of WACC can be carried out.

the context of the Reference scenario projection driven by RES supporting policies and other policies aiming at increasing energy efficiency. The projection shows that the remaining market volume, i.e. the competitive part of the wholesale market, is diminishing over time.

The share of must-take generation in total generation in the EU is found to increase by 16% in 2020 relative to 2010 and by 24% in 2030. Approximately 53% of total generation remains for a virtual competitive wholesale market in 2020 (45% in 2030), compared to 70% in 2010.

As a result of the increasing shares of must-take generation, the supply curves in the competitive part of the market shift to the right (cf. section 7.2.3); hence, wholesale marginal prices in case of marginal cost bidding tend to decrease over time; consequently the net revenues[43] of plants positioned in the merit order below peak plants tend to decrease, rendering capital cost recovery more difficult.

The number of countries with must-take generation higher than 50% of total is found to increase in 2020 (6 countries) compared to 2010 (5 countries). This number is projected to further increase in 2030 (11 countries).

7.2.3 Typical supply curves

Regardless of the bidding regime, the merit order or supply curves are crucial for the results of the market simulations. The supply curves naturally differ by country and change over time as old capacity is decommissioned, the share of RES generation increases and new market based capacity is commissioned. Figure 16 shows examples of supply curves for four MS.

The supply curves reflect zero price bidding of must-take plants and shift to the right as the shares of must-take generation increase over time. The slopes of the supply curves depend on the evolution of the capacity mix. Open cycle plants, which have higher variable costs than CCGT, are needed to operate in the future to support the increasingly penetrating RES and as they have to operate few hours they are often old refurbished gas plants. As the utilization rates of base-load plants are lower due to RES penetration, investment in base-load is lower than in the past. The same applies to CCGT plants, but at a lesser extent.

As a consequence old gas plants (including some industrial gas plants) become price-setting plants more often than in a system with lower RES, which would invest more in base-load and CCGT and would avoid using old gas plants. Hence, wholesale marginal prices tend to increase in peak load with high RES penetration (in a context of marginal cost bidding). However, the increase of must-take generation (following the high-RES penetration) as simulated in this analysis also implies that high variable costing plants are less frequently needed compared to a system with lower must-take generation. As must-take generation is considered to bid zero priced offers, the number of hours with high marginal prices tends to decrease as must-take generation increases. This further implies that although peak prices may increase in the context of high must-take generation revenues at such peak times become more uncertain because their frequency decreases. As a result,

---

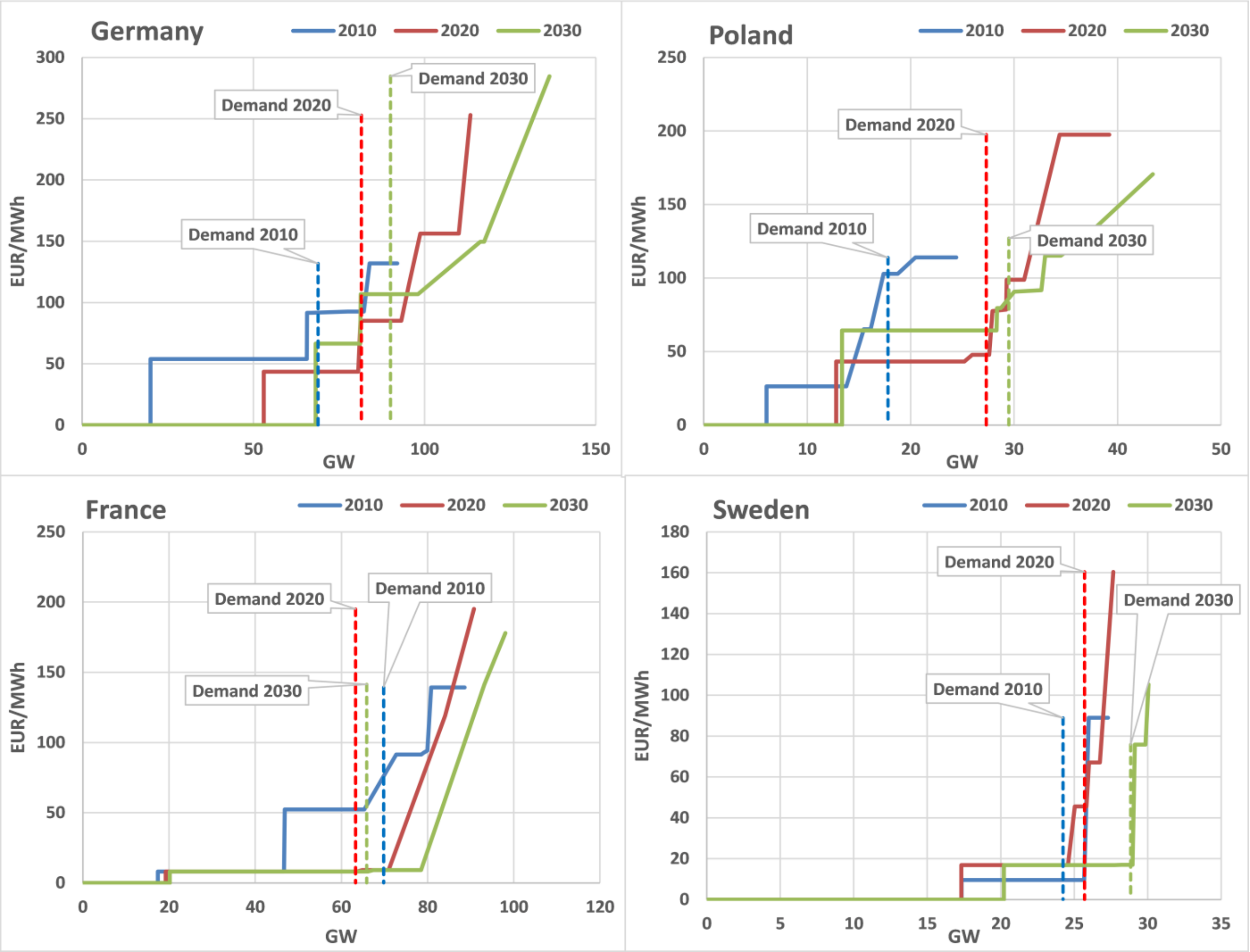
[43] Net revenues are revenues above variable costs. Their purpose is to recover annual capital costs, which include normal profits on equity, accounted for through the WACC values. If net revenues exceed annual capital costs then the plants succeeds to get super normal profits (i.e. rents above total costs).

the impact of increasing RES on yearly average wholesale prices is towards lower levels negatively impacting capital cost recovery of base and mid-merit power plants.

The supply curves take into account that gas and coal prices, as well as the ETS carbon prices, increase over time. Taking into account ETS auction payments as part of variable costs of generation, and by considering typical CCGT plants and supercritical coal plants, the fuel and carbon costs of generation from CCGT gas plants increase by 80% in 2020 and by 109% in 2030 relative to 2010 and by 58% and 139% for coal-based generation (see Appendix 2 for a detailed overview of fuel and carbon prices in the Reference scenario).

This implies that electricity prices are also projected to increase significantly in the future, spurring demand-side response and slowing down the pace of electricity demand. Another factor contributing to the slow-down is the growing energy savings enabled by the strong efficiency legislation assumed for the Reference scenario.

Figure 16: Examples of supply curves (marginal cost bidding) as estimated by the model for the Reference scenario and comparison to average load



The supply curves for Germany in Figure 16 reflect the gradual nuclear phase-out which partly explains the increase in slope over time. The shifting of supply curves to the right over time is a consequence of the increasing generation by variable RES. The simulation for Germany also finds that during a non-negligible number of hours per year marginal wholesale prices are close or equal to zero (assuming no negative price bidding) because of excess RES generation.

The graphic on France illustrates that if low variable cost generation is dominant, the penetration of RES induces not only a shift to the right but also an increase in the steepness of the supply curve (marginal prices abruptly increase from low levels to very high levels), implying that low cost generation has to recover capital costs during a few hours per year.

New projected investment in Poland adds steps to the supply curve, compared to that of 2010, while increasing must-take generation shifts the curve to the right. Systems with high hydro and high nuclear can only have a very steep supply curve, like in Sweden.

7.2.4 Results of wholesale market simulations

As mentioned above, the aim of the simulation is to estimate the likelihood that energy-only markets deliver the dispatchable plant investment that the Reference scenario projection finds as adequate for meeting demand at least cost. For this purpose we take the perspective of individual plants and we estimate investment economics by comparing expected revenues to expected costs over the lifetime of each plant type under different market competition contexts. If the calculation shows comfortable recovery of capital costs from the simulated market context, we infer that an energy-only market is likely to be able to deliver the investment. Otherwise, we infer that probably capacity supporting mechanisms or other market arrangements may be required to complement the energy-only market to ensure capacity adequacy. Although the calculations are made at a detailed plant level, we show the results grouped in a few categories: base-load plants, CCGT and open-cycle gas plants.

The market simulation model results are aggregated and shown as a capital recovery indicator which is calculated as the ratio of net present value of revenues minus expenditures over the lifetime of the plants divided by the amount of capital investment. A value above 1 implies successful cost recovery. A value between 0 and 1 indicate partial recovery of capital costs. A negative value indicates that the present value of future revenues is not sufficient to recover the present value of variable and operation and maintenance expenditures.

Marginal cost bidding case

The simulation under marginal cost bidding shows that the revenues are sufficient to recover capital costs of new base-load plants, but not sufficient for most new CCGT and almost all new open cycle gas plants. Figure 17 depicts average ratios for all planned investments (new and retrofitting) in the EU.

New CCGT plants succeed to recover capital costs only in a few countries. In half of the countries new CCGT plants commissioned after 2020 recover their capital costs but CCGT plants commissioned before 2020 do not in almost all countries. Cost recovery ratios above 0.4 on average from 2010 until 2030 are obtained for CCGT only in Belgium, France, Denmark, Sweden, Slovenia, Finland, Luxembourg, Malta and Greece.

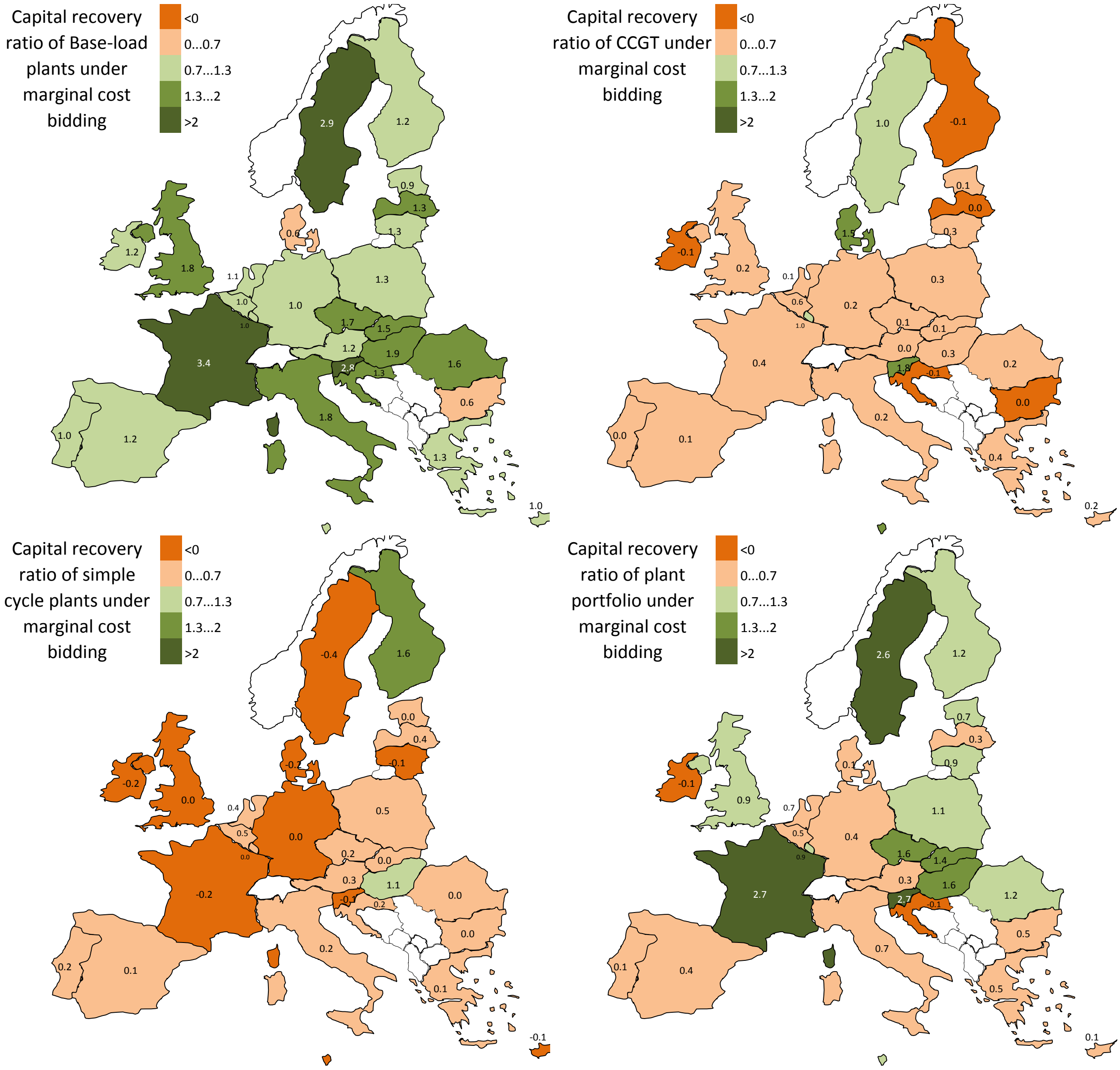
Very few of the new open cycle gas plants recover capital costs under pure marginal cost bidding. In particular, open cycle gas plants are close to recover capital costs only in Finland, Netherlands, Poland, Latvia, Luxembourg, Malta, Slovenia and Hungary. The results are shown in Table 8.[44]

In most cases, revenues from the simulated wholesale market under marginal cost bidding are above revenues required to recover capital costs of new investments in base-load plants. Generally capital cost recovery is more difficult for base-load plants commissioned before 2020 and easier for those commissioned after 2020.

---

[44] Detailed results are presented in Appendix 3.

Figure 17: Capital recovery ratio under marginal cost bidding (for all types of investments and cumulatively for the period 2011-2030)



Taking a portfolio accounting perspective on new dispatchable plants, the results under marginal cost bidding show that revenues are sufficient to recover total capital costs in 10 countries, with higher recovery rates in Finland, UK, Luxembourg, Malta, and the eastern European countries. Capital cost recovery is equal to or below 0.5 in the southern European countries, as well as in Germany, Denmark, France, Austria, Belgium, Ireland and Latvia.

Recovery of capital costs of retrofitting is successful in almost all cases of base-load and CCGT plants (few of them are to be retrofitted) but not for open cycle gas plants. As the latter are used as peak plants in the simulations and their revenues under marginal cost pricing are not sufficient to recover even the low capital cost of retrofitting.

Based on the above, we conclude that wholesale markets under marginal cost bidding operating in the context of the Reference scenario developments are likely to provide sufficient revenues for new plant constructions of base-load type. The results are mixed for investment in CCGT plants: those commissioned before 2020 have far more difficulty to recover capital costs than CCGT plants to be commissioned after 2020. For the entire fleet of new CCGT capital cost recovery is found significantly below requirements at the EU level. Finally, as expected, open cycle gas plants, which are mostly necessary to provide flexibility and backup services to RES, completely fail to recover capital costs under marginal cost bidding.

Table 8: Capital recovery index in marginal cost bidding case (average value for the EU27)

	Base-load				CCGT				Open cycle plants				All plants			
Commissioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
All projected investments																
Capital recovery ratio	0.6	1.0	2.4	1.8	0.1	0.2	0.3	0.2	0.1	0.1	0.0	0.1	0.2	0.6	1.7	1.1
No of countries	15	22	25	26	5	6	16	5	3	6	4	2	3	4	15	13
Retrofitting investments																
Capital recovery ratio	1.0	1.6	3.5	3.3	1.0	-0.1	-0.1	-0.1	1.0	0.5	0.4	0.5	1.0	1.1	3.4	3.0
No of countries	28	23	22	24	28	24	24	22	28	12	10	7	28	11	16	14
New plants																
Capital recovery ratio	0.6	0.9	1.6	1.2	0.1	0.2	0.3	0.2	0.1	0.1	0.0	0.1	0.2	0.6	0.9	0.7
No of countries	15	22	27	25	5	6	18	6	3	8	7	4	3	6	13	10

(*) No of countries refers to those in which investments recover capital cost (capital recovery ratio above 0.8)

Supply function equilibrium case

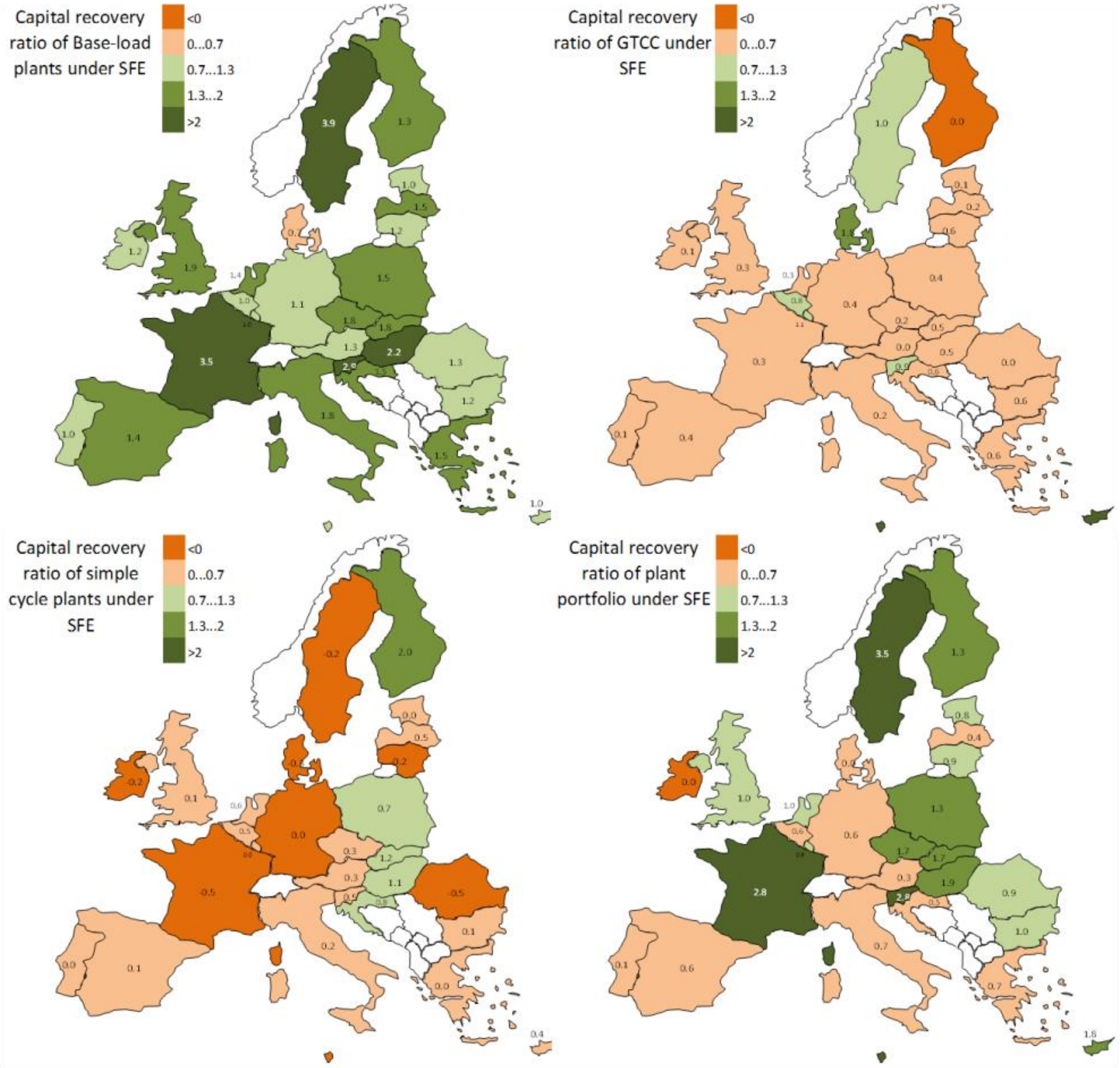
In the supply function equilibrium case generators bid above variable costs, particularly in peak load hours, to the extent competition allows for. The assumption is made that every generator has knowledge of the bidding behaviour[45] of the others, they take it as given and they determine their bidding accordingly.

The simulation shows higher peak load prices than in the marginal cost bidding case for a total of 200 to 1200 hours by year, varying by country. The higher peak and high load prices relative to the marginal cost bidding case allow for higher revenues for all plants. In a market with supply function equilibrium conditions, peak load plants can benefit from higher prices at peak load times, however they do not have sufficient market power to drive higher marginal prices during base-load and intermediate load hours. This is a common situation in electricity wholesale markets. Higher prices at peak load times may resolve the "missing money problem" under certain circumstances. The increase in revenues depends on the variable cost structure of generation plants and the degree of variety of plant types and range of variable costs. Market cases with generation structures lacking sufficient variety of plants with diverse variable costs provide little opportunities to plants standing low in the merit order to recover capital costs. Cost recovery becomes then uncertain for plants standing low in the merit order. Uncertainty tends to increase with increasing must-take generation, which limits the number of high price hours per year.

---

[45] Under supply function equilibrium, every generator commits to a supply function that relates the level of quantity offered to a bidding price; this supply function constitutes the "bidding behaviour" of the generator.

Figure 18: Capital recovery ratio under supply function equilibrium (for all types of investments and cumulatively for the period 2011-2030)



In the supply function equilibrium simulation base-load comfortably recover capital costs (cf. Figure 18 and Table 9). We could infer that base-load investment as projected in the Reference scenario would be delivered successfully by an energy-only market, provided that peak load marginal prices exceed marginal costs in peak load times. This finding is confirmed by the simulation until the end of the horizon (2050). Despite the increasing penetration of must-take generation the variability of this generation requires peaking units to be dispatched which, when bidding under supply function equilibrium conditions, drive higher wholesale market prices and allow for comfortable capital recovery by base-load plants to be invested in the future[46].

---

[46] This finding should not be misinterpreted; comfortable recovery of base-load plants does not imply that there is room for more investments than those projected in the Reference scenario. Capacity expansion as projected with the PRIMES model in the Reference scenario is optimal but subject to certain constraints. For example, investments on base-

Capital cost recovery is also positive for a substantial part of the projected CCGT investment. However, a non-negligible part of the CCGT plant capacities projected for commissioning before 2020 do not fully recover capital costs in the supply function equilibrium case. However the results show a marked improvement of capital cost recovery by CCGT plants in the period after 2020, compared to the period before 2020.The cases with earnings below capital costs for CCGT plants include Austria, Italy, the Iberian countries and the UK.

Table 9: Capital recovery index in supply function equilibrium case (average value for the EU27)

	Base-load				CCGT				Open cycle plants				All plants			
Commissioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
All projected investments																
Capital recovery ratio	0.7	1.1	2.5	1.9	0.2	0.3	0.6	0.4	0.2	0.2	0.0	0.1	0.4	0.7	1.8	1.3
No of countries	17	24	26	27	6	6	17	6	4	6	4	3	5	10	17	16
Retrofitting investments																
Capital recovery ratio	1.0	1.9	3.7	3.6	1.0	0.1	0.2	0.1	1.0	0.1	0.0	0.1	1.0	1.1	3.6	3.2
No of countries	28	25	23	24	28	24	24	22	28	13	11	10	28	12	15	14
New plants																
Capital recovery ratio	0.7	1.1	1.7	1.4	0.2	0.3	0.6	0.4	0.2	0.2	0.0	0.1	0.4	0.7	1.0	0.8
No of countries	17	24	27	26	6	6	20	7	4	8	7	5	5	12	16	15

(*) No of countries refers to those in which investments recover capital cost

The supply function equilibrium conditions are still not sufficient for open cycle gas plants to recover their capital costs except in five countries. Recovering retrofitting investment costs of simple cycle plants is slightly more successful than for new simple cycle plants.

Adding up costs and revenues for the entire fleet of dispatchable generation investments, the results indicate that the supply function equilibrium conditions are sufficient to recover capital costs in almost all countries, except in Portugal, Ireland, Denmark and Austria. This implies that when we consider all plants of a country as part of a portfolio under supply function equilibrium conditions, recovery of capital costs of new investments is achieved in the large majority of cases.

The rapid penetration of RES until 2020 clearly creates trouble for cost recovery of newly invested dispatchable plants even under supply function equilibrium

---

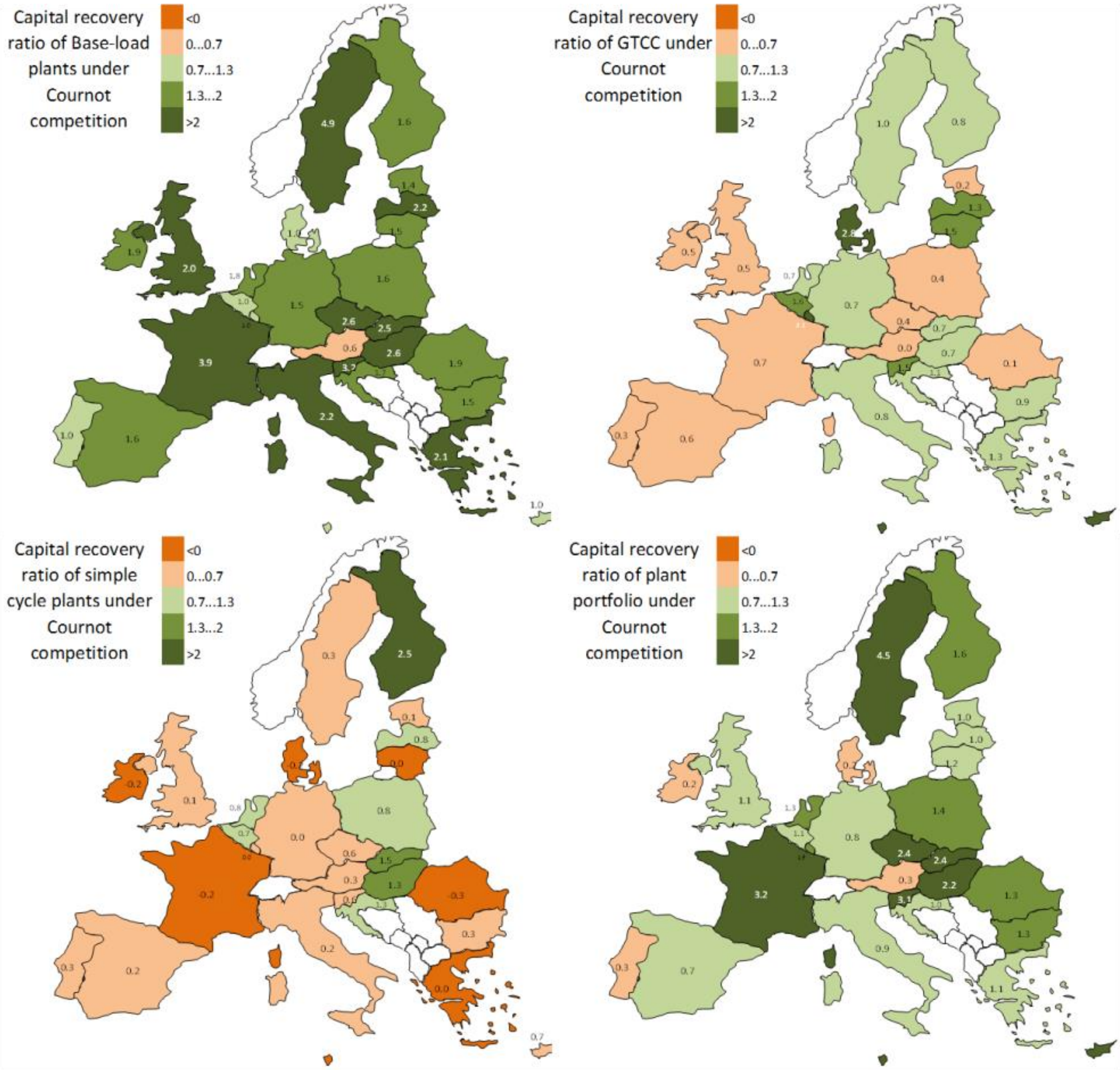
load plants are restricted by nuclear policies and availability of CCS. Such policy constraints result in investments receiving a scarcity rent when we simulate the wholesale market. Extension of lifetime through refurbishment investments involves significantly lower capital costs than for new investments but possibilities of refurbishment are limited. Such investments may have capital cost recovery ratios above one. For capacity expansion optimisation the PRIMES model also considers non-linear costs for fuel supply, where applicable, non-linear costs for new plant siting and dispatching technical constraints. Influenced by these constraints, it would be possible that certain plant types present capital cost recovery ratios above one, which does not mean that the model result corresponds to non-optimal underinvestment, simply because that costs would increase non-linearly with additional investment.

conditions. This is fully confirmed for open cycle gas which mostly provide system services and for few of the CCGT plants (during the period until 2020) in some countries. Base-load plant investments are less affected and obtain sufficient revenues. The recovery is more comfortable after 2020 but open-cycle gas plants still struggle to recover capital costs even under supply function equilibrium assumptions.

Cournot competition case

The Cournot competition case is an extreme market case in which wholesale market prices are set above marginal costs in many hours (not only in peak load). Real markets rarely operate under such extreme market power. We include this simulation for illustrative purposes. Figure 19 and Table 10 show the results of the Cournot competition simulation.

Figure 19: Capital recovery ratio under Cournot competition (for all types of investments and cumulatively for the period 2011-2030)



As expected, the Cournot competition conditions allow both base-load plant investments and CCGT investments to recover capital costs and in most cases earn revenues significantly higher than the normal return on capital. However, parts of the open-cycle gas investments are still unable to recover capital costs individually. The negative results apply mainly to Denmark, France, Malta, Romania and Ireland where the operating hours of open cycle gas plants are too low to allow capital cost recovery unless extreme price spikes are assumed for a few hours per year.

For the fleet taken as a whole (portfolio accounting), net revenues generally lie well above capital costs. Some recovery difficulties still remain in Portugal, Denmark, Ireland and Austria. Capital cost recovery is generally more successful for plants to be commissioned after 2020, compared to plants to be commissioned before 2020 and regarding simple cycle plants, recovery is easier for retrofitted plants rather than for new constructions.

Table 10: Capital recovery index in the Cournot competition case (average value for the EY27)

	Base-load				CCGT				Open cycle plants				All plants			
Commissioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
All projected investments																
Capital recovery ratio	0.9	1.5	3.0	2.3	0.5	0.6	1.0	0.8	0.4	0.3	0.1	0.2	0.6	1.0	2.2	1.6
No of countries	24	26	26	27	11	13	21	12	7	7	5	4	12	20	19	22
Retrofitting investments																
Capital recovery ratio	1.0	2.4	4.4	4.2	1.0	0.5	0.6	0.5	1.0	0.5	0.4	0.4	1.0	1.6	4.3	3.9
No of countries	28	28	24	25	28	24	24	22	28	14	11	10	28	16	19	16
New plants																
Capital recovery ratio	0.9	1.4	1.9	1.6	0.5	0.6	1.0	0.8	0.4	0.3	0.1	0.2	0.6	0.9	1.3	1.1
No of countries	24	25	28	27	11	13	23	13	7	8	8	5	12	20	19	21

(*) No of countries refers to those in which investments recover capital cost

Average SMP and mark-up ratios

To compare the three market conditions simulated, we include information on average (annual) wholesale system marginal prices (SMP) and we calculate mark-up ratios by comparing to the marginal cost bidding case. Table 11 shows calculated average wholesale prices for the different bidding regimes.

As expected, the average SMP increases towards 2020 because of the increases in international fuel prices and the system requirements for balancing[47] the increasing RES penetration. The increasing fuel prices drive up variable costs of gas fuelled plants which are price setting in peak and intermediate load. The increasing fuel prices are the main factor explaining rising SMP values by 2020. After 2020 the increase in average wholesale prices are also due to the projected increase in carbon prices (see Appendix 3).

The increasing RES penetration implies declining utilization rates of mid-merit, balancing and peaking gas units. This discourages further investment in CCGT

---

[47] In reality, balancing services are determined in real time in order to handle deviations of demand and/or supply from the day ahead plant dispatch scheduling. However, the model does not simulate this situation; it mimics balancing services through posing reserve power and ramping constrains, hence generation for balancing purposes is determined in the model simultaneously with the optimal unit commitments (see Appendix 1). Therefore, the reader should keep in mind that there is no distinction between the day-ahead market and the balancing market in the model logic and that the model treats generation for balancing services as if it was part of the wholesale market constraints.

plants or in other load following plants which could moderate prices in peak and intermediate load. The effects of higher RES on SMP prices are thus twofold: because of higher must-take generation, supply curves shift to the right, putting downward pressure on low and intermediate load prices; but at the same time, investment in base-load and intermediate load plants is profitable; hence, open cycle gas plants are increasingly used to cover intermediate and peak load, thus yielding higher prices during peak load and intermediate load.

Under these circumstances, which implies very low rate of use of peaking units, the extension of lifetime of open cycle gas plants, industrial units and CHP is a highly preferred choice according to the model-based projection until 2020. As these plants have high marginal costs and are price setting for some hours per year (between 1000 and 2500 hours), this implies a further increase of average prices towards 2020. After 2020 the pace of RES penetration slows down, energy demand increases, and the ageing of power plants calls for more new constructions. The combination of these factors justifies higher investment in CCGT and in base-load power plants, and lower use of open cycle gas plants towards 2030. As a result, the increase of average annual prices is moderated and in several countries becomes lower than in the period before 2020 in all the simulated bidding regimes.

Table 11: Simulated average wholesale market marginal prices (SMP)

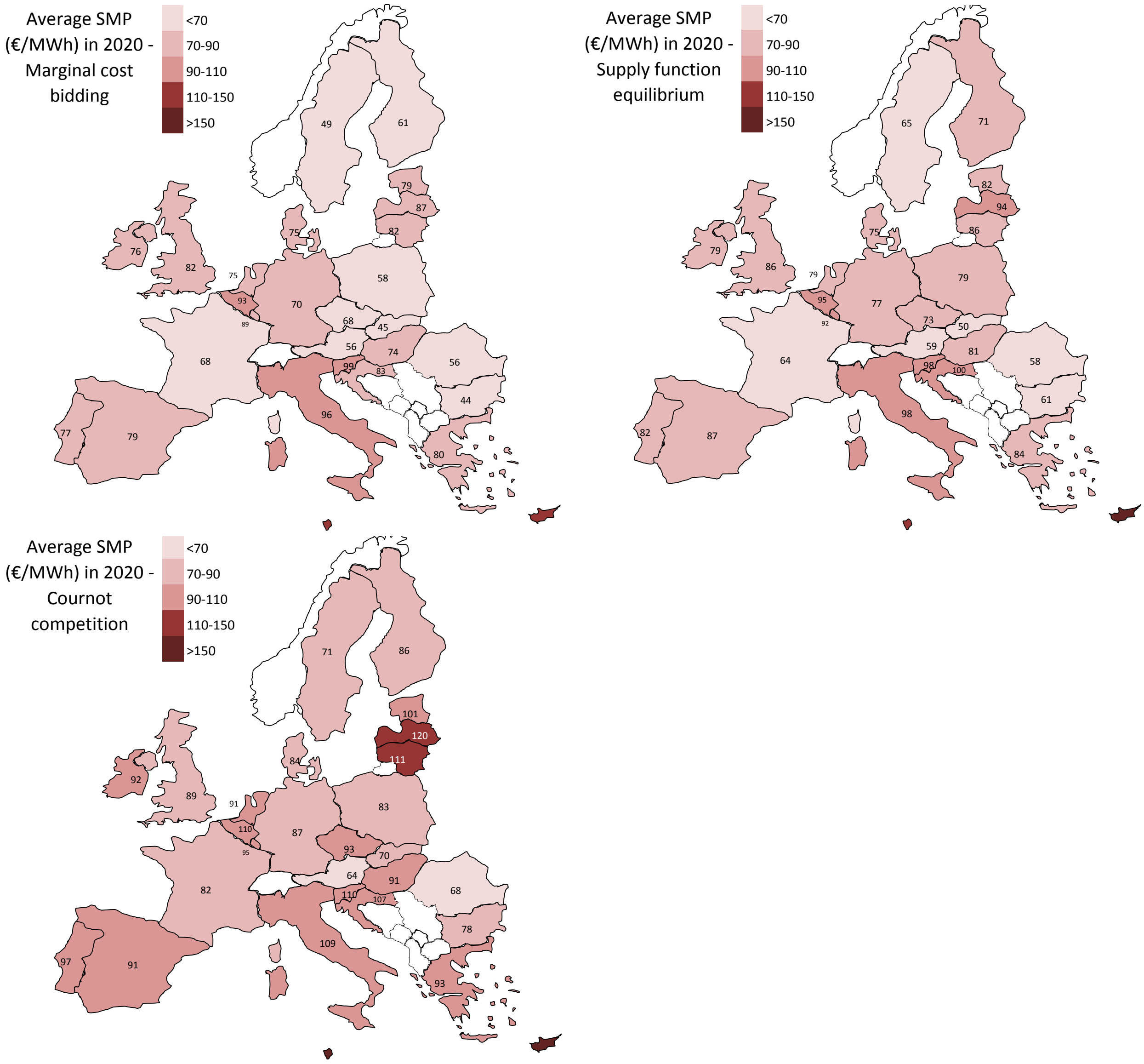
EU27	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
Average SMP (€/MWh)	40	65	76	69	82	79	90
Mark-up (% change over marginal cost bidding)				6.5	8.1	21.4	18.5

Cost mark-up ratios (cf. Table 11) are calculated from average wholesale marginal prices as a percentage change with respect to the marginal cost bidding case. A mark-up percentage of 10% means that average wholesale prices are 10% above average marginal costs. (Note that average prices are equal to average marginal costs in the marginal cost bidding case.) In the supply function equilibrium case the average EU mark-up ratio is between 6% and 8% above the marginal cost bidding levels. In the Cournot competition case average wholesale prices are between 19 and 22% higher than in the marginal cost bidding case. The mark-up values differ a lot across the EU countries. The wide market coupling assumed in the market simulations imply converging average SMPs in all bidding regimes, and especially in regions with well-developed interconnecting capacities. The convergence is more pronounced between France and Germany, in the Iberian Peninsula, in the Nordic system as well as in the eastern European region. Italy continuous to see higher price levels than the EU average. Figure 20 and Figure 21 show average wholesale prices per country in 2020 and 2030 for the different bidding regimes, whereas Figure 22 summarizes the number of countries within a particular SMP range.

Before 2020, energy efficiency measures mitigate increases of SMP, as the measures tend to smooth the load curve and moderate electricity demand growth. An example is France, which according to the simulation succeeds to increase the average rate of use of the nuclear fleet compared to 2010; this explains the modest SMP average values in the marginal cost bidding case and the low capital cost recovery ratios for base-load investment commissioned before 2020. For similar reasons, the simulations yield moderate average SMP values for Finland, Sweden and Bulgaria, as well as for Czech Republic, Slovakia, Hungary, Poland, Romania, the UK and Lithuania for the year 2030, as new nuclear is projected to be commissioned after 2020.

In countries with nuclear phase out, like Germany and Belgium or with limited possibilities for refurbishment of old nuclear power plants, like the UK, the average SMP increases due to the replacement of low variable cost plants with higher variable cost plants. The simulations for the UK indicate that capital cost recovery ratios of base load plants commissioned before 2020 are below one in the supply function equilibrium case, but well above one for plants commissioned after 2020.

Figure 20: Average annual wholesale prices in 2020 under different bidding regimes



In some countries like Cyprus and Malta, where gas supply emerges, the power fleet in 2030 is more efficient than the fleet operating in 2020 because of new investment; this explains a decrease of average SMP as new gas plants substitute older oil fired fleet.

Figure 21: Average annual wholesale prices in 2030 under different bidding regimes

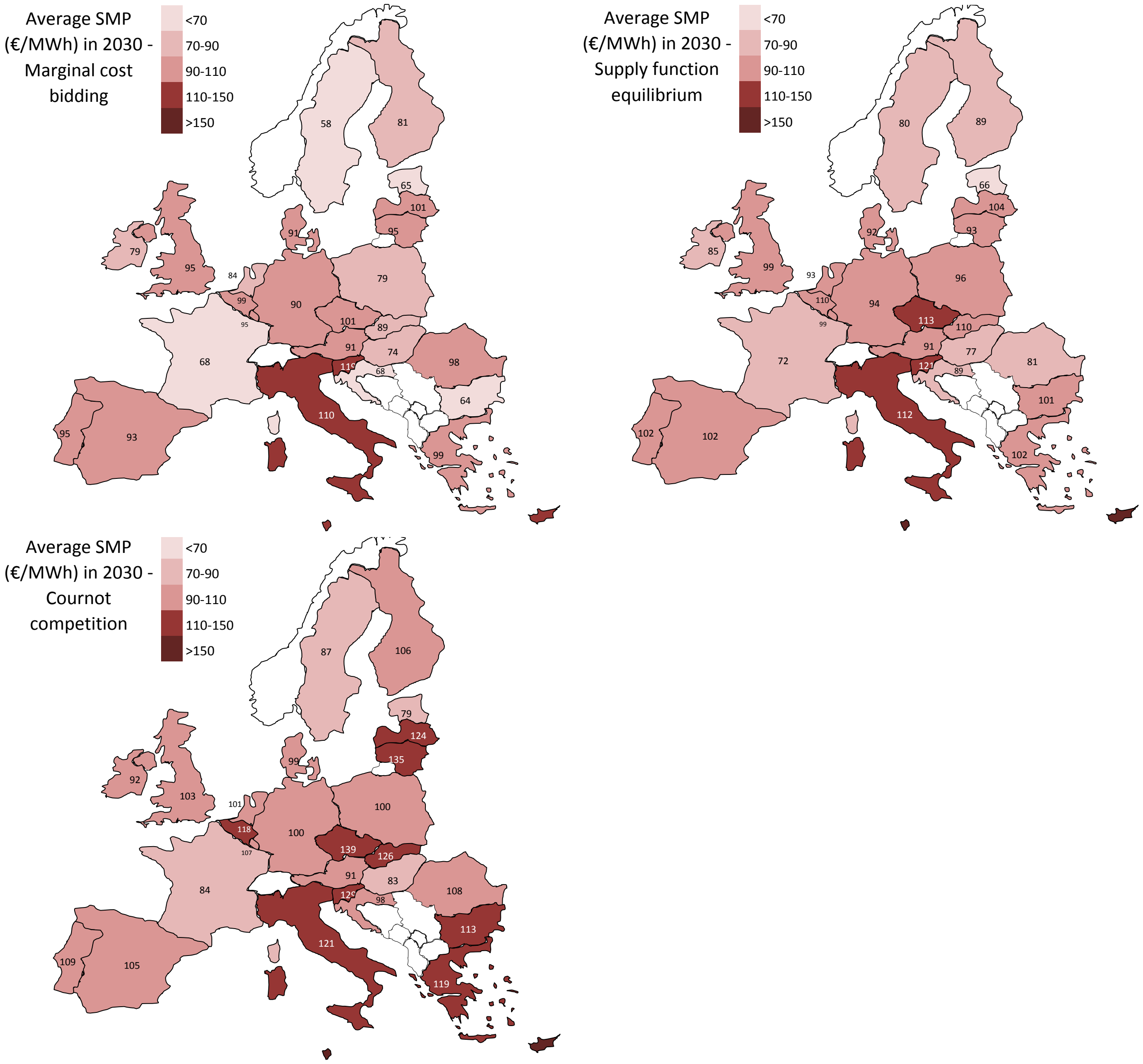
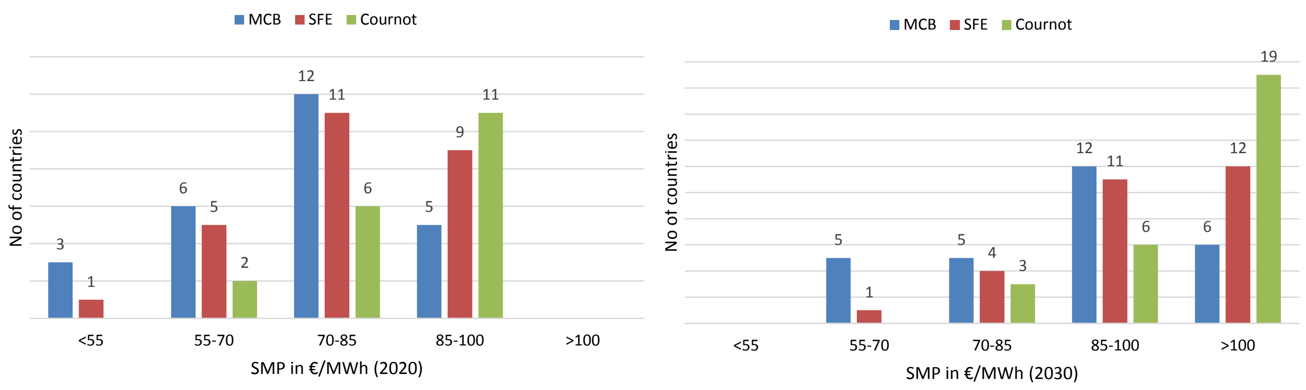


Figure 22: Distribution of average SMP under three bidding regimes



7.3 The influence of higher renewables

This section carries out a sensitivity analysis on the development of RES and the corresponding impacts on the results of the wholesale market simulation. In particular, it assesses the impacts of renewable power development higher than in the Reference scenario. For this purpose, the Diversified technologies scenario of the European Commission Energy Roadmap[48] has been updated, using the PRIMES model in order to determine the volumes of RES and the adjusted dispatchable plant investments up to 2030. Compared to the Reference scenario the increased RES generation is significant only in the long term (beyond 2020), since both the Energy Roadmap and the Reference scenario assume successful implementation of the 20-20-20 policy package by 2020. Relative to the Reference scenario, the updated projection of the Diversified technologies scenario includes lower investment on thermal power plants because demand is lower following more enhanced energy efficiency progress. The decrease in thermal capacity is higher for base-load plants than for CCGT. Another marked difference is that the average rate of use of the gas plants decreases in the decade after 2020 compared to the Reference scenario.

The assessment of capital cost recovery under higher RES indicates that all new plants get less revenues above variable costs with higher RES penetration. Despite the decrease in revenues, base-load plants still recover capital costs under marginal cost bidding conditions and of course as well as under the other two competition conditions. The decrease in revenues under high RES conditions is detrimental to capital cost recovery by CCGT plants, in particular after 2020: CCGT plants to be commissioned after 2020 struggle to recover capital costs, whereas they did recover capital costs in most countries in the Reference scenario. The capital cost recovery of simple cycle plants is negative but the situation is slightly improved in the high RES case compared to the Reference scenario because the rate of use of simple cycle gas plants is slightly higher. Hence, CCGT plants suffer the largest adverse effects among the plants commissioned after 2020. The revenues of base-load plants are also negatively impacted, mainly due to the increase of must-take generation and the increasing ramping constraints in power plant dispatching. Trade flows of peak capacity increase under high RES conditions in order to serve

---

[48] http://ec.europa.eu/energy/energy2020/roadmap/index_en.htm

balancing purposes, which creates a crowding effect on trade flows of base-load capacity. This is also a reason for the diminishing returns of base-load plants.

The results clearly indicate that energy-only market cannot support investment in gas plants as required to support the increased development of RES in the Energy Roadmap scenario, for all bidding regimes (cf. Table 12 and Table 13). This result suggests that mechanisms must complement the energy-only market for specifically supporting gas plants to remain in the market despite low rates of use and thus low capital revenues.

Table 12: Capital cost recovery ratio under high RES conditions

Plants to be commissioned before 2020	Base-load		CCGT		Open cycle	
	high RES	Reference	high RES	Reference	high RES	Reference
Marginal cost bidding	0.8	1.0	0.1	0.2	0.2	0.1
SFE	1.0	1.1	0.2	0.3	0.2	0.2
Cournot competition	1.3	1.5	0.5	0.6	0.3	0.3
Plants to be commissioned after 2020	Base-load		CCGT		Open cycle	
	high RES	Reference	high RES	Reference	high RES	Reference
Marginal cost bidding	2.1	2.4	0.2	0.3	0.0	0.0
SFE	2.1	2.5	0.3	0.6	0.0	0.0
Cournot competition	2.7	3.0	0.6	1.0	0.1	0.1

Table 13: Impacts of high RES scenario on plant revenues above variable costs

% change of cumulative capital revenues relative to reference												
	Base-load			CCGT			Open cycle plants			All plants		
Commis-sioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
Marginal cost bidding	-11.3	-36.4	-30.7	-12.6	-38.3	-26.1	-1.0	-32.7	-10.7	-10.7	-36.4	-30.0
SFE	-10.6	-40.6	-33.2	-21.3	-54.4	-38.9	-14.0	-26.9	-17.6	-11.8	-41.0	-33.1
Cournot competition	-11.1	-35.9	-29.4	-18.3	-40.3	-28.9	-14.5	-16.2	-15.0	-12.4	-35.9	-28.9

7.4 Low XB trade

This section carries out a sensitivity analysis examining the impact of limited cross border flows potential on the ability of investments to recover capital cost. For this purpose, a low XB trade scenario is developed which assumes that the Internal Energy Market is not successfully implemented. In addition, the ENTSO-E development plan fails to increase net transfer capacities. Consequently, barriers to cross-border trade persist at least up to 2030, leading to system balancing predominantly by system control area.

In order to quantify a low XB-trade scenario which sufficiently contrasts the Reference scenario, the assumptions that are adopted regarding the barriers to trade are rather extreme. The model does solve equilibrium at an EU-wide scale and applies flow based allocation of capacities, but the assumed restrictions on XB trade reduce trade possibilities to levels close to the trade flows observed in 2010. It is assumed that this failure persists and the trade flows decrease further in 2030 compared to 2020 contrasting evolution under reference conditions where flows substantially increase in 2030 relative to 2020. It is also assumed, in order to obtain a sufficiently contrasted scenario, that trade volumes decrease both at the intra-regional and inter-regional power exchanges.

Table 14: Changes in volume of trade flows under low XB trade conditions relative to the Reference scenario

% change in volume of trade flows	Intra-regional trade		Inter-regional trade	
	2020	2030	2020	2030
Central-western EU	-45%	-73%	-37%	-72%
Central-south EU	-45%	-71%	-43%	-69%
Eastern EU	1%	-55%	-10%	-51%
Iberian EU	-33%	-77%	-2%	-67%
British isles	-50%	-85%	-44%	-82%
Nordic and Baltic EU	-45%	-57%	-44%	-58%
South-east EU	-49%	-73%	-39%	-59%
non IEM regions			-15%	-25%
Total			-34%	-63%

The reduced trade possibilities imply that system control areas have to apply stricter reserve margins and reliability criteria. Hence, investments by control area increase compared to the Reference scenario. The impacts on investment are rather limited in the decade until 2020 but they are very significant in the decade after 2030 (cf. Table 15). The results show that the main additional investments are gas plants, both CCGT and open cycle. Base-load investments are held back after 2020, as part of the base-load capacity in the Reference scenario is economical due to export opportunities. In addition, the lower access to XB trade for balancing allows gas plants, especially open cycle plants, to operate more than in the Reference scenario. The usage rates of CCGT decrease by 4% until 2020 and increase by 2% after 2020. For peaking units, rates increase by 4-10% throughout the period until 2030. For base-load plants they decrease by 6-10% (see Appendix 3 for detailed results).

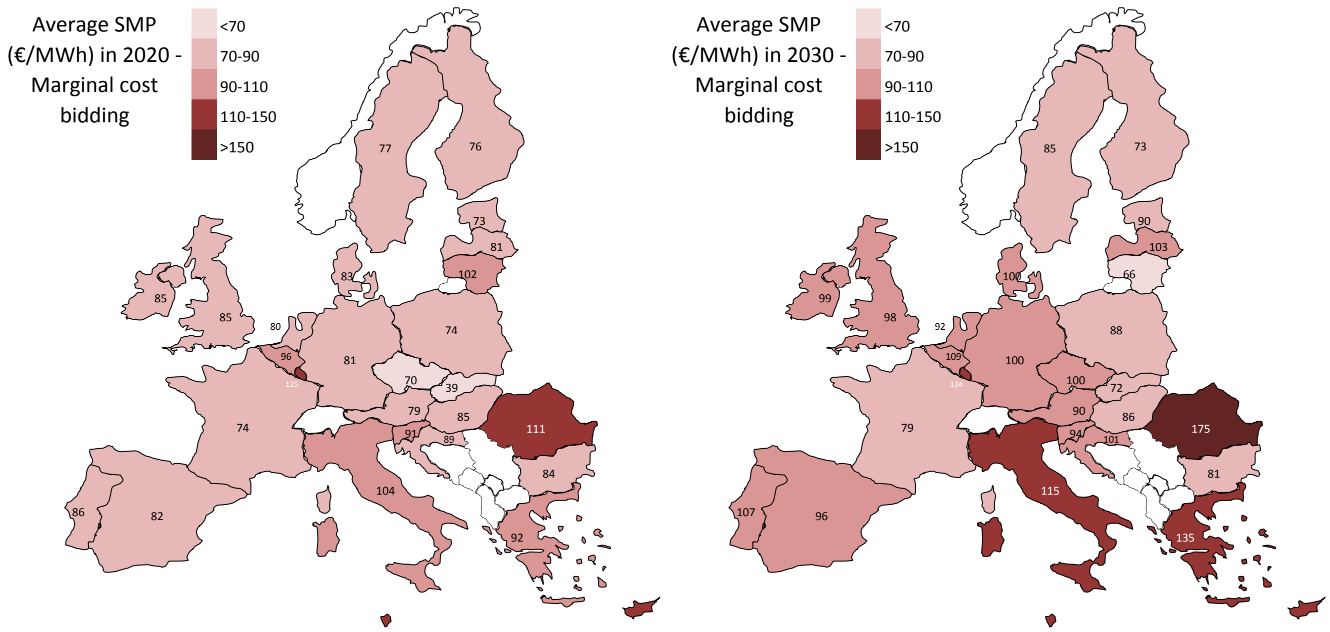
Table 15: Investment impacts under low XB trade conditions

	11-20	21-30	11-30
Reference case			
Base-load	42.5	72.5	115.1
CCGT	44.0	27.5	71.5
Open cycle	42.4	37.4	79.8
Total	128.9	137.4	266.3
Low XB-trade			
Base-load	45.9	74.6	120.5
CCGT	45.2	30.2	75.5
Open cycle	44.7	66.0	110.7
Total	135.9	170.8	306.7
% change in Low XB-Trade			
Base-load	8.0	2.8	4.7
CCGT	2.9	10.0	5.6
Open cycle	5.4	76.5	38.7
Total	5.4	24.3	15.2

(*) include refurbishments

These changes in investment and utilization rates of the different types of plants will have an effect on wholesale prices. The market simulations under low XB trade conditions show significantly altered wholesale prices relative to the Reference scenario. The general result is that average SMPs and consumer prices increase. This is expected as a result of higher investment in gas plants, increased use of highly costly plants (CCGT, peaking units) and lower use of less costly plants (base-load). The modelling results indicate significant increases in average SMPs even under the marginal cost bidding regime (cf. Figure 23 and Table 16). The lack of market coupling leads to diverging prices within regions and between countries.

Figure 23: Impacts of low XB trade on average SMPs



We estimate that the increase in consumer bills of low XB trade is between 25 and 30 bn€ per year (roughly 8-10% of total power generation cost, excluding grid costs). This number may be compared with the investment cost of the 10-year ENTSO-E development plan of approximately 50 bn€. The comparison suggests that the pay-back period of the investment is roughly 2 years, which corresponds to a well rewarding investment.

The average SMPs increase by roughly 7-10€/MWh in all bidding regimes. The mark-up ratios of the imperfect competition regimes are smaller under low XB-trade because prices are significantly higher already in the marginal cost bidding regime.

Table 16: Impacts on EU average SMPs and mark-up ratios of low XB trade

Average SMP (€/MWh)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
Low XB Trade	40	74	86	80	89	87	97
Diff. from Reference	0.0	9.2	9.4	10.9	6.5	8.3	6.7
Mark-up (% change over perfect competition) in low XB trade				8.1	3.7	17.6	13.3
Diff. from Reference				1.6	-4.4	-3.8	-5.2

Due to the higher use of CCGT and simple cycle gas plant revenues above variable costs increase very significantly for CCGT and simple cycle gas plants in the low XB trade case (cf. Table 15). The impacts are small for base-load plants, and slightly negative in the SFE and Cournot cases.

Table 17: impacts of low XB trade on capital return of new investment

% change of cumulative capital revenues relative to reference												
	Base-load			CCGT			Open cycle plants			All plants		
Commis-sioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
Marginal cost bidding	28.6	-5.8	2.0	120.2	143.1	132.2	61.0	46.7	56.6	36.8	-1.8	7.8
SFE	19.0	-7.1	-0.7	80.6	63.4	71.4	81.6	124.2	93.5	29.2	-3.0	5.7
Cournot competition	10.4	-9.6	-4.3	35.6	39.0	37.2	80.9	177.8	107.9	19.5	-4.5	2.7

Additional revenues in the low XB trade context facilitate capital cost recovery slightly for base-load plants and a lot for CCGT plants, because the latter are more used under low XB trade. In particular, capital cost recovery by CCGT plants is successful as assessed for different bidding regimes. The low XB trade also facilitates capital cost recovery of simple cycle gas, mainly for commissioning until 2020. However, the open cycle gas plants continue to bear deficits under all bidding regimes. The deficits are generally reduced in the low XB trade, compared to the Reference scenario, but the capital return deficit of open cycle gas plants is not resolved, despite the increased payments by consumers under the low XB trade context.

Table 18: Capital cost recovery under low XB trade

Plants to be commissioned before 2020	Base-load		GTCC		Open cycle	
	Low XB trade	Reference	Low XB trade	Reference	Low XB trade	Reference
Marginal cost bidding	1.2	1.0	0.4	0.2	0.3	0.1
SFE	1.3	1.1	0.5	0.3	0.5	0.2
Cournot competition	1.5	1.5	0.8	0.6	0.6	0.3
Plants to be commissioned after 2020	Base-load		GTCC		Open cycle	
	Low XB trade	Reference	Low XB trade	Reference	Low XB trade	Reference
Marginal cost bidding	2.2	2.4	0.7	0.3	0.0	0.0
SFE	2.3	2.5	0.9	0.6	0.1	0.0
Cournot competition	2.6	3.0	1.3	1.0	0.2	0.1

7.5 Cost impacts of capacity mechanisms

This section aims at calculating costs associated with the adoption of capacity remuneration mechanisms in the IEM. The aim is to calculate costs for the consumers and to evaluate what level of capacity fees would be required to complement the capital-related earnings of power plants so as to establish capital recovery ratios close to one individually by plant type. For this purpose, we take as given the investments in the Reference scenario. We then assume a certain level of capacity remuneration procured from capacity mechanisms in addition to revenues from the energy-only markets, ignoring implementation aspects of such mechanisms. The analysis does not consider the different capacity mechanism designs but only their outcome, which is capacity remuneration. The term capacity remuneration does not suggest that a capacity mechanism regulation should apply in practice to deliver the remuneration. The extra revenues may come from other market arrangements, such as well-functioning real time balancing, procurement of ancillary services (including long term reserve), strategic reserve contracts, etc. The analysis of such arrangements goes beyond the scope of the present study. The PRIMES model based projections for the Reference scenario determine consumer prices so as to recover all costs, including capital costs of all generation plants as projected to the future under least cost expansion conditions. The PRIMES model does not specify which market or regulatory arrangements would ensure this cost recovery. The revenues simulated under virtual wholesale market conditions, as simulated in the present study, may not recover capital costs as already mentioned. To cover the missing money amounts under wholesale market conditions, the present section calculates capacity remuneration fees which differ depending on the assumed bidding behaviour. The corresponding payments by consumers do not constitute additional costs on relation to consumer costs determined by the PRIMES model, since the model has included such cost recovery in the Reference scenario projection.

As mentioned in section 7.2.4, the consideration of capital-related earnings for the portfolio of new plants suggests that revenues from energy-only markets, at least under the supply function equilibrium regime, are sufficient to allow capital cost recovery. This section takes the view of individual plant economics as the only basis for inferring about the likelihood of energy-only markets delivering the planned investments. In this respect the modelling analysis indicates (section 7.2.4) that the major issue concerns the new open cycle gas plants and to a lesser extent the CCGT plants. This result suggests investigating capacity mechanism schemes that are oriented to specific plant types. For this reason, we distinguish between three cases of capacity remuneration:

- Only to new open cycle gas plants
- Only to new open cycle and CCGT gas plants
- To all new dispatchable plants (excluding dispatchable RES)

As new plants we consider those commissioned or to be commissioned after 2000. In practice, distinguishing between new and old plants when implementing a regulatory capacity mechanism may imply legal difficulties (because of the asymmetry) and may also entail adverse incentives. Old plants may be decommissioned before the end of their technical lifetime and refurbishment investment may be cancelled. Both adverse effects are undesirable from a capacity adequacy perspective. In our approach, where investments are exogenously introduced as given in the Reference scenario, such effects are not accounted for.

As mentioned in section 7.1.4, the projection of investment includes a significant part of refurbishments allowing for extension of plant lifetimes, including open cycle gas plants. At present, the capacity payment schemes that are in place in few European countries do apply capacity remuneration to all plants. However, more sophisticated capacity mechanisms that are currently implemented in the Eastern states of the USA apply capacity remuneration only to new plants and include regulatory provisions for obliging old plants to participate in the capacity auctions otherwise penalties apply.

It is therefore worth estimating the costs for the case of applying capital remuneration to old plants as well provided that they commit to deliver capacity for a certain period of time in the future, possibly after refurbishment. For the purposes of the modelling analysis, we assume that capacity remuneration applies equally to new plants and refurbished plants. This is the equivalent of assuming that there are regulatory procedures that ensure that new constructions and refurbishments investments conclude contracts with the body in charge of capacity adequacy management, with sufficient time duration in the future, and that these contracts are successfully implemented. We exclude capacity remuneration to old plants which do not extend their lifetime through refurbishment (assessed using the model). This assumption in fact neglects possible adverse effects on capacity adequacy, i.e. that old plants are decommissioned earlier because of the lack of capacity remuneration. Including refurbishment investments in the capacity mechanism has a positive impact on capacity mechanism costs, because refurbishment costs are significantly lower (per MW) than investments in new plants.

The first step of the analysis is to determine the minimum level of remuneration fee to be applied. For this purpose, we only consider new (and refurbished) open cycle gas plants and we estimate the minimum amount of capacity remuneration fee (per MW and per year) necessary to allow them to recover capital costs. The evaluation of the minimum fee is based only on open cycle gas plants because capital cost recovery has been found particularly difficult for this plant type, contrary to other plant types. In case this minimum fee, calculated on the basis of open cycle gas plants, is also applied to remunerate CCGT plants the fee level is found to suffice for allowing CCGT also to recover the missing part of capital costs. Obviously applying the fee also to base-load plants would correspond to a theoretically not necessary cost, as base-load plants are successfully recovering their capital costs. We have examined all coverage cases, however.

The model-based calculations find different minimum capacity remuneration fees by country. The values range from 5 to 85 k€/MW-year, in levelised terms for the time period until 2030. The estimations differ according to the assumed market bidding regime, being of course higher under marginal cost bidding assumptions.

The EU average capital remuneration fee is estimated to range between 35 and 50 k€/MW-year. It is assumed that this EU average is applied uniformly in all MS to avoid possible adverse effects of asymmetric capacity remuneration. Applying this fee implies additional annual costs for the consumer in 2020 and 2030, as follows:

- Only for open cycle gas: 1% of total generation costs
- Also for CCGT: 2.5% of total generation cost
- All dispatchable plants: 3.5% of generation total cost

When applying such a capacity remuneration fee to open cycle gas and CCGT plants, the capital recovery ratios at the EU overall level for the open cycle gas plants reach levels slightly above one and for CCGT plants they become close to one, obviously above the ratios estimated for energy-only market cases.

Table 19: Capital cost recovery ratios after applying capacity remuneration to gas plants

EU27	**Marginal cost bidding**			**SFE**		
	CCGT	Open cycle gas	Plant portfolio	CCGT	Open cycle gas	Plant portfolio
Energy-only market	0.23	0.09	1.13	0.40	0.10	1.27
With capacity payment	0.80	0.43	1.31	0.92	0.39	1.42

The analysis indicates that for an annual cost of roughly 2-3% of total generation costs the EU MS can ensure that all new and refurbished plants obtain revenues from energy-only markets and also from capacity remuneration which allow them individually recovering capital costs (Table 19).

If we assume that capacity remuneration is applied to old capacities as well, the annual cost for the consumers escalates to:

- Only for open cycle gas: 2.5% of total generation costs
- Also for CCGT: 4.5% of total generation cost
- All dispatchable plants: 7-9% of total generation cost

The above analysis has been extended to the sensitivity cases of high RES and low XB trade conditions.

Under high RES conditions, CCGT and other gas plants have higher difficulty in recovering capital costs compared to the reference case. In addition, the calculations show that annual cost of capacity remuneration to fill the capital cost gap is higher, compared to the reference and that the gap is larger for CCGT plants than for simple cycle plants, compared to similar gaps in the reference. On average, annual cost of capacity remuneration of new plants is approximately 3% of total generation costs under high RES conditions.

Under low XB trade conditions, the cost of additional capacity remuneration is significantly lower. The reasons are twofold: a) system marginal prices increase on a national level compared to the Reference scenario because of the lack of trade flows which provide cheap sharing of balancing resources between system-control areas, b) gas plants are more used under low XB trade because of the lack of trade flows. The higher utilization rates of simple cycle gas plants under low XB trade conditions allows for more comfortable recovery of capital costs, and thus the need for capacity remuneration is limited compared to the reference case. Total annual cost of capacity remuneration is close to 1% of total generation cost, whereas the minimum capacity remuneration fee is estimated lower than 25k€/MW-year. The reader may refer to Appendix 3 for detailed results on the cost impact of capacity remuneration under high RES and low XB-trade conditions.

7.6 Impacts of asymmetric capacity mechanisms

Asymmetric capacity mechanisms in the IEM imply that capacity remuneration in addition to energy-only market revenues are only applied in some system control areas and only remunerate plants located in this area. It is assumed that other (usually adjacent) system control areas operate as energy-only markets. Assuming that the asymmetry is taken into account by investors, generation capacity investments by country differ from symmetric energy-only market cases (and symmetric capacity mechanisms). As discussed in section **Error! Reference source not found.**, the deviations depend on the capacity remuneration fee, the specific market economics in the country applying the capacity mechanism and the interconnecting possibilities which will also influence investments in countries that do not apply capacity mechanisms. As a result of changed investment, the power generation mix as well as XB-trade flows will change. Hence, wholesale market prices will also change, both in the country applying the capacity mechanism and in other interconnected countries, relative to a symmetric energy-only market case. Consequently, capital cost recovery rates will also change in all countries, and so will prices to be paid by consumers.

The approach in this section is that the asymmetric capacity mechanism represents a distortion of the optimal market configuration presented in previous sections. This simulation assumes that reserve and reliability criteria are met in all system control areas, taking interconnections into account. In other words, the LOLPs are below the maximum accepted thresholds and there is no reason for an individual control area to adopt a unilateral capacity mechanism. The question posed in this section is then what would be the impacts if a distorting regulation which remunerates capacities unilaterally was adopted in one control area (cf. the theoretical analysis in section **Error! Reference source not found.**). The modelling does not account for any direct benefits in terms of loss of load probabilities.

Few research studies have been published on the consequences of asymmetric capacity mechanisms in interconnected electricity markets. The published studies share a common approach establishing a causality link between capacity remuneration and investment, assuming that investments deviate towards the country which applies the capacity mechanism (see Capeda and Finon, 2011). Consequently, countries without capacity mechanisms see lower investment and increased flows from the country implementing the capacity mechanism. Hence, the countries that do not apply capacity mechanisms gain some security of supply benefits to the extent that overall investments are higher compared to the case without any capacity remuneration. If the asymmetric case only implies a different allocation of capacity by country, without changing the total volume of investments, such external security of supply benefits would not occur.

The studies in the literature generally assume that the base case is lacking in capacity adequacy, and calculate LOLP improvement for unilateral capacity mechanisms. Our modelling follows a different approach: we assume that investment develops in an optimal way under reference conditions (cf. 7.1.4) so as to ensure capacity adequacy (captured through system reserve margin thresholds and the ramping constraints). This development of investment constitutes the benchmark case or, as referred to in the text that follows, the energy-only markets case. Then, we assume the unilateral application of capacity mechanism as a deviation from the benchmark case, which implies a different allocation of total investment by country; this constitutes the asymmetric case. To the extent interconnecting capabilities allow for, it is possible to see equal total investment in the asymmetric case compared to the energy-only markets case. Thus, the impacts arise from the different allocation of investment by country and manifest in terms of differentiated flows, generation mix and wholesale market prices. We do not model capacity adequacy failure cases. So, the additional payment for capacity born by consumers in the country applying the asymmetric capacity remuneration acts as an incentive to attract investment which otherwise would take place in other countries. The possible benefits of such an additional cost in terms of avoiding damages from unforeseen power supply failures are not accounted for in our modelling.

We have quantified two cases of asymmetric capacity mechanisms: a) only in France and b) only in Germany. We assume that the capacity remuneration fee allows open cycle gas plants to recover capital costs. We also assume that the same fee applies to CCGT plants as well. The level of this fee is 40k€/MW-year in both cases. We also assume that the prevailing bidding regime is described by supply function equilibrium. We simulate the wholesale market at the EU level under the asymmetric conditions and we draw conclusions on the impacts of asymmetric capacity remuneration by comparing the results to those obtained in the simulation of the symmetric energy-only market under the SFE bidding regime (cf. 7.2.4).

We use the two cases to demonstrate how the characteristics of the energy system in the country with the unilateral capacity mechanism (in this analysis France and Germany) influence the result within the country as well as in other countries. In the case of France, the focus is on meeting increased peak demand and on replacing old coal and oil-fired plants in order to comply with environmental requirements. Its investments in the reference case, mainly for replacing the ageing nuclear fleet, are dominated by base-load capacity, which represent approximately 70% of all projected investments (non-RES) in the period 2011-2030. Germany, on the other hand, is abandoning its nuclear production and aims to replace it with RES. Projected investments in CCGT and open-cycle plants in the reference case represent more than 70% of overall investments (non-RES). We therefore expect different changes in the generation mix triggered by unilateral capacity remuneration for CCGT and open cycle plants in the two countries. Moreover, net transfer capacities and the development of the TYNDP will play a significant role in how generation and flows are reallocated between interconnected countries and ultimately on the impact on the wholesale market prices. In the following, we present the effects of the asymmetric application of capacity remuneration in the two countries.

Capacity remuneration only in France

As expected, the increased incentives to invest in peak load devices in France leads to an increase in the overall investments in France, while the opposite effect is observed in neighbouring, interconnected countries. More specifically, up to 2030, the model suggests that, relative to when France operates an energy-only market, investment in France will increase by 21.7 GW, while investments decrease by 15.9 GW in Germany, 3.6 GW in Belgium and 2.1 GW in the Netherlands. The changes mainly concern open cycle gas plants and to some extent CCGT plants (Table 20). The generation mix in France is considerably altered, as capacity remuneration attracts much more investments in open cycle plants than projected in the reference case. The share of open-cycle plants in the overall non-RES projected investments is 40%, more than double than in the reference case. The corresponding share of the base-load investments falls to 50% from 70% in the reference case.

Table 20: Change in investment relative to Reference, when capacity remuneration is applied only in France

Change in investment relative to Reference when capacity remuneration is applied only in France - All projected investments in GW												
	Base-load			CCGT			Open cycle plants			All plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.0	0.0	0.0	1.6	-9.1	-7.5	-1.6	9.1	7.5	0.0	0.0	0.0
Belgium	0.0	0.0	0.0	-0.1	-0.9	-0.9	-1.4	-1.3	-2.7	-1.5	-2.2	-3.6
France	0.0	0.0	0.0	4.2	0.0	4.2	5.5	11.9	17.4	9.7	11.9	21.7
Germany	0.0	0.0	0.0	-1.4	-8.0	-9.3	-5.5	-1.1	-6.6	-6.8	-9.1	-15.9
Netherlands	0.0	0.0	0.0	-1.3	-0.3	-1.5	-0.2	-0.5	-0.6	-1.4	-0.7	-2.1

Table 21: Mix of projected investments in France and the EU, when capacity remuneration is applied only in France

Mix of projected investments	Base-load			CCGT			Open cycle plants		
	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
France									
Reference under SFE competition	21%	83%	71%	61%	0%	12%	18%	17%	17%
Capacity remuneration only in France	10%	62%	48%	52%	0%	14%	38%	38%	38%
EU27									
Reference under SFE competition	33%	53%	43%	34%	20%	27%	33%	27%	30%
Capacity remuneration only in France	33%	53%	43%	35%	13%	24%	32%	34%	33%

Cross-border trade readjusts accordingly; reallocation of investments towards France results in increased energy exports from France to neighbouring countries. The additional exports are mainly generated from peak devices. In other words, the effect on exports of France is two-fold; France is exporting more capacity for balancing and reserve purposes compared to when it operates an energy-only market, and a significant part of this service is based on peak load capacity instead of base-load capacity (Table 21).

So far, we see that the utilization of peak devices of France is much higher than in the reference case, both for internal consumption as well as for exports. As the marginal cost of operating peak devices is much higher than operating base-load plants, average wholesale prices increase (Table 22). The increase in the average wholesale price is 7.1€/MWh (10%) in 2030. The readjustment of cross border trade has an impact on prices in other countries as well, with EU average prices unchanged in 2020 and increasing by 1.3% in 2030, compared to the reference projection. In interconnected countries however, intuition suggests a decrease in average prices as the increased availability of peak capacity in France benefits interconnected countries. Instead of undertaking domestic investments to cover peak load demand, they may increase the imports from France. This constitutes a free riding effect; other countries benefit from increased capacity reliability while the cost (capacity remuneration) is born by French consumers. The results confirm that free riding occurs in the short term in Germany and also in Belgium, but at a smaller scale. The results do not confirm such an effect for the Netherlands and in the long term for Germany.

Changes in average prices in Germany are particularly interesting. In the short term, the price level in Germany decreases relative to the energy-only markets case, as the country benefits from the increased capacity availability in France to cover its balancing needs. Hence, instead of undertaking necessary investments in new efficient plants to provide balancing and reserve services Germany relies more on importing capacity from France and temporarily benefits from the decreased cost. The 2020 price level is decreased by 4% relative to the reference case. In the long term however, the significant capacity needed to support the intense penetration of RES cannot be covered only by imports from France, and Germany must increase the operation of (old and inefficient) German peak plants since investment in new more efficient plants did not take place in the asymmetric case contrary to the reference case. As a result of the lack of investments in new, efficient plants in the short term, the price level in Germany is found to increase in the long term (3% in 2030), cancelling out the free riding effect observed for 2020.

Through capacity remuneration, the ability of French peak plants to recover their capital costs individually is improved. When France is operating an energy-only market, capital recovery of open cycle plants fails, with the capital recovery ratio being -0.5 for the period 2011-2030. The corresponding ratio with the capacity remuneration of 40k€/MW-year, is 0.3. CCGT plants also improve their position, with the ratio increasing from 0.3 to 0.5. Finally, it should be noted that French base-load plants enjoy additional profits as well, due to the increased wholesale prices (ratio of 3.7, compared to 3.5 in the energy-only markets case). The increased cost recovery rates imply higher costs for consumers in France.

The cost of generation in France increases by 12% in 2030 relative to the reference case. Germany, which as we explained above benefits in the short term in terms of cost, experiences lower electricity generation costs in 2020 (-4.5%) but higher costs in 2030 (2.7%). At the EU level, total generation costs increase by 1.5% in 2030, with the corresponding figure differing by MS (Table 23).

Table 22: Average wholesale market marginal prices (SMP) and changes relative to the Reference scenario when capacity remuneration is applied only in France

	Average SMP in €/MWh		Change relative to Reference in €/MWh	
	2020	2030	2020	2030
EU27	69	84	0.07	1.05
France	70	79	5.81	7.11
Germany	74	98	-3.03	3.29

Table 23: Payment for electricity and change relative to Reference scenario when capacity remuneration is applied only in France

	Payments for electricity in bn€		Change relative to Reference in bn€	
	2020	2030	2020	2030
EU27	241	322	-0.09	4.72
France	34	45	3.23	4.59
Germany	40	55	-1.88	1.47

Capacity remuneration only in Germany

When capacity remuneration is applied unilaterally in Germany, reallocation of investments yield 9.4 GW additional investment in Germany, 4.1 GW lower investment in France (only for the period after 2020), 3.5 GW less in Belgium and 1.8 GW less in the Netherlands. The changes mainly concern open cycle gas plants and to some extent CCGT plants (Table 24). Compared to the case when the capacity remuneration is applied in France, the overall effect on investments is more subtle. The generation mix of Germany is almost unaltered compared to the reference case, with only a small decrease of the share of CCGT and a corresponding increase in the share of open cycle plants (Table 25). The explanation can be that the reference case already projects a lot of investments on peak plants for Germany, necessary to support the increased penetration of RES, especially given the on-going phasing-out of nuclear power. This is in contrast to the case of France, where the reference case projects investments mainly in base-load capacity. At the EU level, the generation mix is the same as in the energy-only markets case.

Table 24: Change in investment relative to Reference, when capacity remuneration is applied only in Germany

Change in investment relative to Reference when capacity remuneration is applied only in Germany - All projected investments in GW												
	Base-load			CCGT			Open cycle plants			All plants		
Commis-sioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belgium	0.0	0.0	0.0	0.0	-0.8	-0.8	-1.4	-1.3	-2.7	-1.4	-2.1	-3.5
France	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4.1	-4.1	0.0	-4.1	-4.1
Germany	0.0	0.0	0.0	0.8	0.8	1.6	1.5	6.3	7.8	2.3	7.0	9.4
Netherlands	0.0	0.0	0.0	-0.8	0.0	-0.8	-0.1	-0.9	-1.0	-0.9	-0.9	-1.8

Table 25: Mix of projected investments in France and the EU, when capacity remuneration is applied only in Germany

Mix of projected investments	Base-load			CCGT			Open cycle plants		
	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
Germany									
Reference under SFE competition	43%	9%	28%	13%	71%	39%	43%	20%	33%
Capacity remuneration only in Germany	40%	7%	24%	15%	58%	36%	45%	35%	40%
EU27									
Reference under SFE competition	33%	53%	43%	34%	20%	27%	33%	27%	30%
Capacity remuneration only in Germany	33%	53%	43%	34%	20%	27%	33%	27%	30%

The effect on XB trade is different than in the case when the capacity remuneration is applied in France. The new investments in gas plants due to capacity remuneration primarily provide balancing and reserve services to the German system because this system particularly requires such services. Therefore, the results do not show the similar increases in exports as in the case of capacity remuneration only in France, but rather a downward adjustment of Germany's balancing imports.

Similar to the change in investments, the effect on average prices is more subtle than in the case of capacity remuneration only in France (Table 26). The dynamics in this case are also different. In Germany average prices increase by 3.3€/MWh

(4%) in 2020 and 2.5€/MWh (3%) in 2030. Relative to the energy-only markets case Germany bears higher costs in order to increase self-sufficiency in balancing and reserve services. The long-term increase appears smaller compared to the medium term because long-term average prices were projected to be high in the reference case as well, due to the high utilization of peak devices following higher penetration of RES.

The effect on the average wholesale price in other countries (including the interconnected countries) is upward also in the case of the capacity remuneration in Germany only. At the EU level average wholesale prices increase by 2.5% in 2020 and by 1.3% in 2030. Free riding is not occurring to the same extent as in the French case, at least not until 2020. Constraints with respect to power transfer distribution factors (PTDF) play a significant role in this context. As interconnected countries incur lower investments in new peak plants, they should either operate old peak plants or increase imports in peak load. In this case, we see that countries are mainly operating their existing peak plants, which causes an increase in average wholesale prices.

Such dynamics are mostly prevalent in France, whose average price level increases in the short term (by 5% in 2020), and decreases in the long-term (by 4.9% in 2030). In the short term (up to 2020), France is increasing the use of its own peak plants although no change in investment in peak devices is projected up to 2020 for France. In Belgium and the Netherlands however, investments in peak devices are lower already in 2020, which, as mentioned above, implies that those countries are either utilizing old peak plants or that they increase the imports of peak capacity. Parts of France's peak capacity that is no longer serving Germany's balancing needs flows towards these countries. This in turn implies higher utilization of peak plants relative to the reference case, leading to an increase of the wholesale prices in France. In the long term, when France reduces its investments in peak plants, it can benefit from the increased availability of capacity in neighbouring Germany leading to free riding from its part, and thus to decreased wholesale prices.

German investments in open cycle gas plants achieve individually partial recovery of their capital costs, with the corresponding ratio for the period 2011-2030 being 0.3. The improvement from when the country is operating an energy-only market is significant, especially for the period 2021-2030 when the capital recovery ratio is negative. Capital recovery ratios improve for CCGT plants as well (ratio 0.5 compared to 0.4 in the energy-only markets case). Base-load plants indirectly benefit from the capacity remuneration, showing some extra profits (ratio 1.2, compared to 1.1 in the energy-only markets case). This improvement is however at the expense of consumer costs in Germany (Table 27).

Finally, the remuneration of capacity increase total generation costs by 2.6% in 2020 and 0.9% in 2030 at the EU level. The cost increases occur to different degrees in EU MS with the major exception of France (-8% in 2030). In Germany the increase is 5.1% in 2030. In contrast to the case when the capacity remuneration was applied only in France, the increase in the cost for the country with the individual capacity mechanism (Germany) is not significantly higher than in other countries. On the contrary, the impact on generation costs in other MS seems to be similar or even higher than for Germany. This is due to the fact that the overall impact on investments in Germany is not that intense, exactly because Germany is projected to undertake a considerable amount of investments in peak plants even when it operates an energy-only market.

Table 26: Average wholesale market marginal prices (SMP) and changes relative to the Reference scenario when capacity remuneration is applied only in Germany

	Average SMP in €/MWh		Change relative to Reference in €/MWh	
	2020	2030	2020	2030
EU27	71	84	1.75	1.05
France	67	69	3.43	-3.52
Germany	80	97	3.33	2.50

Table 27: Payment for electricity and change relative to Reference scenario when capacity remuneration is applied only in Germany

	Payments for electricity in bn€		Change relative to Reference in bn€	
	2020	2030	2020	2030
EU27	241	322	6.20	2.83
France	34	45	1.56	-3.22
Germany	40	55	2.55	2.74

Overall, the model results indicate that the distortion of investment, relative to the optimum allocation by country, is significant and that the distortion propagates across the entire internal electricity market of the EU. Investments increase in countries were individual capacity remuneration is applied while the opposite effect is observed in interconnected countries. The adverse effects on electricity costs in the countries with capacity remuneration are not compensated by the decrease in electricity costs in adjacent countries with energy-only markets. As a result total regional and EU-wide electricity costs increase in the asymmetric scenarios, approximately by 1-2% in 2030 compared to the energy-only markets case. The asymmetry creates undesirable externalities such as free-riding, thus reducing the efficiency of the market. Finally, the intensity and the dynamics of the impacts depend widely on the structure of the energy system of the countries where the capacity remuneration is applied.

7.7 Conclusions

The aim of the section is to present a model-based (PRIMES model) quantification of the power generation investment requirements in the EU member-states until 2020 and 2030 in the context of the Reference scenario. The Reference scenario projects the achievement of the 2020 renewable obligations and also low energy demand growth as a result of strong energy efficiency policies. Additionally, the analysis in this section investigates whether energy-only markets would be able to deliver the optimal capacity expansion plan suggested by the model in the Reference scenario. Using Reference scenario figures, a market model was built to address this issue. This model simulates virtual wholesale markets by country under stylized market bidding regimes which span a range of economic bidding behaviour.

The assessment of future capacity margins in the EU when we only take investments under construction and planned decommissioning capacities into account show that:

- until 2015 the EU exhibits robust reserve margins, except for a few countries where nuclear phase out is taking place or nuclear construction is delayed
- to the horizon of 2020 the amount of investments currently under construction are not sufficient to fill the capacity gap from planned decommissioning ; the investment requirements (dispatchable plants only) for the entire EU represent in 2020 9% of total dispatchable capacities operating in 2010; there is a big variety of situations in the EU countries regarding investment requirements until 2020; the requirements are higher in countries which pursue nuclear phase out and in countries which have ageing coal plants which do not comply with the large combustion plant directive
- in the decade 2021-2030 the investment requirements are significantly higher as planned decommissioning concerns much higher capacity amounts; the overall EU requirements in this decade represent 28% of 2010 dispatchable capacities; the investment requirements are relatively higher in the central-western, eastern and northern regions of the EU
- assuming no new market-driven investment in dispatchable capacities, 14 EU countries are likely to face capacity adequacy risks by 2020 and 25 EU countries by 2030

The model-based projection for the Reference scenario suggests a mix of retrofitting and new power plant constructions to meet the investment requirements in a least-cost way.

According to the Reference scenario projection, the market-based investment structure is dominated by capacity expansion of flexible gas plants and by lifetime extensions of old (typically open cycle) plants until 2020. New base-load and CCGT plants are likely to cover a rather small part of investment requirements until 2020 (less than 30%). Unlike the previous decade, the Reference scenario projection shows new constructions (including extensive retrofitting) of base-load and CCGT plants to be the main option for meeting the investment requirements during the decade 2021-2030. Open cycle gas plants still have a market share in this decade, which is substantially lower in total investments than in the previous decade. Open cycle gas plants, but also CHP and industrial plants, are shown to contribute for meeting peak load and for providing flexibility and balancing services to the system, hence leading marginal price formation for a few hours per year, which are more in 2020 and less in 2030. The share of dispatchable generation in the total system is diminishing over time and thus it is increasingly uneconomic to undertake large new investments in base-load and CCGT plants beyond the levels shown in the Reference scenario projection. Under such conditions retrofitting investment is found economically justified and in fact represents approximately one third of total investments. Pure merchant plant investment (i.e. new base-load and CCGT plants) is shown to be small until 2020 and to increase substantially only in the decade after 2020.

The Reference scenario projection shows that to the horizon of 2020 the market-based investment issue mainly concern retrofitting and open-cycle flexible units and that only to the horizon of 2030 the market will be increasingly demanded to deliver significant amounts of new merchant plant capacities. The system servicing requirements will be equally important and substantially higher than in the past both in 2020 and in 2030.

The structure of new investment as suggested by the Reference scenario differs a lot by country. In one extreme we see countries with a dominant share of hydro to mainly require flexible and reserve plants in the future; we also see countries which are pursuing ambitious RES programs to require mainly flexible and open cycle units. The projected structure is different in countries which will require replacing ageing coal and nuclear plants: the investment requirements in merchant plants are significant and are more pronounced in the decade 2012-2020.

The share of must-take generation is projected to increase over time and by 2030 becomes higher than 50% in 11 EU countries (they were only 5 countries in 2010). This implies that wholesale marginal prices are likely to be low in a high number of hours per year (and even equal to zero because of high RES generation) discouraging capital intensive investment. As open-cycle gas units (new and retrofitted) is the preferred choice for meeting peak load and balancing, wholesale marginal prices tend to moderately increase albeit in few hours per year.

The increasing development of intermittent RES implies significantly higher system balancing and reserve needs. The rates of use of flexible dispatchable plants are reduced and the market revenues are declining, as margins above marginal fuel costs are not increasing due to the increasing amounts of must-take (RES and CHP) generation. The balancing services through increasing cross-border flows play a more important role thanks to the 10-year investment plan of ENTSO-E and the assumed completion of the IEM. Despite this ambitious plan assumed to be largely implemented until 2020 and although the model simulates flow-based allocation of interconnecting capacities in conformity with the target model, price differentials among the countries are still found in 2020 and in 2030 according to the simulations.

The increasing steepness of the supply curves implies marginal price profiles which are less uniform than in the past. This indicates an increase of risk factors associated with capital intensive generation investment (base-load plants) as they would require recovering capital costs in a smaller timeframe per year than in the past. The changing shape of supply curves and marginal prices is more favourable to CCGT plant investment especially in the decade 2021-2030 compared to base-load plants. Nevertheless, the projected average utilisation rates of CCGT plants are decreasing over time and capital cost recovery depends on price setting behaviour by old and open cycle gas plants during rather few hours per year. Thus, for both base-load and new CCGT plant investments, the economic prospects are increasingly difficult in the projection because of the foreseen increase of must-take generation (RES and CHP) and so growing uncertainties are likely to increasingly surround such investments.

To assess the likelihood of energy-only markets to deliver the required dispatchable investment, three stylized virtual wholesale markets have been simulated for each EU country. All three markets assume availability of dispatchable plants and also load profiles as projected in the Reference scenario.

The three market conditions differ in mark-ups on short term marginal costs when submitting economic offers to the wholesale market:

- Marginal cost pricing: Bidding not exceeding variable costs is assumed as representative of perfect competition.

- Supply function equilibrium: Bidding above marginal costs only in peak load and in part of intermediate load hours is simulated as representative of supply function equilibrium conditions. This bidding behaviour allows investments taken as a generation portfolio to collectively recover capital cost.
- Cournot competition: The third stylized market condition mimics Cournot competition and corresponds to a bidding behaviour allowing most of the plants recovering capital costs on an individual basis.

The simulations of virtual wholesale markets under *marginal cost bidding* show that in most countries the investments in base-load plant[49] are likely to recover capital costs because of variable costs differentials in the merit order and despite the lack of price spikes at peak load. The situation for CCGT investment is however mixed: in half of the countries they are not likely to recover capital costs in the energy-only market whereas in the other half CCGT plants can fully recover or almost recover capital costs, despite the absence of price spikes in peak load hours. The economics of CCGT are found less favourable mainly in eastern European countries. As suggested by the “missing-money” theory, the open-cycle gas plants are in almost all cases unable to recover capital costs in an energy-only market with pure short term marginal cost pricing. The non-recoverable capital costs of open-cycle plants represent roughly a range between 1 and 2% of the annual turnover of the wholesale market (which includes only generation by dispatchable plants); in capacity terms these plants represent between 17 and 20% of total dispatchable capacities on average in the EU. This comparison reveals that as a rule of thumb an uplift charge of the order of 1-2% of wholesale market turnover (lasting however for many years until 2050) is likely to suffice for recovering the missing revenues of peaking and reserve plants in a perfect market context.

Under *supply function equilibrium* assumptions, the simulation found that for 11 countries, it is necessary to increase bidding above variable costs to recover on a collective basis new plants’ capital costs. In the rest of the countries higher marginal prices were required for few hours per year. On average at the EU level, the additional marginal prices incurred to allow for collective recovery of new plants’ capital costs was estimated to be roughly 7% above average SMP under marginal cost bidding (both for 2020 and for 2030). The supply function equilibrium conditions allow comfortable recovery of capital costs by all base-load investments and by almost all CCGT new investments (except 4-5 cases), as projected in the Reference scenario. But despite higher marginal prices in peak hours, open cycle gas plants still have trouble to recover capital costs on an individual basis. Nevertheless, the base-load and CCGT are found to earn above normal return on capital under supply function equilibrium conditions, and the additional revenues are sufficient to compensate for the capital losses of the open cycle plants. Using uplift charging as a means of complementing earnings for open-cycle gas plants would represent approximately 1% of wholesale market turnover annually.

Under *Cournot competition* conditions, all base-load and CCGT plants and the majority of open cycle gas plants succeed to recover capital costs on an individual plant basis. This extreme market situation implies average marginal prices approximately 20% above marginal cost bidding.

---

[49] As projected in the Reference scenario which optimizes capacity expansion

The above analysis spans a range of economic bidding regimes in the EU countries. The main finding of the wholesale market simulations is that, except in few cases, the energy-only market is able to ensure capital cost recovery for base-load and most of the CCGT investment cases but not for new open-cycle gas plants which however are increasingly required to support the growing RES penetration. Bidding above marginal fuel costs considerably increase the likelihood of energy-only markets to deliver required investment, except in some countries and mostly for peak and system servicing new plant investment, which can also get revenues (not accounted for in the wholesale market calculations) from system services and real-time balancing markets. Various regulatory arrangements exist to cope with this kind of investment gap situation, which do not necessarily point to sophisticated capacity mechanism arrangements.

However, the analysis has ignored the effects of uncertainty and market failures. The level of the WACC assumed for capital recovery (i.e. 9% real) addresses uncertainties to some extent. In case high uncertainties and market failures are the cause of inability of energy-only markets to drive new investments, the suitable regulatory remedies would primarily be to remove such causes.

In case the energy-only markets scenario is close to that of the main decarbonisation scenario of the European Commission’s Energy Roadmap to 2050, which involves higher RES development especially in the time period after 2020 and until 2030, the model-based analysis suggests the following conclusions.

The requirements significantly increase for back-up and balancing services by flexible plants and by thermal capacities with very low rates of use mainly after 2020 and close to 2030, compared to the Reference scenario.

The increase of must-take generation volume under decarbonisation assumptions implies lower wholesale market prices and lower rates of use of thermal/nuclear non-RES plants.

Consequently the problem of capital cost recovery aggravates for CCGT and simple cycle gas plants in the decarbonisation scenario, compared to the reference, especially in the time period after 2020.

The high renewables sensitivity case indicates that measures to support availability of dispatchable capacities for providing balancing and reserve services to the system become highly imperative. Since it is unlikely that novel techniques of electricity storage can develop until 2030 at a significant scale capacity incentives will have to apply in the Energy Roadmap scenario, at levels above those estimated for the Reference scenario at least for the time period after 2020. The possible capacity incentivising measures are not only capacity mechanisms; the study did not assess possible alternative measures.

The low XB-trade sensitivity analysis results assess the completion of the IEM and the implementation of the ENTSO-E development plan is of utmost importance for capacity adequacy and for the costs to be incurring for consumers. In case failures lead to low XB trade capabilities the model-based analysis suggests the following conclusions.

Under low XB-trade assumptions, the system control area operations will be carried out following national reliability criteria, which implies significantly higher requirements for gas plants to provide balancing and reserve services to increasing volumes of must-take generation mostly at a national scale. The decreased trade flow volumes also implies that importing countries in the reference will have to invest more at home to meet demand and exporting countries will have to produce less by plants which were participating in the exports. In addition, the low contribution of XB balancing implies that ramping and technical minimum constraints become more restrictive under low XB trade assumptions, compared to the reference and thus dispatching of plants with low ramping capabilities is more difficult, especially in some countries. Consequently, considerably higher wholesale market prices are found under low XB-trade assumptions compared to the reference and also regional divergence of prices are found to persist.

The higher average wholesale market prices allow higher capital cost recovery performance for gas plants, although the deficit if simple cycle gas plants remains. Adverse effects on base-load plants are found for capital cost recovery under low XB trade assumptions.

In general the low XB trade scenario implies considerably higher costs for consumers.

As a next step in the analysis, we evaluate the cost associated with the application of capacity mechanisms. In particular, we want to calculate what level of capacity fees would be required in addition to revenues from energy-only markets so as to establish capital recovery ratios close to one. Capital recovery ratios are evaluated individually by plant type.

The EU average capital remuneration fee is estimated to range between 40 and 45 k€/MW-year and it is applied uniformly in new plants and old plants after refurbishment. Model-based results indicate that applying this fee implies additional annual costs for the consumer in 2020 and 2030 of about 2%, which is a rather small fraction of the total generation costs. If we consider remuneration of all dispatchable capacities, both old and new, the corresponding figure is 9%. The evaluation of the corresponding benefits of capacity mechanisms are beyond the scope of this analysis.

Additionally we explore the case when capacity remuneration is applied asymmetrically in the EU IEM, considering two cases: a) capacity remuneration applied only in France, and b) capacity remuneration applied only in Germany. This case entails significant distortions in investment relative to the symmetric energy-only market case; the country that applies the capacity remuneration has increased investment incentives and thus increases its investments. This deviation influences interconnecting countries that, on the contrary, decrease their level of investments. Cross-border flows readjust accordingly and energy flows increase from the part of the country that applies the capacity remuneration. As a result, wholesale market prices change, in particular to the country that applies the remuneration, and in consequence so do capital cost recovery ratios and costs borne by the consumers. The intensity and the nature of the effects depend on the structure of the energy system in the countries where the capacity remuneration is applied as well as in the interconnecting countries.

When the capacity remuneration is applied only in France, the investments in the country increase significantly while overall investment in Germany, Belgium and the Netherlands decrease. The effect on the exports of France is upward. Germany seems to be benefitting significantly from the increased availability of France, at least in the short term, having a lower SMP and cost of generation than when France was operating an energy-only market; there occurs a free-riding effect, with Germany being able to cover its increased balancing needs through the increased availability of capacity in France without bearing the cost of additional investments in its own territory. The same applies to other interconnecting countries, in a smaller scale. In the long term, this reliance in capacity availability from France has an adverse effect for Germany, whose needs are increasing significantly and can no longer be covered through imports. The lack of investments in efficient plants results in a higher SMP and cost for the consumers in 2030. French gas plant investments recover their capital costs while there are significant profits for the French base-load plants. At the EU level, generation cost is increased by 1.5% in 2030 relative to when France operates an energy-only market.

When the capacity remuneration is applied in Germany, the distortions in investment and the subsequent changes in cross-border flows and wholesale prices are less intense. This is attributable to the fact that even when Germany is operating an energy-only market, the projected investments in peak devices are high in order to support the increased penetration of RES. The results show that investments in the country increase and investments in France, Belgium and the Netherlands decrease. The effect on the imports of the country is downward. Free riding also takes place in this case, with France lowering its SMP and cost of generation in the long term. German gas plant investments improve their ability to individually recover their capital costs. The effect on generation cost at the EU level is an increase of 1.3% relative to when Germany operates an energy-only market.

Overall, the asymmetric application of capacity remuneration is distorting significantly the optimum allocation of investments. It also creates undesirable externalities (free riding), which hinder the efficiency of the market; countries that do not apply the remuneration benefit from the fact that investments take place in another country, as they avoid the cost of investment while they do not risk security of supply. The adverse effects on electricity costs in the countries asymmetrically applying capacity remuneration are not compensated by the decrease in electricity costs in adjacent countries which do not apply capacity remuneration. As a result, total regional and EU-wide electricity costs increase in the asymmetric scenarios, relative to the energy-only markets case, approximately by 1-2% in 2030. Finally, the intensity and the dynamics of the impacts depend widely on the structure of the energy system of the countries where the capacity remuneration is applied, while the development of the grid plays a significant role in respect to the impacts.

In essence the model-based analysis has shown in detail the adverse effects of increasing RES on capital cost recovery possibilities of gas plants, primarily open cycle plants and secondarily combined cycle plants, which however are needed in the system for reliability and balancing purposes. Under such conditions, the missing-money problem of energy-only markets is intensified. However, as these plants essentially provide specific services to the system, one should inquire in priority about mechanisms for directly remunerating such services, for example through real time balancing markets and the procurement of ancillary services and backup power. Such arrangements may prove sufficient to convey the missing capacity remuneration to gas plants providing system services in the presence of high variable RES without recourse to general purpose capacity mechanisms. This issue becomes more acute in the context of a decarbonisation pathway such as the scenarios included in the Energy Roadmap to 2050. The completion of the internal market and the implementation of grid investments facilitate sharing of resources between control areas and significantly contribute to achieving price convergence and lower costs for consumers. Individual (asymmetric) measures to convey capacity remuneration above market levels to plants belonging to certain system control areas implies higher costs which propagate across the entire EU.

8 A European approach to individual capacity mechanisms

The discussion in chapter 6 and the modelling in chapter 7 show that individual capacity mechanisms to varying degrees undermine the efficiency of the IEM and the target model. In this chapter we discuss the two main approaches the EU can take regarding cross-border trade and capacity mechanisms: Provisions for the inclusion of cross-border capacity in individual mechanism designs, or a common European capacity mechanism design. Whatever is chosen a common approach to capacity adequacy assessments should be developed.

Individual capacity mechanisms are likely to distort cross-border trade and the efficiency of the IEM. In order to mute the adverse effects, the impact of cross-border trade must be taken properly into account when determining the capacity adequacy target and cross-border participation must be facilitated where relevant. The latter may be achieved by defining a specific European capacity mechanism design, or by setting certain criteria for individual capacity mechanisms to ensure that the adverse effects are minimized.

From the discussion above, we can distinguish between two main adverse effects of capacity mechanisms on cross-border trade and the efficiency of the IEM:

1 The adverse effects of setting capacity margins too high

2 The adverse effects of individual (asymmetric) capacity mechanisms

In addition to raising total electricity system costs, investing in too much capacity in one market suppresses wholesale prices, and distorts trade and the incentives for investments in interconnector capacity. In addition, even if the capacity level is not set too high (compared to the optimal solution), different design of capacity mechanisms in individual markets is likely to affect the location and mix or investments, and consequently the value of trade and cross-border interconnection. The first effect is a general concern regarding introduction of capacity mechanisms, but will also amplify the adverse effects of individual capacity mechanisms within the IEM.

The questions analysed in this chapter are

1 What general criteria apply to market intervention in the form of individual capacity mechanisms?

2 How should cross-border capacity be included in capacity adequacy assessments of individual markets?

3 If any capacity mechanism model is allowed for individual capacity mechanisms, how could and should cross-border participation be facilitated?

4 Should the EU establish one standard model for individual capacity mechanisms, and if so, what are the pros and cons of the different models in terms of adverse effects on the IEM?

In order to implement an individual or common capacity mechanism and define the proper level of capacity payments or capacity margin, a capacity adequacy assessment needs to be carried out. If the conclusion of the capacity adequacy assessment is that a capacity mechanism is needed, the next question is what capacity mechanism to introduce. In order to minimize the adverse effects of the IEM the EU Commission should set down certain principles for individual capacity mechanisms, either in the form of a set of criteria for individual capacity mechanisms, or in the form of a standard design.

8.1 Criteria for market intervention

MS have the right to implement measures that are deemed necessary to preserve security of supply in the domestic market, according to public service obligation (PSO) regulations. However, market intervention requires documentation that such intervention is merited on certain grounds.

The overall criteria for introduction of individual capacity mechanisms with reference to PSO, as well as other market interventions, are that they be:

1. Necessary: A thorough gap analysis is needed to demonstrate that intervention is needed
2. Appropriate: Analysis of alternative measures is needed to determine the appropriate action. The appropriate action depends on the challenge at hand. In principle, capacity mechanisms should only be implemented if it is clear that other means, which could remove or reduce weak investment incentives, and are deemed superior, are implemented first.
3. Proportional: Implementation of the capacity mechanism should not unduly increase system costs and costs to end users, or inflict unnecessary costs upon adjacent markets. Common guidelines on the methodology for calculation of costs should be developed (cf. experience from UK; DECC, 2012b).

8.2 Inclusion of cross-border capacity in capacity adequacy assessments

A proper capacity adequacy assessment requires projections for and analyses of a large number of parameters, and is a complex undertaking. Never-the-less such analyses are needed as a basis for all capacity mechanisms although estimations of all parameters are not necessary for all designs. Before the particular capacity mechanism design is chosen, however, one must assess whether a capacity mechanism is needed at all.

The capacity adequacy assessment may be divided into three steps. First, a capacity gap analysis, based on a projection for consumption growth and more or less certain developments in the generation capacity, should be carried out. Second, an assessment of the contributions from interconnector capacity should be made. Third, the options for closing the gap should be analysed.

Hence, the guidelines for the capacity adequacy assessment should include

1. Reference capacity gap analysis:

› Electricity demand: Scenarios for demand growth, including historical trends and economic growth assumptions, plus impacts of e.g. energy efficiency targets and other policies.

› Electricity supply: Existing capacity and known investments and decommissioning, availability of intermittent (non-controllable) generation sources based on historical data.

2. Cross-border contribution

› Development in cross-border capacity, and the utilization of cross-border capacity

- Import and export flows in scarcity situations, including analysis of correlations between the markets and the patterns of hourly price differences.

3 Options for closing the gap:

- Assessment of price sensitivity of demand (demand response)
- Expansion of interconnector capacity, including increased availability of interconnector capacity
- Market (commercial) basis for investments in new generation capacity, including profitability of different options and uncertainties

The steps are explained in some more detail below. The approach is of course partly inspired by the ENTSO-E Scenario outlook and adequacy forecasts (ENTSO-E, 2013). The current ENTSO-E approach does however not fully include the assessment under point 2, and does not include the assessment under point 3.

1. Reference capacity gap analysis

The basis for the capacity adequacy assessment should be a "traditional" analysis of future demand and supply. We propose that the starting point for demand projections include a reference scenario and sensitivity analysis provided without taking *new* measures for e.g. demand response into account. However, expected impacts of e.g. energy efficiency measures associated with policy targets should be part of the analysis. And so should the possible impacts of market developments that expose end-user to market based (hourly) prices.

On the supply side, an analysis of current capacity, known investments and decommissioning should be provided. This analysis should to the extent possible not be speculative, i.e. there should be a large degree of consensus about the development. Clear guidelines for the assessment of availability of different kinds of capacity should be defined, including e.g. a methodology for determining the expected contribution from wind and other RES technologies in different situations.

2. Cross-border contribution

The gap analysis and the assessment of contributions from demand side response, particularly in peak hours, should provide a clear picture of when import capacity is needed the most. The probability that existing interconnections can indeed provide imports at times of stress must take into account the correlation between markets, availability of cross-border capacity including capacity allocation methods and loop flows. Historical data should shed light on these issues, but as the capacity mix is changing in all markets, assessments of future developments in adjacent markets need to be made.

As it would be a mistake to assume that interconnector capacity will *not* contribute to capacity adequacy, it would also be a mistake to assume that interconnector capacity will *always* contribute in full, by default. The model analysis in this project as well as the methodology for capacity adequacy assessments developed by ENTSO-E (annual Scenario Outlook and Adequacy Forecasts) should provide relevant guidance on the way in which interconnector capacity may be taken into account in regional analyses.

3. Options for closing the gap

The detection of a future capacity gap should not be taken as a proof of insufficiency capacity adequacy in the future without further assessment. Hence, step 3 of the analysis is to consider the options for closing the gap, including the probability that the gap will be closed by the market and alternative measures that may be taken in order for the gap to be closed.

First, the development in demand response should be assessed, taken into account planned changes in the framework conditions for demand response, and including the profitability of demand response.

Second, possible increases in the contribution from cross-border trade should be assessed, including investments in physical interconnector capacity and improved utilization and availability of interconnector capacity.

Third, the profitability of investments in new generation capacity needs to be addressed. Here, not only the revenues from the day-ahead market should be taken into account, but even probable revenues from intraday trade and the provision of system services including balancing. On the other hand, the costs of providing such services should also be assessed.

Assessing the basis for market based investments is perhaps the most complicated task on the list as it requires an analysis of the "faith" in the market, the relevant risks and the risk appetite of investors. Since the very reason for the capacity adequacy assessment in the first place is concern that the market will not provide sufficient investment signals, the outcome may to some extent be given. On the other hand, assessing the basis for market based investments will anyway be necessary in order to determine the proper capacity margin for the possible capacity mechanism.

The proposed criteria for capacity adequacy assessment suggest that before the decision to introduce a capacity mechanism is made, alternative measures should be considered.

If the gap analysis concludes that capacity is inadequate, i.e., the total of imports, generation and demand response will not be sufficient to cover peak demand in the future, the next step of the analysis should be to assess the market failures explaining the deficit:

1 Demand response: Is demand response insufficiently stimulated? Will demand response be better activated and/or increase in the future? What measures can be taken to improve demand response?

2 Market intervention: Do market interventions in price formation create a "missing money problem"? Will the situation prevail? Can interventions be reduced?

3 System services: Is supply of system services inappropriately compensated? Will system services provide more revenues in the future? What measures can be taken to improve the compensation schemes for system services?

4 Interconnector capacity: Is interconnector capacity optimally utilized? Will the utilization improve? What measures can be taken to improve utilization of interconnector capacity?

5 Market functioning: Do the DAM and ID markets provide market participants with adequate price signals? Will the situation improve? Can additional measures improve short term price signals?

6 Market failures in other markets: Do other market failures, e.g. in the gas market or financial markets, constitute barriers for investments? Will barriers be reduced? Can measures be taken to reduce barriers?

Finally, the long term developments in these dimensions should be assessed: What long term measures can be implemented to close the gap, including improved market coupling, expansion of interconnector capacity, etc.? Currently, the impacts of implementing the target model and the TYNDP are important developments that must be considered, in addition to the expansion of renewable electricity generation and implementation of the energy efficiency directive. Hence, the *duration* of the need for a capacity mechanism must also be part of the assessment. The duration of the gap is relevant for the choice of capacity mechanism design.

What alternative measures should be taken depends on what the analysis reveals to be the source of the challenge. Naturally, the solution may consist of a combination of measures of which a capacity mechanism may be one option. Even if a capacity mechanism is still deemed necessary, implementing other corrective measures should reduce the scope, and hence reduce the costs as well as the adverse effects of capacity mechanisms.

The analysis of the capacity gap and options for closing the gap should also reveal what kind of capacity is missing based on a model based assessment of the optimal future capacity mix. Obviously several scenarios and sensitivities should be analysed, including scenarios for variables such as CO_2 prices and fuel prices.

In accordance with our model analysis in chapter 4, an element to consider is the expected profitability of the required investments. However, even the uncertainty of crucial parameters must be assessed.

A particular concern is that the very discussion of capacity mechanisms may inspire investors to withhold or postpone investments. Hence, the analysis and consideration of capacity mechanisms may in themselves amplify or even create a capacity adequacy challenge. On the one hand, capacity mechanisms that are market wide and particularly include existing capacity should mitigate such behaviour. On the other hand, investments in the expectation of capacity mechanisms may send a signal to authorities that capacity mechanisms are not needed after all. Hence, it is challenging to see how capacity adequacy assessments can be made purely objective.

Such a capacity adequacy analysis requires the use of system and market models spanning beyond national markets and individual control areas. With the introduction of flow-based market coupling however, TSOs should have access to adequate tools for making regional gap analyses. For well-interconnected regions, the TSOs and other relevant authorities should cooperate on the development of regional gap analyses. Alternatively, regional analyses may be the responsibility of ENTSO-E.

8.3 Cross-border participation in individual capacity mechanisms

If the capacity adequacy assessment concludes that a capacity mechanism is needed, the next question is how cross-border participation could be facilitated in different designs of individual mechanisms.

Obviously, the capacity contribution of cross-border capacity cannot exceed the interconnector capacity between the markets. Hence, the direct participation of generation capacity or demand response in adjacent markets is limited by the cross-border capacity. Alternatively, capacity contributions from adjacent markets can be represented by direct participation of the interconnector capacity. As interconnector revenues accrue from price differences between the interconnected markets, interconnector revenues are also affected by a “missing money problem”. Hence, capacity mechanisms should also provide appropriate incentives for trade and investments in interconnector capacity.

Capacity payment

As discussed above, capacity payments can be designed in many different ways. A general capacity payment may for example be market wide or targeted, and the payment may be subject to actual generation (capacity margins) in times of stress. Moreover, the payment may be made directly at times of stress, as the uplift factor according to LoLP (Loss of Load Probability) in the original UK capacity mechanism or in the current Irish system.

A general capacity payment should in principle include payments to all capacity contributing to capacity adequacy, including interconnector capacity, or capacity in adjacent markets confined by the interconnector capacity. If the capacity payment accrues to the interconnector, capacity in adjacent markets may benefit indirectly in the longer term because expansion of interconnector capacity becomes more attractive.

Ideally, an appropriate uplift charge, reflecting the value of capacity per hour, would correct the negative impact on the price duration curve in B, cf. the shift a) in Figure 7 and Figure 8. If capacity charges are reflected in wholesale market prices that form the basis for trade, the capacity payment increases the value of trade. The less correlated the markets are, the more is the capacity value reflected in the adjacent market.

It is difficult to see how capacity payments may be applied to generation capacity or demand response in adjacent markets without linking it to interconnector capacity directly. It would be unreasonable to make cross-border capacity eligible for capacity payments without some sort of “guarantee” that the capacity would contribute to relieve stress in the market with a capacity mechanism, which depends on the availability of interconnector capacity between the markets.

As discussed in chapter 5, payment according to LoLP and subject to VOLL will implicitly yield the same price signal to cross-border participation as to domestic generation in the country implementing the capacity mechanisms. Moreover, if two markets introduce similar models, the mechanism will implicitly value the interconnector capacity more in the market with the higher stress factor, according to the LoLP and the VOLL of the markets.

We note here that a combination of general (fixed) capacity payments and end-user prices with dynamic capacity charges is possible. Such designs provide two options for rewarding contributions from cross-border capacity. We return to this issue at the end of this section.

Strategic reserves

The strategic reserve is typically procured by the TSOs. If only one market (individually) implements a strategic reserve, cross-border participation may be realized as follows:

- A TSO may procure reserves in an adjacent control area at its own risk.
- A TSO may procure reserves in an adjacent control area subject to corresponding PTR rights on an interconnector.

The first case is questionable as it may weaken the capacity adequacy in the control area where the reserves are located, since this capacity is then removed from the market. Hence it cannot at the same time contribute to reserves and balancing – or peak demand – in that market. The second case is even more questionable as it requires reservation of interconnector capacity which may "permanently" reduce trade between the markets. That the authorities in the home market has not implemented a capacity mechanism does not necessarily imply that the capacity does not have a "Security of Supply value" in that market – the capacity value may be reflected in payments for balancing reserves, etc. If the capacity is then procured as part of a strategic reserve in an adjacent control area the cost of balancing increases in the home market.

There is a danger that TSOs may find themselves competing for reserves, and that one control area with a satisfactory capacity adequacy situation, finds itself forced to implement a capacity mechanism. However, TSOs may cooperate on cross-border strategic reserves, organized in the same way as cooperation on short term balancing and reserve capacity.

Capacity markets

As with capacity payments cross-border capacity may participate directly or indirectly in the capacity market. In a pure reliability options market, assuming it is appropriately designed, interconnector capacity owners should be allowed to offer their capacity in the capacity auction in similar to other capacity and under the same criteria and obligations. Hence, the interconnector owner may take the same risk as owners of generation capacity or load offering demand side response, i.e. the risk of not being able to provide capacity in times of stress. If there is a stress situation in both markets simultaneously (market price above strike price) the interconnector can obviously not deliver capacity in both markets. The interconnector would then supply the market with the lowest penalty. Flow should go in the direction of the market with the highest willingness-to-pay. (Recall that reliability options should not be targeted at specific investments, but at correcting missing long term investment incentives.)

However, there may be legal or regulatory obstacles to the interconnector capacity participating in the capacity market in this way. Typically TSOs are the owners of the interconnector capacity and may also be responsible for capacity adequacy and the capacity auction. Hence, the TSO implementing a capacity mechanism may get the capacity contribution from interconnection "for free" whereas the capacity payment must be shared by the counterpart, i.e. the TSO in the adjacent market (in the case of TSO cables). It could also be argued that TSOs – as interconnector owners – should not be allowed to take such market risks on behalf of transmission customers. On the other hand, they do already take risks by investing in interconnectors in the first place and should have an obligation to utilize the capacity in the best possible way, including ensuring that benefits accrue to the customers (provided that customers are also exposed to the downside risks).

A capacity market typically consists of two main design features:

1 The capacity procurement mechanism

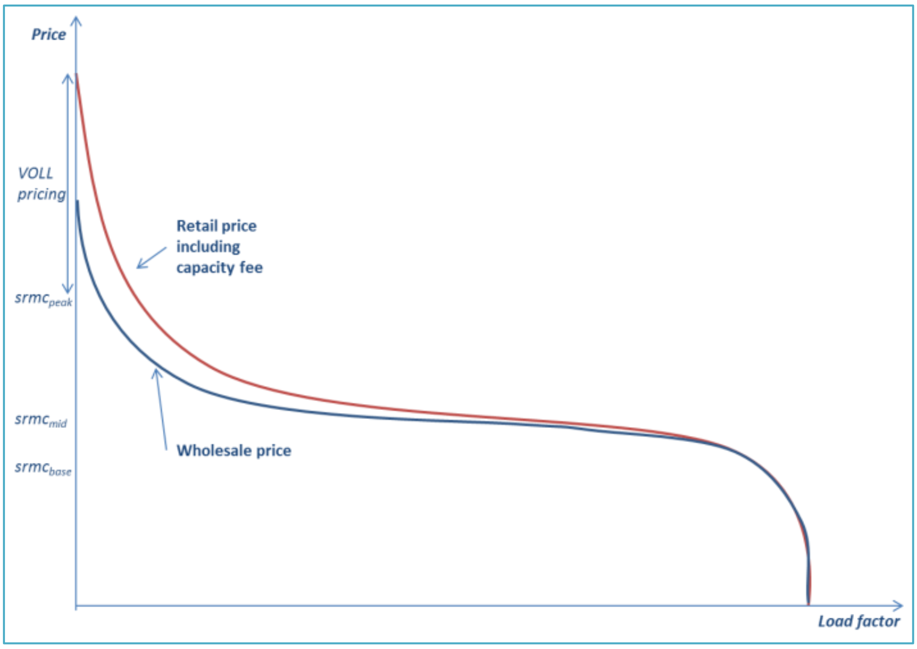
2 The funding of the capacity payments

The first part is associated with exchanging uncertain peak load revenues with certain capacity payments (cf. figure 3), correcting the "missing money problem" for generation (and demand side response) and thereby investment incentives. The capacity payment may be funded by a flat capacity charge on all TSO customers, or by a dynamic capacity charge. The Irish mechanism is partly funded by such a dynamic charge, and a similar design feature is proposed for the UK mechanism.

Assuming that the capacity charge is added to the short term energy price and distributed according to the system stress (cf. discussion of LoLP and VOLL above), interconnector flows may be made subject to prices including capacity charges. This will provide interconnectors to revenues that include a real capacity payment, in line with other capacity in the market (higher prices in times of stress, cf. Figure 3).

A stylized illustration is provided in Figure 24. The price duration curve in the wholesale market after introduction of a capacity mechanism is depicted by the lower blue curve, while the wholesale price including the capacity charge (payable for suppliers and demand in the system) is depicted by the upper red curve. In the figure, the capacity charges are applied to most hours but in a dynamic way. Alternatively, capacity charges may only be applied in hours with stress, or, with reference to reliability options, only when wholesale market prices exceed the defined strike price. I.e., participants in the reliability options market are never faced with prices above the strike price, whereas consumers and capacity not participating are exposed to “real” market prices and as such incentivized to respond to system marginal prices.

Figure 24: Price duration curves with and without capacity charges



A problem with the “real price” approach, when it comes to providing adequate relative incentives to imports and investments in interconnectors, is that if the capacity margin is set too high, prices will never or hardly ever exceed the strike price. Thus the incentives for investments in interconnector capacity remain weaker than the incentives for investments in domestic capacity. We therefore regard a mechanism with dynamic capacity charges as the one depicted in Figure 24 as more realistic than the pure, or theoretical, Reliability Option model depicted in Figure 3.

Compared to the optimal solution where interconnectors participate in the capacity auction and receives option payments up-front, exchange based on prices including capacity charges will probably be less potent in terms of investment incentives; firstly because a certain income is generally preferred to an uncertain income, and secondly because dynamic capacity charges will mimic optimal prices only to a limited extent. Capacity charges must be set administratively and will not perfectly mimic the optimal market prices. Exposing interconnectors to capacity charges hence does not provide a perfect price signal. Compared to exposing interconnector capacity to pure DAM energy prices would however distort the relative investment incentives between domestic and cross-border capacity more.

Concluding remarks

It is possible for cross-border capacity to participate in all capacity market designs. Indeed, the participation of cross-border capacity should be required for individual capacity mechanisms. However, such participation raises questions as to external effects on the security of supply and capacity adequacy situation in adjacent markets.

Fixed capacity payments aimed at strengthening long term investment signals should apply to interconnector capacity as well.

Cross-border participation in strategic reserves seems more relevant in the case where TSOs cooperate: "individual" procurement of strategic reserves in an adjacent market may adversely affect the capacity situation in that market and impose additional costs on the TSO there, ultimately forcing that TSO to implement a capacity mechanism as well.

Capacity markets should allow for interconnector participation. However, a preferred model may be to make trade exposed to prices including capacity charges (cf. discussion in the Capacity Market EMR Expert Group[50]). That way interconnector capacity is rewarded for actual capacity contribution and price signals spill over to the adjacent market via the possibly increased export demand (cf. discussion of market implications of capacity prices in chapter 6), hence indirectly benefitting cross-border generation capacity and demand response.

Here we merely conclude that it is possible for cross-border capacity to participate in most individual capacity mechanism, and such participation should be required. The efficiency of such designs depends on the actual implementation of the scheme, referring back to the initial capacity adequacy assessment.

8.4 A standard European model?

In the above section we have argued that cross-border participation in individual capacity mechanisms is possible in all models, and should indeed be facilitated. However, if adjacent markets implement different capacity mechanisms, the sum of incentives and the overall capacity adequacy situation may become very complex even if cross-border participation is facilitated in all of them. Multiple possibilities for double-counting, unhealthy competition for reserves and gaming may arise. Such concerns provide a case for defining a common standard European capacity mechanism. Instead of allowing any kind of capacity mechanism design in individual markets – subject to documentation of necessity and including provisions for cross-border participation as suggested above – MS who decide to implement a capacity mechanism on an individual basis, have to implement a mechanism according to a predefined European mechanism design.

In this section we discuss the efficiency of the various options as a model for a common European capacity mechanism design. In line with the previous analysis, a common (optional) mechanism should be designed so as to distort trade as little

---

[50] See https://www.gov.uk/government/policy-advisory-groups/114: Meeting Papers for 5 March 2013.

as possible in terms of general over-capacity and the location and composition of generation and investments. In line with the recommended criteria for implementation of individual capacity mechanisms we assume that other practical and efficient options to tackle the challenges at hand are exhausted. Moreover, in view of the uncertainties about future market conditions and the need for capacity mechanisms, the chosen mechanism should be possible to implement as a transitory measure.

In addition to the general design elements securing cross-border participation, the mechanism should be suitable for cross-border cooperation in the case of capacity mechanisms being implemented in adjacent markets.

In addition to the general criteria for capacity mechanisms listed in section 8.1, criteria for a European standard individual capacity mechanism, from the perspective of IEM efficiency, are that it

1. Does not create excessive over-capacity, i.e. the capacity should be kept at a reasonable level cf. the capacity adequacy assessment guidelines.
2. Distorts the price structure as little as possible, i.e. they should be market based or not intervene with the price formation in the energy market (DAM, ID).
3. Provides clear provisions for cross-border participation.

Criterion number 1 implies that general remuneration with no link to the required capacity level should not be accepted.

Criterion number 2 implies that the remuneration should not be differentiated in a way that obscures or distorts energy market signals. Remuneration targeted at e.g. peak capacity or CCGT capacity impact the price duration curve, distorts general investment signals and is consequently detrimental to efficient trade.

Market-wide and market based remuneration mechanisms in the form of capacity markets with a clear capacity target are less prone to distort trade than capacity payments. As capacity markets are more complex regulatory measures, however, and since capacity mechanisms implemented in the short term should be of a transitory nature, strategic reserves may be a more practical and less elaborate option for a European capacity mechanism. Although strategic reserves do not directly provide stronger investment incentives and may not increase the short term availability of flexible capacity, they may indirectly strengthen investment incentives, provide insurance in case of insufficient market capacity and are likely to trigger increased demand flexibility.

It is however difficult to set forth a strong advice when it comes to a standard for individual mechanisms in Europe. In view of the variety of challenges related to capacity inadequacy that may apply to individual markets in the transitory phase (cf. model results in chapter 7), and before it is clarified to what extent other measures and the implementation of the target model can mitigate these challenges, it is difficult to clearly identify a “one-size-fits-all” European capacity mechanism. For example, some markets may not dispose of sufficient capacity suitable for strategic reserves in the short term.

Rather, the main concern is that individual capacity mechanisms are designed in ways that distort market prices and trade as little as possible and that do facilitate cross-border trade. In the case of conflicting capacity mechanisms in adjacent or interconnected markets, practical solutions probably have to be developed on a case-to-case basis.

In the following we discuss what the crucial design features of different capacity mechanisms are.

Capacity payment design

The crucial design features of a capacity payment are the capacity payment level, the degree of differentiation/targeting, the duration and adjustment of payments, and the funding of the capacity payment (fixed or dynamic).

The design of capacity payments should be linked to the challenges identified by the capacity adequacy assessment (as outlined in section 8.1 above). Although capacity payments do not require administrative determination of a specific capacity adequacy level, they must be monitored and measured against the development in capacity adequacy.

It is unlikely that a common capacity payment rate would work for the challenges in all markets, as the magnitude of "missing money" is likely to differ. Hence, if a capacity payment is adopted as the common mechanism common guidelines for the determination of capacity payments in individual member states should be developed rather than a common rate or common (differentiated) rates.[51] The specific design and scope of the payment should specifically make sure that the payment does not incentivize general over-capacity or adversely affects the price structure.

As mentioned above (section 8.3) the funding of payments via capacity charges or direct remuneration to interconnector capacity should be included. When it comes to capacity payments in adjacent markets, the remuneration of interconnector capacity in both markets should not be ruled out. Interconnectors provide capacity in both interconnected markets and this value should be reflected. (This is merely a reflection of interconnectors providing the possibility to utilize resources across system borders and over larger regions.)

Strategic reserves design

The crucial design features of strategic reserves are the definition of the proper magnitude, the duration of the scheme, demand side participation, funding mechanism, and the rules for activation. In addition, strategic reserves in adjacent markets could be shared. In the case of common reserves across control areas cost sharing principles must be developed.

The definition of reserve margins must be based on the capacity gap assessment. Common guidelines and methodology for calculation of reserve margins are needed.

In principle, in addition to demand response, only generation capacity which would otherwise not be available should be eligible. The latter would be difficult to guarantee, and this is an important source of adversity by strategic reserves. Hence, some market distortions must be expected, unless only new, dedicated capacity is procured. As the arrangement should be transitory, it would be unreasonable and costly to require that only new capacity be eligible for strategic reserves.

If strategic reserves may be targeted at investments, the issue of the duration of a strategic reserve payment should also be clarified. E.g. the inclusion of longer term investments could only be resorted to if existing supply is too little or too

---

[51] This also illustrates the point that other regulations such as price caps or TSO practices that affect scarcity pricing should also be harmonized between markets.

expensive. The latter provision implies a sort of maximum price for reserves. This brings up the issue of whether reserves should be remunerated on a pay-as-bid basis or at a uniform price according to the marginal bid.

Demand side participation should be required, and common guidelines for demand side participation developed (contracted duties and limits to the liability, e.g. duration, notification time, etc.). The eligibility of demand side participation should also be based on the capacity gap assessment, in particular an assessment of the ability of the market to realize demand side participation via market prices. The critical question is to which extent investments on the demand side are necessary in order to increase demand side flexibility and whether there are barriers to such investments in the market. The presence of such barriers should also be revealed by the capacity gap analysis.

The rules for activation are crucial for the market impacts and should be common. A strategic reserve should not be activated unless the market fails to find a solution, including full utilization of interconnector capacity. There should also be common rules for how the market price is determined under activation, as this affects the congestion rent and hence the incentives to invest in interconnector capacity.

Finally, rules regarding the sharing of strategic reserves in adjacent control areas must be developed, and coordination or cooperation criteria (sharing of “stack” subject to available cross-border transmission capacity, including compensation for sharing of resources.

Capacity markets design

Capacity markets generally offer more long term solutions to a capacity adequacy challenge than capacity payments and strategic reserves, but may even be short term in nature, cf. the proposal for the French certificate market and the UK reliability option. The crucial design features that need to be harmonized include the capacity requirement and the choice of scheme, including decentralized obligation or centralized auction, eligibility (reliability standards, if any), funding, duration of the scheme, penalties for non-compliance, and strike price (if a reliability option is chosen).

For all capacity market schemes, common rules for eligibility of different capacity – including demand side participation and the funding of the scheme are crucial. Cross-border participation may be included by allowing interconnector capacity to participate directly, or by exposing interconnectors to prices including dynamic capacity charges. Direct participation of cross-border capacity coupled with transmission rights is not compatible with the target model.

If the chosen model is a decentralized capacity obligation on LSEs, efficient trade and interconnector investments should be incentivized by making interconnector capacity eligible to certificates. How interconnectors should be assigned capacity certificates depends on the rules for eligibility of generation capacity and demand side participation. (Such rules should be defined in terms of characteristics of different sources, not by the type of source.)

Both capacity obligations and capacity auctions imply that a penalty applies if participants fail to comply with the obligation. Common guidelines should therefore include the level of the penalty and whether it is linked to a reliability standard or to availability in defined periods of stress (predefined for certain hours of the year or subject to the actual reserve margin in a predefined number of hours per year).

A common reliability option design implies setting common rules for auction design, eligibility, a common strike price and common rules for the duration of reliability contracts. In principle, reliability option schemes may not set any rules for reliability, in which case the level of the penalty for non-compliance becomes crucial. Moreover, as participation in the reliability option auction should be voluntary, common rules for adjustment of the capacity margin in order to account for the availability of capacity not participating in the auction needs to be developed. When it comes to cross-border participation it has to be decided whether interconnector capacity should be allowed to participate in the auction directly or be exposed to prices including dynamic capacity charges. And finally, common design or principles for dynamic capacity design have to be laid down.

Concluding remarks

The main reason for implementing a common capacity market design would be to harmonize design features of capacity mechanisms in adjacent markets in order to reduce or mitigate the adverse effects of individual capacity mechanisms. As such, the choice of model is less important than the harmonization of important design features of the different models. The discussion above points out some important design features, that should be harmonized in the different mechanism options.

As short term instruments, strategic reserves seem to be the least complex mechanism to implement, as it may be limited in scope and time, it is easily adjustable, can easily include demand side participation and is suitable for TSO cooperation. Capacity payments are simple, but inaccurate measures. Making capacity payments more efficient implies increased complexity, and capacity markets are likely to provide a more efficient framework than an elaborate, administrative system of capacity payments.

As a long term measure, reliability options are likely to be the more efficient instrument. The administrative costs are likely to be high, however, and a large number of design features need to be carefully worked out. Even though the UK proposal for a reliability options market does not include a strike price, Cramton and Ockenfels warn that a successful reliability options market, based on a defined strike price, needs a strong spot market foundation. Hence, a reliability options market could work well with the target model for electricity, provided that it is successfully implemented across Europe. Apart from the adverse effects of over-capacity, which applies to the other capacity market designs as well, reliability options could provide the least adverse effect on the IEM. The general concern that market dynamics as the main incentive for investments are replaced by administrative does however apply to all capacity mechanisms, although the mechanism in itself may be market based.

8.5 Conclusions

With regard to mitigating the adverse effects of individual capacity mechanisms on the IEM, it is crucial that the contributions of cross-border capacity are taken into account both in the capacity adequacy assessment and in the design of capacity mechanisms. Before individual capacity mechanisms are implemented, the need should be documented through an objective capacity adequacy analysis. Common guidelines for such adequacy assessments should be provided.

Second, cross-border participation may be facilitated in all market designs. Hence, the EU should require that such provisions are made in individual capacity mechanisms.

There are basically three options for a European approach to capacity mechanisms:

1 *Criteria for individual design*: MS could choose their design individually, but in accordance with common guidelines and requirements.

2 *EU standard design*: MS could implement a capacity mechanism individually, but according to an “EU standard capacity mechanism”.

3 *Target capacity mechanism model*: Including a European capacity mechanism in the target model, implying that all MS would be required to implement this capacity mechanism design.

An EU standard approach may be more efficient than merely setting criteria for individual designs. This is however an area where “one-size-fits-all” probably does not apply, particularly for transitional capacity mechanisms. The situations and possible capacity adequacy concerns in different MS are likely to differ with respect to a number of framework conditions, and are likely to remain different during the coming years of the energy transition as well.

At some time in the future, when important uncertainties are resolved and the effects of market integration and grid expansion become clearer, it may be concluded that capacity mechanisms are indeed needed as part of the electricity market design. It is however premature to make that decision at the present time.

9 Summary of conclusions and recommendations

The investment climate is challenging for several reasons

The current market situation is characterized by several market interventions which have thrown the market way off the long term equilibrium situation, the most prominent intervention being the policy-induced expansion of new renewable generation capacity. Generally, the renewable capacity is characterized by operational and locational properties that differ substantially from conventional generation capacity. In addition, conventional power generation has to be phased out due to age, reduced profitability, environmental regulations and moratoriums on nuclear power. Investments in new capacity will be needed to replace old capacity and to handle the demands of a new electricity system based on increased shares of renewable and low-emitting capacity.

At the same time, there is concern over the ability of energy-only market models, such as the European target model, to deliver sufficient investment incentives. However, the current investment climate is challenging due to a number of policy and market uncertainties:

1. *Climate policy uncertainty:* The processes of climate policy negotiations and future climate policy design are slowly proceeding and the long term outcome in terms of targets and measures is uncertain, including framework conditions for renewable generation, carbon pricing and regional vs. global policies.
2. *Market uncertainty:* Market integration is evolving, but the long term market implications are still uncertain. This is linked to the impact of system challenges, the impact and implementation of flow-based market coupling and the degree of physical market integration. Market uncertainties include also the developments in gas markets generally, and the impacts of implementation of IEM on European gas prices.
3. *Regulatory uncertainty:* Market design, where the outcome of changes in mechanisms such as flexibility payments, increased demand side participation, improved TSO payment mechanisms for system (operation) services, etc., is not known.
4. *Technology and cost development:* Development and introduction of technologies may change price structures and capacity needs and payment, cf. the rapid introduction and cost reductions seen in solar power in recent years.
5. *Economic environment:* General economic and financial conditions which influence investors' decisions also in the power sector.

Consensus: Improve short term IEM efficiency by implementation of the target model, TYNDP and price signals for RES-E

The academic literature is inconclusive when it comes to the ability of energy-only markets to deliver long term capacity adequacy. Given the profound changes taking place, it is also not possible on an empirical basis to conclude on the ability of the energy-only market design of the European target model to deliver capacity adequacy in the long term. There is however a clear consensus that it is necessary to improve the efficiency of the internal electricity market in Europe, by:

- Implementation of the target model including implicit (flow-based) market coupling in the day-ahead market and intraday markets, and increased cooperation between TSOs in balancing markets, would provide improved price signals and a better basis for long term financial markets and investments.
- Completion of the TYNDP would provide improved competition and liquidity in markets.
- Improving market based price signals for renewable generation and ensuring adequate pricing of system services to promote development of and investments in new technologies and flexible solutions both in generation and consumption.

With sustained market and policy uncertainty, politicians and regulators in more and more European countries may be compelled to introduce capacity mechanisms in order to safeguard security of electricity supply.

No urgent need for capacity mechanisms, increased investment needs in the longer run

Model based analyses show that there is no urgent need for capacity mechanisms in most European countries in the first few years to come. Approaching 2020 and beyond new investments will be needed, however.

As the share of must-take increases, price structures become less uniform than in the past. The change in price structure is more favourable to CCGT capacity than to base load capacity, but the average annual utilization rates for CCGT plants decline. On the other hand, the need for system balancing and ancillary services increases. Hence, growing uncertainty surround the revenues for such investments. Cross-border balancing services play a more important role as implementation of the IEM and the TYNDP increase cross-border trade. Hence, flexible resources can be utilized for larger areas than before.

We analyse revenue prospects by way of three different bidding regimes. By assumption, open-cycle gas plants do not recover capital costs with strict marginal cost pricing and revenues accruing from the wholesale market only. The missing money represents 1-2% of the total turnover of dispatchable plant in the wholesale market. Assuming more realistic bidding behaviour, the missing money for peaking units is reduced to 0,5-0,7% of total turnover.

Base load capacity is generally better off, even with strict marginal cost bidding, whereas the situation for CCGT capacity is much improved when more realistic price formation is assumed.

A common European target capacity mechanism is premature

Our first advice is to not implement a capacity mechanism in the European target model, or a target capacity mechanism at this point in time. In addition to the inconclusive theoretical and empirical evidence, and the current relatively robust capacity adequacy in most European markets, our analysis shows that there are numerous design challenges associated with capacity mechanisms that needs to be sorted. Both capacity payments and strategic reserves tend to be imprecise and more sophisticated capacity market designs quickly become very complex. In view of the significant uncertainties pertaining to policy and market developments, it is by no means clear that the benefits of sophisticated capacity markets would merit the costs associated with their implementation and operation.

Individual capacity mechanisms are likely to distort trade

Individual capacity mechanisms with different design features are prone to distort trade and undermine the efficiency of the internal electricity market.

The market and efficiency impacts of individual capacity mechanisms depend on

- The degree of overinvestment: Capacity requirement is likely to be set too high and thus yield over-investment (compared to the optimal solution). If a capacity mechanism is perfect in the sense that it merely corrects the market failure caused by the so-called “missing money problem”, no harm is done. However, regulators are likely to overestimate the need for capacity to be on the safe side.
- The degree to which interconnection is taken into account: Failure to take capacity contributions from cross-border trade will amplify the tendency towards over-investment.
- The interconnectivity between markets, i.e. the exchange capacity.
- The correlation of prices (and market conditions) between markets, i.e. the ability of one market to “help” the other market in times of stress.

It is difficult to recommend a standard design for individual mechanisms

Member states may still opt for implementation of capacity mechanisms due to security of supply concerns. As implementation of asymmetric capacity mechanisms in interconnected markets could harm the IEM in several ways, a solution could be to identify a standard model for individual capacity mechanisms. However, in the transition period the challenges associated with capacity adequacy may differ substantially between markets. This is an area where a “one-size-fits-all” approach probably does not apply. In cases where different capacity mechanism designs are chosen in interconnected markets, practical solutions to share cross-border resources and minimize adverse effects on trade will rather have to be developed on a case-to-case basis.

Common guideline and requirements for gap analysis should be developed

One important implication is that the capacity adequacy assessment and the capacity requirement are crucial for the magnitude of the adverse effect of individual capacity mechanisms on the efficiency of the IEM. Hence, clear guidelines and requirements for the capacity adequacy assessments should be developed. The guidelines for assessment should include

1 Reference capacity gap analysis:

- Demand: Scenarios for demand growth, including historical trends and economic growth assumptions, plus impacts of e.g. energy efficiency targets and other policies.
- Electricity supply: Existing capacity and known investments and decommissioning, availability of intermittent (non-controllable) generation sources based on historical data.

2. Cross-border contribution
   - Development in cross-border capacity, and the utilization of cross-border capacity
   - Import and export flows in scarcity situations, including analysis of correlations between the markets and the patterns of hourly price differences.
3. Options for closing the gap:
   - Assessment of price sensitivity of demand (demand response)
   - Investments in new generation capacity, including profitability of different options.

Such a gap analysis requires the use of system and market models spanning beyond the national markets. With the introduction of flow-based market coupling however, TSOs should have access to adequate tools for making such a gap analysis. For well-interconnected regions, the TSOs should cooperate on the development of regional gap analyses.

Alternatives to capacity mechanisms should be carefully considered …

If the gap analysis concludes that capacity is inadequate, i.e., the total of imports, generation and demand response will not be sufficient to cover peak demand, the next step of the analysis should be to assess the market failures explaining the deficit:

- Is demand response insufficiently stimulated?
- Is supply of system services inappropriately compensated?
- Is interconnector capacity optimally utilized?
- Do the DAM and ID markets provide market participants with adequate price signals?
- Do other market failures, e.g. in the gas market or financial markets, constitute barriers for investments?
- Do market interventions in price formation create a missing money situation?

What long term measures can be implemented to close the gap, including improved market coupling, expansion of interconnector capacity, etc.?

… in order to demonstrate necessity, appropriateness and proportionality

In short, such an analysis should be required as a basis for introduction of a capacity mechanism. The overall criteria for introduction of individual capacity mechanisms, as well as other market interventions, should be:

- Necessary: A thorough gap analysis is needed to demonstrate that intervention is needed
- Appropriate: The analysis of alternative measures is needed to determine the appropriate action. The appropriate action depends on the problem at hand. In principle, capacity mechanisms should only be implemented if it is clear that other means, which could remove or reduce weak investment incentives, are implemented first.
- Proportional: Implementation of the capacity mechanism should not unduly increase system costs and costs to end users. Common guidelines on the

methodology for calculation of costs should be developed (cf. experience from e.g. UK).

When all of this is done, and if the conclusion is that a capacity mechanism is needed, the choice of mechanism and design features should be made on the basis of the analyses. The overarching goal should be to design the mechanism in a way that corrects the identified market failure(s) as precisely as possible – based on the identification of relevant market failures – and that distorts cross-border trade and competition in the IEM as little as possible.

Given the uncertainty as to the need for capacity mechanisms in the long term, a clear exit strategy should be provided.

Cross-border participation can and should be facilitated

In order for individual capacity mechanisms to distort short and long term trade as little as possible, it is necessary to provide the right incentives for cross-border trade. How cross-border trade could be exposed to capacity mechanisms, depends on the choice of model.

Capacity payments: General capacity payments should apply to interconnector capacity on the same conditions as domestic generation and demand response.

Strategic reserves: Contracting of generation capacity in adjacent markets requires (guaranteed) access to interconnector capacity in times of stress. Interconnector capacity should however not be permanently reserved as back-up capacity. Instead, interconnector capacity could be treated as demand side resources in the strategic reserve, i.e. not permanently removed from the market, but as a guarantee of flow in the right direction in times of stress. In practice such agreements must be negotiated from case to case. If two adjacent markets opt for strategic reserves, the benefits of cooperation should be explored (cf. common stack of balancing reserves).

Capacity market: If capacity is secured through a centralized auction or, in the case of a decentralized capacity obligation, interconnector capacity could be eligible for certificates or capacity remuneration on the same conditions as generation or demand side response.

Cross-border capacity can be remunerated directly or compensated through prices reflecting a capacity charge

Capacity mechanisms are likely to undermine the profitability of cross-border trade through its effect on prices. The objective of the IEM is to provide efficient price signals to generators and consumers – including cross-border trade and investments in infrastructure. Hence, if there is a “missing money problem” affecting generation and demand response, there is also a “missing money problem” affecting trade and interconnectors. In principle, interconnectors can be included in the capacity market directly, i.e. offer reliability options or . In a pure market-wide capacity auction with wide reliability standards and appropriate penalty provisions for non-compliance, interconnector owners could also chose whether to bid their capacity. Like for all other capacity, i.e. generation and demand response, interconnector bids would be based on the interconnector operator’s assessment of the availability of the connection and the risk of not being able to deliver in times of stress (which inter alia depends on the capacity adequacy and correlation with the market at the other end of the connection).

Both for capacity payments and capacity markets, the way in which capacity payments are collected allows for another possibility. Instead of including interconnector or cross-border directly in the capacity payment ex ante, cross-border trade may be exposed to capacity payments by reflecting capacity charges in the exchange prices. This is in line with the treatment of import and export in the Irish capacity mechanism. A similar design is proposed for the UK capacity mechanism.

REFERENCES

A2A Group (2012): *Results & 2013-2015 Business Plan*

ACER (2012): *Framework Guidelines on Electricity Balancing*, FG-2012-E-009.

Batlle, C. and Pérez-Arriaga, I. J. (2007): Design criteria for implanting a capacity mechanism, *Utilities Policy* vol. 16 (3), pp. 184-193.

Brunekreeft, G., Damsgaard, N., de Vries, L., Fritz, P. and Meyer, R. (2011): *A Raw Model for a North European Capacity Market.* Elforsk Rapport 11:30, Elforsk, Sweden.

Cepeda, M. and Finon, D. (2011): Generation capacity adequacy in interdependent electricity markets, *Energy Policy*, vol. 39, pp. 3128-43.

Cramton, P. and Ockenfels, A. (2011a): *Economics and design of capacity markets for the electricity sector*, Frontier Economics, UK.

Cramton, P. and Ockenfels, A: (2011b): *Practical considerations of capacity mechanisms – German situation and international experience*. In "Is a capacity market required in Germany to guarantee system security? Two related investigations on capacity markets." Frontier Economics Ltd., London.

Cramton, P. and Stoft, S. (2005): A Capacity Market that Makes Sense, *Electricity Journal* vol. 18, pp. 43-54.

DECC (2011): *Planning our electric future: a White Paper for secure, affordable and low carbon electricity.*

DECC (2012a): *Annex C: Capacity Market: Design and implementation update.*

DECC (2012b): *Impact Assessment: Electricity market Reform – Capacity Market.*

Elberg, C., Growitsch, C., Höffler, F., et al. (2012): *Untersuchungen zu einem zukunftsfähigen Strommarktdesign.* Energiewissenschaftliches Institut an der Universität zu Kön (EWI).

ENTSO-E (2012): *Draft CACM Network Code – Supporting Document*.

EU (2003): *State iad N 475/2003 – Ireland. Public Service Obligation in respect of new electricity generation capacity for security of supply.* C(2003)4488fin, Brussels, 16.12.2003

Growitsch, C., Matthes, F. C. and Ziesing, H.-J. (2013): *Clearing-Studie Kapazitätsmärkt*, Energiewissenschaftliches Institut an der Universität zu Kön (EWI).

Joskow, P. (2006): *Competitive electricity markets and investment in new generating capacity*, 06-009 WP, Center for Energy and Environmental Policy Research, Sloan School of Management.

Meulman, L. and Méray, N. (2012): *Capacity markets in Northwest Europe – between a rock and a hard place?* Clingendael International Energy Programme (CIEP), the Netherlands.

Pöyry (2011): *Capacity payment mechanism medium term review. A Report to CER and NIAUR.* Pöyry Energy Consulting, April 2011.

Roques, F. A. (2007): *Market Design for Generation Adequacy: Healing Causes rather than Symptoms*, International Energy Agency, Economic Analysis Division.

Süßenbacher, W., Schwaiger, M. and Stigler, H. (2011): *Kapaizitätsmärkte und –mechanismen im internationalen Kontext*, IEWT 2011, Technische Universtität Graz, Austria.

de Vries, L. and Heijnen, P. (2008): The impact of electricity market design upon investment under undertainty: The effectiveness of capacity mechanisms. *Utilities Policy* vol. 16 (3), pp. 215-227.

APPENDIX 1: DETAILED MODEL APPROACH

The standard PRIMES model[52]

The standard PRIMES model has been used to quantify the Reference scenario projection. PRIMES simulates demand, supply and price formation for all sectors and for all energy commodities and markets.

For the electricity sector, the PRIMES model quantifies projection of capacity expansion and power plant operation in detail by MS distinguishing power plant types according to the technology type (more than 100 different technologies). The plants are further categorised in utility plants (plants with main purpose to generate electricity for commercial supply) and in industrial plants (plants with main purpose to cogenerate electricity and steam or heat, or for supporting industrial processes). The model finds optimal power flows, unit commitment and capacity expansion as a result of an inter-temporal non-linear optimisation; non-linear cost supply functions are assumed for all resources used by power plants for operation and investment, including for fuel prices (relating fuel prices non-linearly with available supply volumes) and for plant development sites (relating site-specific costs non-linearly with potential sites by MS); the non-linear cost-potential relationships are relevant for RES power possibilities but also for nuclear and CCS.

The simulation of plant dispatching considers typical load profile days and system reliability constraints such as ramping and capacity reserve requirements. Flow-based optimisation across interconnections is simulated by considering a system with a single bus by country and with linearized DC interconnections. Capacity expansion decisions depend on inter-temporal system-wide economics assuming no uncertainties and perfect foresight.

The load profile of demand is constructed bottom up for future times based on demand projections by sector and by type of energy uses. The demand projections depend on prices which are determined endogenously by the model so as to recover all types of costs; the tariffs by type of consumer are determined according to a Ramsey-Boiteux methodology which allocates power production costs according to a least cost matching between power plant operation profiles and customer-type load profiles taking into account the different price-elasticity of customer types. So demand is elastic depending on electricity tariffs (not on time-of-use prices) and the model performs a closed-loop simulation of the market balancing demand and supply of electricity.

The optimisation of system expansion and operation and the balancing of demand and supply are performed simultaneously across the EU internal market assuming flow-based allocation of interconnecting capacities. The outcome of the optimisation is influenced by policy interventions and constraints, such as the carbon prices (which vary endogenously to meet the ETS allowances gap), the RES feed-in tariffs and other RES obligations, the constraints imposed by legislation such as the large combustion plant directive, constraints on the application of CCS technologies, policies in regard to nuclear phase-out, etc.

The optimality simulated by the model can be characterised either by a market regime of perfect competition with recovery of stranded costs allowed by

---

[52] See http://www.e3mlab.ntua.gr/e3mlab/PRIMES%20Manual/PRIMES_ENERGY_SYSTEM_MODEL.pdf

regulation or as the outcome of a situation of perfectly regulated vertically integrated generation and energy supplying monopoly. This is equivalent of operating in a perfect way a mandatory wholesale market with marginal cost bidding just to obtain optimal unit commitment and a perfect bilateral market of contracts for differences for power supply through which generators recover the capital costs.

According to the model-based simulations, the capital costs of all plants, taken all together as if they belonged to a portfolio of a single generating and supplying company, are exactly recovered from revenues based on tariffs applied to the various customer types. This result does not guarantee that more realistic market conditions with fragmentation and imperfections will be able to deliver the optimal capacity expansion fleet suggested by the model-based projection. The aim of the analysis presented in the section of the report is to further investigate whether an energy-only market would deliver the optimal capacity expansion plan suggested by the model in order to identify possible investment gaps which may be addressed by capacity regulations.

The market simulation model

The market simulation model has been developed by E3MLab for the purposes of the capacity mechanisms project. It is computationally more complex than the standard power sector model included in PRIMES, but smaller in size, as it does not determine investments endogenously. It represents the entire European ENTSO-E country interconnecting system, with every country corresponding to a single bus. Interconnectors are fully represented and handled as linear DC power flows.

The market simulation model is static. Electricity demand functions (price-elastic in the market simulation model), fuel prices/costs and investments in power generation and in grids are introduced exogenously, using the projections of the standard PRIMES model. The model is solved as a mixed complementarity problem, which satisfies the first order conditions (Kuhn-Karesh-Tucker/KKT conditions) of the different market agents while ensuring that the market clears, i.e. that supply equals demand through adjusting prices. The equilibrium defines system marginal and consumer prices, generation by plant type, cross-border flows and consumption.

In particular, the model formulates oligopoly competition over 30 European interlinked markets with flow based allocation of interconnecting capacities. The model represents competition among explicit companies each disposing a portfolio of generating plants and being active in sales at specific countries. The portfolios of companies are exogenous and the resulting concentration influences their market power.

The market simulation model is formulates the market simulation according to a conjectured supply function competition approach (Day, Hobbs and Pang (2002), Smeers (2005)), which provides flexibility in representing various competition regimes (e.g. perfect competition, supply function equilibrium, Cournot, Stackelberg).

In the context of this project, we examine three stylized competition cases, perfect competition (termed marginal cost bidding in the analysis), supply function equilibrium and Cournot competition. Bidding behavior in wholesale markets is simulated by plant type depending on marginal costs and on conjectures about bidding by competitors. Demand flexibility (linear price-related demand curves are assumed by load category with parameters calibrated to standard PRIMES demand results) is perceived by the bidders and cross-border flows adjust to exploit arbitraging between price areas, which coincide with system control areas, i.e. identical to countries in our approach. The bidders and the arbitragers also compete in reserving capacity on interconnectors by perceiving marginal costs of transmission system use in each system node (where a TSO is assumed to operate) which are endogenous and depend on flow-based allocation of interconnecting capacities, determined according to Kirchhoff's laws. The TSOs are represented to maximize the value of the transmission system they control. To the extent the interconnected system allows, arbitragers (i.e. traders who maximize profits of power flow transactions between system nodes) ensure convergence of market prices across system areas. In other words the market model simulates EU wide market coupling. The model solves simultaneously for day ahead wholesale market clearing and real time balancing market clearing; for representing the latter ramping and reserve constraints are introduced in the wholesale market equilibrium and plant dispatching. Finally, the companies represented in the model compete in the domain of sales to customers and so consumer prices are determined, which are influenced by the assumed price elasticity of demand.

The output of the market simulation model includes for each country and for each future year figures on generation by plant, power flows across interconnectors, electricity sales, wholesale market prices and consumer prices.

The simulation incorporates must-take generation as given for each country and load category. Must-take generation is supposed to include all variable RES production, as well as generation by biomass and CHP plants which are assumed to operate mostly under (explicit or implicit) power purchasing agreements or driven by heat demand fluctuations. Hydro storage and pumping are assumed to be centrally dispatched so as to shave peak load, taking into account water and storage constraints on a yearly basis. Must-take generation is taken as projected by the standard PRIMES model, and is dispatched in priority. Negative price bidding by dispatchable plants as a way of avoiding shutting down is not modelled but minimum technical constraints applicable for some plant types are taken into account, so RES curtailment is possible and according to the model it occurs for a few hours per year.

The annual simulation is carried out for nine typical days (in total 45 load categories are represented), as it considers three seasonal patterns (one for summer, one for winter and one for spring-autumn) and three patterns within a week (one for weekends and public holidays, one for mid-week days, i.e. Tuesday, Wednesday and Thursday, and one for Monday and Friday). Generation by variable RES is assumed to be known by load category, based on available statistical information by country, and is varying by hour within the typical days.

Database of current plants

The PRIMES model database includes a full inventory of all power plants (thermal, hydro and nuclear) operating today and having operated in the past in the EU by member-state. The inventory includes technical information by plant as well as a decommissioning time schedule. The database also includes an inventory of plants under construction or under confirmed investment decision.

Using this database, the model takes as given a decommissioning program and an investment program based on plants that are known to be under construction. The projection using the PRIMES model alters the decommissioning schedule, depending on technical and environmental possibilities, by considering retrofitting investment as part of optimal capacity expansion.

Additional investment (new plants) is also projected as part of the optimal capacity expansion; a distinction is made between development of new plants on existing sites (with limited possibilities) or on new sites (which involve higher costs).

The model database groups RES plants in categories according to: the type of renewable resource (wind, solar, etc.), the intensity of the resource (high wind blowing sites, etc.) and the typical size of the plant (e.g. rooftop solar PV versus larger scale solar PV). For intermittent generation by RES, the model considers typical production profiles according to the typical load days considered for the demand load.

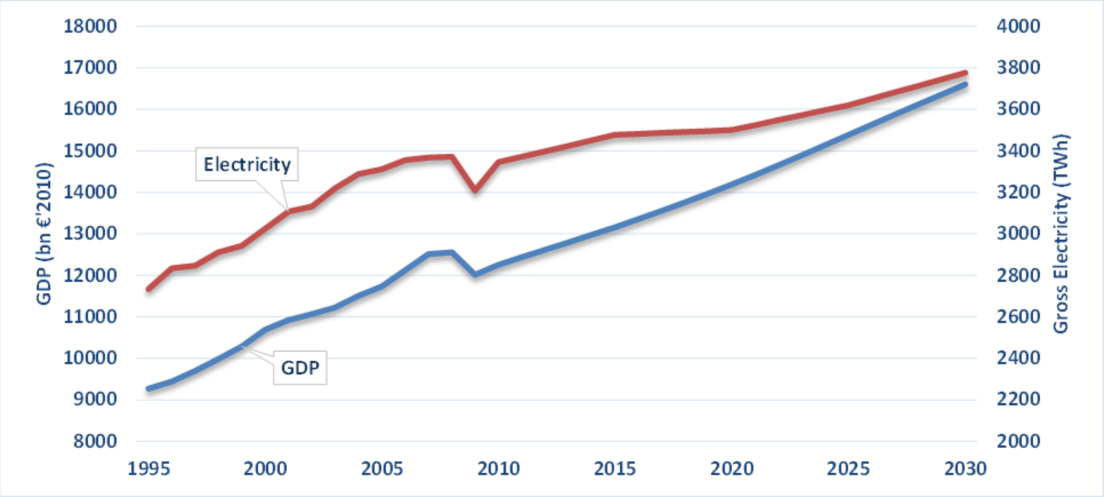
APPENDIX 2: DETAILED REFERENCE SCENARIO PROJECTIONS

Load projection (in the draft Reference scenario of 2012)

The Reference scenario assumes strong policies and measures to support significant progress in energy efficiency in the EU MS to the horizon of 2020 and beyond. The modelling mirrors successful implementation of the energy efficiency directives and regulations of the EU.

The energy efficiency measures also affect electricity demand in particular in end-uses of electricity through electric appliances by households and in services sectors. Energy efficiency also promotes higher use of heat pumps which support higher use of electricity in heating uses. The net effect of these measures is towards lower increase of demand for electricity that otherwise would have been projected.

Figure 25: Electricity demand and GDP projection for the EU27 in the Reference scenario



The Reference scenario projection shows a slowdown of electricity demand growth in the time period until 2020 compared to the growth in the previous decade. For the EU as a whole, electricity demand is projected to increase by an average annual rate of 0.47% during 2011-2020 (significantly below the 1.16% annual growth rate experienced in the period 2001-2020). The projection for the time period 2021-2030 shows a pace of 0.83% growth annually, as electrification trends continue and further efficiency progress is moderated.

For some countries, among the largest in the EU, the projection shows a slight decrease of demand for electricity. A combination of saturation effects of electricity demand and electricity savings effects explain this projection. New uses of electricity in mobility sectors are included in the projection but the market penetration remains very small to the horizon of 2030 in the context of Reference scenario assumptions. Peak load projections are constructed bottom-up from individual load profiles of sectors and end-uses. Peak load is projected to change rather similarly as electricity demand; thus no major changes in the shapes of load profiles are foreseen in this scenario.

Detailed projections on load are presented in Table 30 in Appendix 3.

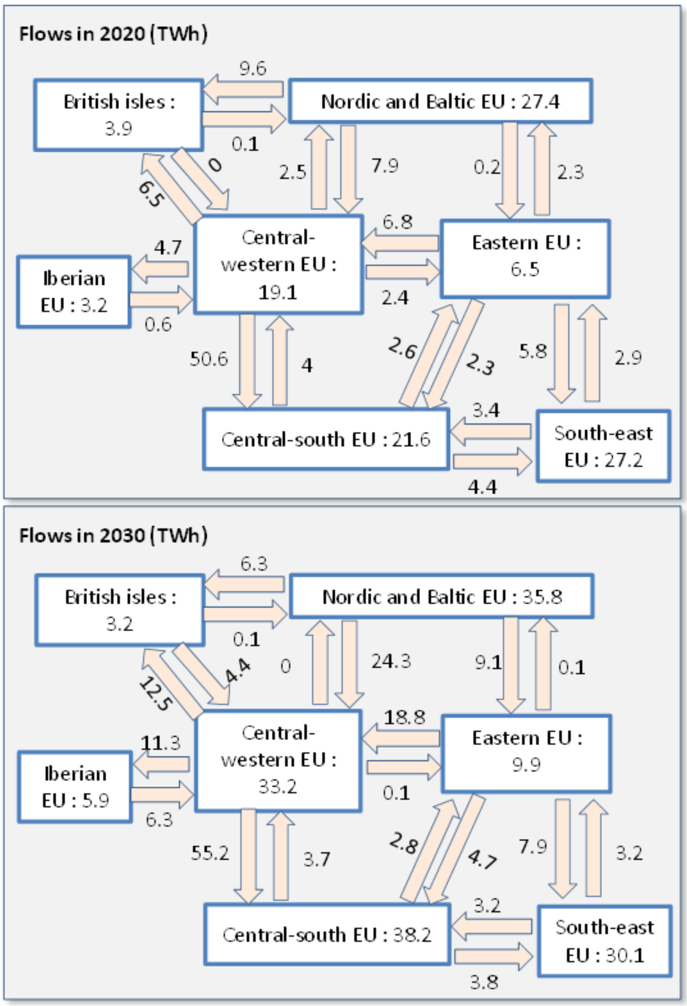
Projection of cross border trade in Reference scenario

The projection of cross border trade using the PRIMES model is performed simultaneously with optimum plant commitment and least cost capacity expansion. The present and future capacities of interconnections are taken as given, assuming that the 10-year development plan of ENTSO-E will be successfully implemented. This allows for a general increase of NTC values (net transfer capacities) according to the plan provisions.

The model simulates flow-based allocation of interconnection capacities (under a DC-linear optimum power flows[53]) limited by NTC and electric characteristics of the interconnectors. This assumption corresponds to full implementation of the target model and the implicit auctions for capacity allocations. The model solution for the Reference scenario corresponds to a pan-European market coupling which attenuates marginal price differences among countries but of course does not lead to uniform prices because of interconnection grid limitations.

System reliability constraints (e.g. reserve margin at peak load, ramping requirements) are modelled as national-level constraints. This approach mirrors a continuation of application of national reliability requirements by the TSOs which refer to control areas defined by country. The reliability requirements applied by country drive at some extent peak and flexible investment which may not be required if pan-European reliability constraints were only applied.

Figure 26: Cross-border flows in Reference scenario



Driven by new interconnection possibilities and increasing balancing requirements in the context of growing penetration of non dispatchable RES, the model-based projection shows continuously increasing total cross-border flows in the EU IEM: in 2020 total flows are found 25% above 2010 levels and in 2030 flows are 80% above 2010.

The increase of cross border trade is higher towards the horizon of 2030 as a larger part of capacities, compared to 2020, is new and location has been optimised according to the model logic.

However, the fact that most of new constructions are gas plants limits the scope for further increasing cross-border trade because of small gas price differences between countries (at least according to the model-base projection which projects a well-

---

[53] This method applies first and second Kirchhoff's laws.

functioning internal gas market in the EU) and because development of new gas plant sites is relatively easy in all countries.

Generally, the projection of cross-border flows shows that the general pattern of flows among countries and regions does not significantly change over time despite the development of new interconnecting possibilities, which nevertheless allow for higher flows from Nordic and eastern to central-western by 2030 compared to 2020.

Intra-regional flows dominate over inter-regional flows in central-western, Nordic, Iberian and south-east regions of the EU. The projection shows increasing inter-regional flows originating from eastern and northern countries of the EU.

Detailed projections of cross-border trade flows are presented in Table 31 in Appendix 3.

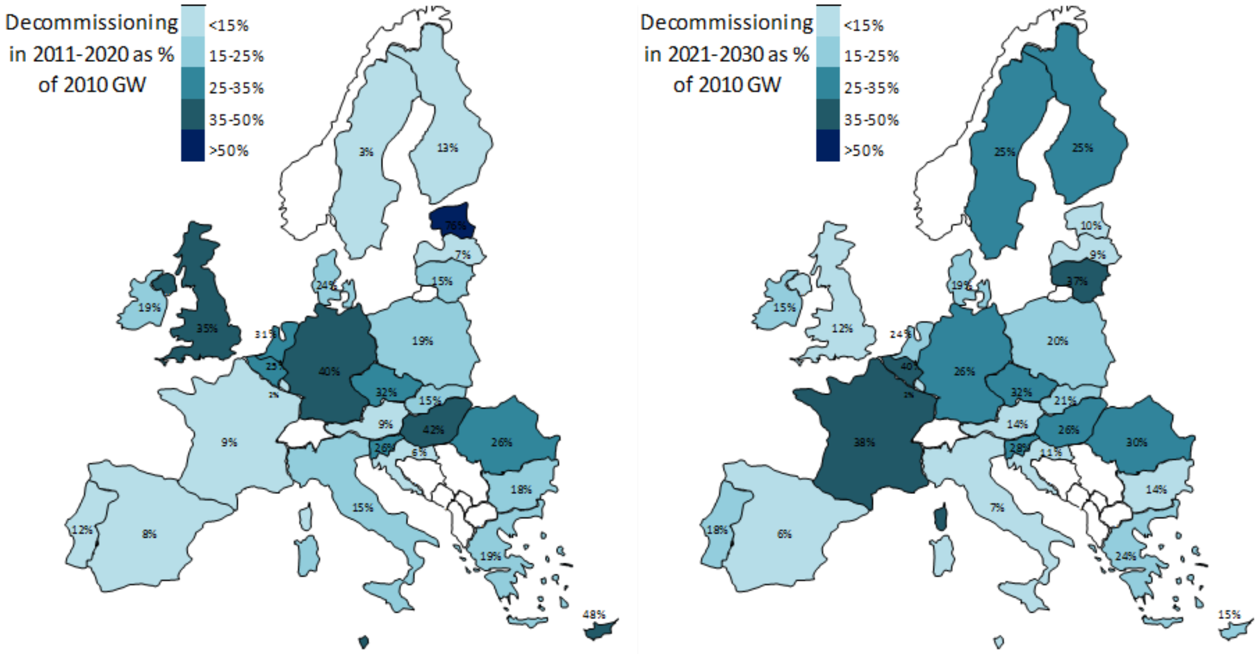
Overview of planned decommissioning

The database on planned decommissioning is based on information from company plans, where available, on licensing for nuclear plants, and on technical lifetime data where other information is not available. Planned decommissioning data are presented in detail in Table 32 in Appendix 3.

The model-based projection may decide on economic grounds to extend the lifetime beyond the date of planned decommissioning, if this is allowed (e.g. extension of lifetime of some nuclear plants may not be allowed), after undertaking investment in refurbishment. The extension is for a fixed number of years depending on the plant type.

The data shown in the graphic refer to planned decommissioning without including model-based projection on extensions and include only dispatchable plants which are further classified in base-load plants (nuclear, solid fuelled plants and CCS), CCGT gas fuelled plants (combined cycle), peak devices and CHP plants (open cycle and old technology oil and gas plants, as well as industrial CHP plants which are built mainly for cogeneration purposes), and dispatchable renewables (including hydro with storage, pumping and biomass plants).

Figure 27: Planned decommissioning of dispatchable plants



The data on planned decommissioning show that 21% of total dispatchable capacities in the EU operating in 2010 are likely to be decommissioned until 2020, and that another 21% of 2010 capacities are likely to be decommissioned between 2021 and 2030.

The largest part of planned decommissioning concern base-load plants: in percentage terms relative to 2010 capacities, the decommissioning of base-load plants is 30% until 2020 and 35% between 2021 and 2030. The reasons refer to phase out of nuclear in two countries, the ageing of nuclear and coal plants in general and the non-compliance of coal to the large combustion plant directive in some countries.

Significant decommissioning is also planned for peak units and CHP plants: in percentage terms the decommissioning represents 43% and 27% in the time periods 2011-2020 and 2021-2030 respectively. This is due to the ages of these plants which include the old designs for oil and gas plants.

The figures of planned decommissioning of CCGT plants and dispatchable RES are significantly lower, as the plants in these categories are new or their lifetime is long (hydro).

In total 17 out of 28 EU countries more than 40% of total dispatchable capacities operating in 2010 are likely to be decommissioned until 2030.

For 8 of them, among which Germany and Belgium which pursue nuclear phase-out, the decommissioning percentage until 2030 exceeds 55% of 2010 capacities.

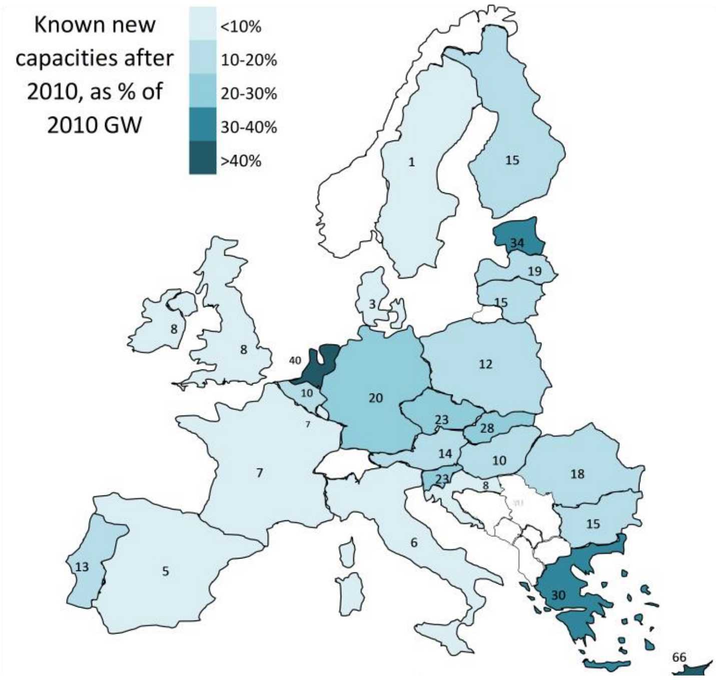
Countries with high shares of hydro, and countries with relatively newer dispatchable thermal plants (among which Italy and Spain), are likely to decommission until 2030 less than 30% of total dispatchable capacity operating in 2010.

Overview of dispatchable plant capacities under construction

The model database includes detailed information on plants under construction collected from companies, the PLATTS database and other sources. Care was taken to confirm likely commissioning dates from different sources. Future projects under consideration by investors or projects with relatively high uncertainty about completion have been excluded. The information concerns only dispatchable plants. Table 33 in Appendix 3 presents in detail new plants under construction as considered in the Reference scenario. The model includes these plants as exogenous investments with known commissioning dates.

The total capacity of new construction of dispatchable plants with commissioning date known today represent 12% of total dispatchable capacity of the EU operating in 2010. The known new constructions replace only 60% of dispatchable capacity to be decommissioned in the EU in the period 2011 to 2020. This percentage is 30% for base-load plants and10% for peak units and CHP plants.

Figure 28: Known new dispatchable plants to be commissioned after 2010



In contrast, known investment in CCGT and in dispatchable RES largely overcompensate planned decommissioning in the period 2011-2020.

The known new constructions in the EU are distributed as follows: 36% in base-load plants, 42% in CCGT, 4% in peak units and CHP, and 18% in dispatchable RES.

Among the EU countries, in 10 countries known new constructions cover less than 50% of planned decommissioning, in 7 countries the same percentage is between 60 and 90% and in 11 countries known new constructions exceed planned decommissioned capacities. These percentages refer to dispatchable plants.

Projection of fuel and carbon prices

According to the Reference scenario projection, average EU gas prices for power generation increase by 72% in 2020 and by 84% in 2030 relative to 2010. The same increases for coal prices are 26% and 37% respectively.

The projection of ETS prices in the context of the Reference scenario shows persisting low market equilibrium prices until 2020 as a result of the EUA surplus that prevail at present and the RES and efficiency supporting policies which reduce emissions acting in addition to ETS carbon price effects. The ETS carbon prices are projected to reach a mere 10 €/tCO2 in 2020 and 6 €/tCO2 in 2015. As allowances are continuously reduced by 1.74% until 2050, according to ETS legislation, and RES policies slow down after 2020, the projection shows escalation of ETS carbon prices after 2020. So ETS carbon prices in 2030 are estimated at 35 €/tCO2.

Taking into account ETS auction payments as part of variable costs of generation, and by considering typical CCGT plants and supercritical coal plants, the fuel and carbon costs of generation from CCGT gas plants increase by 80% in 2020 and by 109% in 2030 relative to 2010 and by 58% and 139% for coal-based generation.

Figure 29 presents the projection of international prices (in terms of average import prices to the EU) in the Reference scenario.

Figure 29: Projections of international prices and price ratios in the Reference scenario

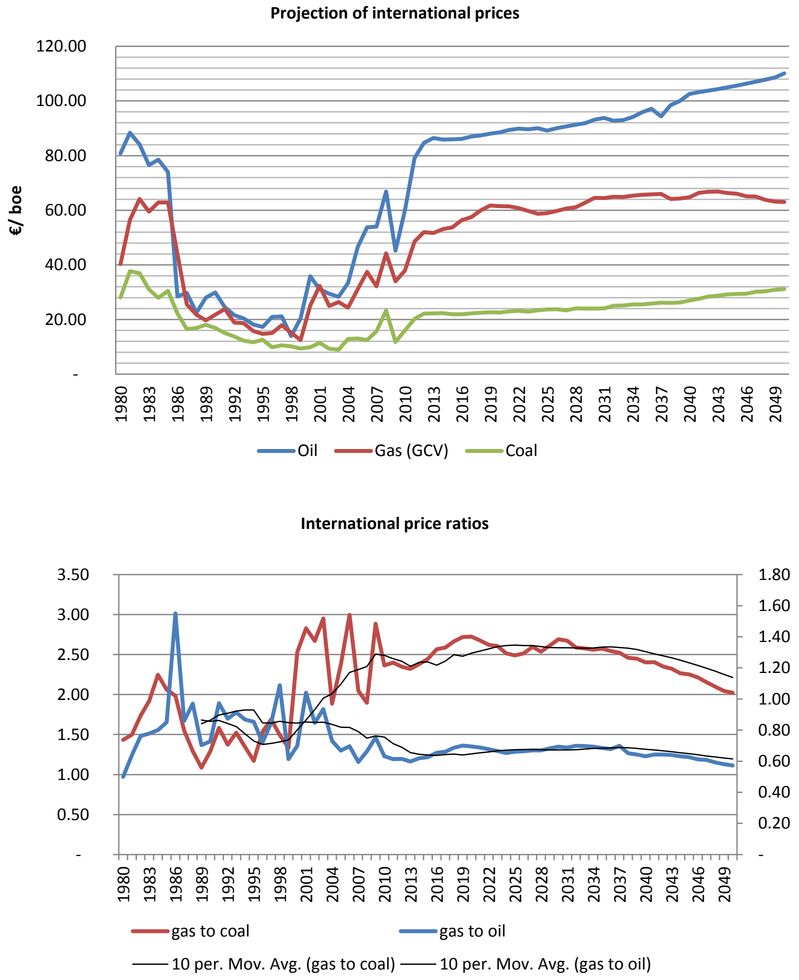


Table 28: Unit fuel including carbon costs of typical gas and coal based generation

€'2010 / MWh	2010	2020	2030	*2020/10*	*2030/10*
CCGT generation	47.2	85.0	98.7	*1.8*	*2.1*
Adv. Coal generation	27.6	43.6	66.0	*1.6*	*2.4*
Gas/Coal ratio	*1.7*	*2.0*	*1.5*		

CCS costs are assumed to be significantly high until 2030 not allowing CCS to emerge. Lignite-based generation has lower variable costs than coal because of lignite pricing at extraction costs and despite a slightly higher emission factor of lignite. Of course variable costs of nuclear generation are significantly lower (9 €/MWh). The above shown variable costs explain the projected slow-down of investment and generation by coal plants post 2020 and the increasing part of gas-based generation among the dispatchable plants.

The model-based generation considers different variable costs by type of plant, than the typical cases shown above for illustration purposes. The modelling takes into account different efficiency rates by plant type, which are generally much lower for old plants than for new technology plants. Gas and coal prices also differ by country depending on supply conditions and transportation costs.

Deviations from the Reference case - High RES and Low XB trade scenarios

The high RES and Low XB trade scenarios constitute deviations in the reference case assumptions as described so far, in respect to two different aspects; the high RES scenario assumes higher penetration of RES, while the Low XB trade scenario assumes limited potential of cross border trade. In particular, the high RES scenario is built on the assumptions of the Diversified technologies scenario of the European Commission Energy Roadmap quantified using the PRIMES model in 2011-2012. The Low XB trade scenario was also quantified using PRIMES assuming that the ENTSO-E development plan fails to increase net transfer capacities and that other market failures and delays in completing the internal electricity market in the EU lead imply barriers to XB trade.

Compared to the projections in the Reference scenario, projections in those two scenarios include different mix in projected investments, different shares of must-take generation and cross-border flows, all resulting from PRIMES model projections. The detailed results of the high RES projections are presented from Table 40 to Table 42 in Appendix 3. The detailed results of the low XB trade projections are presented from Table 43 to Table 45.

APPENDIX 3: DETAILED RESULT TABLES

Reference scenario projections

Table 29: Estimation of past reserve margins and projection to 2015[54]

	2000	2005	2010	2015	Comment
EU27	**31%**	**29%**	**33%**	**30%**	
Austria	38%	32%	33%	46%	increased in 2015
Belgium	19%	17%	15%	4%	below 15%
Bulgaria	40%	53%	18%	15%	
Croatia	18%	5%	12%	4%	below 15% but uses part of Slovenian nuclear
Cyprus	44%	19%	13%	6%	below 15%
Czech	27%	30%	27%	40%	
Denmark	63%	58%	58%	33%	
Estonia	42%	67%	61%	25%	increased in 2015
Finland	18%	12%	8%	12%	below 15%
France	31%	26%	18%	16%	approaching the limit of 15%
Germany	28%	19%	17%	12%	below 15%
Greece	12%	5%	21%	22%	below 15% before the crisis
Hungary	50%	37%	30%	31%	
Ireland	14%	17%	35%	30%	below 15% in 2000
Italy	40%	41%	68%	69%	
Latvia	43%	27%	43%	56%	increased in 2015
Lithuania	87%	96%	57%	69%	drop because of nuclear close
Luxembourg	8%	32%	10%	72%	increased in 2015
Malta	46%	37%	43%	61%	increased in 2015
Netherlands	18%	14%	22%	15%	increased in 2015
Poland	41%	38%	32%	26%	
Portugal	24%	21%	38%	47%	increased in 2015
Romania	130%	93%	93%	78%	
Slovakia	33%	54%	65%	53%	increased in 2015
Slovenia	39%	32%	21%	18%	
Spain	23%	36%	54%	44%	
Sweden	31%	31%	32%	25%	
UK	21%	23%	36%	34%	

---

[54] The projection to 2015 includes only new plants with known commissioning dates and planned decommissioning

Table 30: Load projections, in Reference scenario

	Average annual rate of change of peak domestic load (%)			Average annual rate of change of domestic demand for electricity (%)		
	2001-2010	2011-2020	2021-2030	2001-2010	2011-2020	2021-2030
EU27	**1.36**	**0.22**	**0.91**	**1.16**	**0.47**	**0.83**
Austria	1.91	0.02	0.69	1.78	0.34	0.65
Belgium	1.16	0.16	0.13	0.82	0.20	0.10
Bulgaria	1.25	1.10	0.39	1.08	1.82	0.50
Croatia	1.78	1.94	0.96	2.97	0.97	0.93
Cyprus	5.35	1.89	0.90	4.97	2.53	0.94
Czech	1.14	1.45	1.25	1.26	1.43	1.17
Denmark	0.12	0.34	0.65	-0.09	0.44	0.67
Estonia	3.99	1.81	1.25	3.23	3.17	1.16
Finland	1.06	0.19	0.32	1.04	0.13	0.25
France	1.91	-0.63	1.38	1.40	-0.26	1.34
Germany	0.92	-0.42	0.39	0.82	-0.15	0.32
Greece	1.98	1.34	0.91	2.08	1.41	0.74
Hungary	1.42	0.45	1.18	1.55	0.66	1.23
Ireland	2.83	-0.55	1.56	2.19	0.26	1.59
Italy	1.46	0.01	1.46	1.04	0.43	1.16
Latvia	3.74	-0.50	1.30	3.32	0.94	1.28
Lithuania	2.97	0.37	1.47	2.96	1.10	1.37
Luxembourg	2.02	-0.64	0.75	1.35	-0.45	0.70
Malta	1.64	1.81	0.85	0.25	2.47	0.78
Netherlands	1.25	0.89	0.11	1.11	0.94	0.02
Poland	1.37	3.14	0.92	1.70	2.96	0.77
Portugal	2.62	0.15	1.69	2.64	0.21	1.58
Romania	1.63	1.99	0.31	1.08	2.37	0.44
Slovakia	0.85	1.93	1.46	1.08	2.01	1.43
Slovenia	1.39	2.42	0.51	1.26	2.21	0.60
Spain	2.80	0.75	1.46	3.15	0.80	1.46
Sweden	0.54	0.66	0.96	0.29	0.83	0.92
UK	0.23	-0.47	0.37	-0.10	-0.03	0.39

Table 31: Summary of cross border flows (sum of exports and imports), in TWh[55]*, in Reference scenario*

2015	Central-western EU	Central-south EU	Eastern EU	Iberian EU	British isles	Nordic and Baltic EU	South-east EU	non IEM regions	**Total**	as % of consumption
Central-western EU	16.9	38.1	0.1	7.0	12.5	0.6	0.0	0.0	**75.1**	*6.0*
Central-south EU	0.6	24.2	0.8	0.0	0.0	0.0	1.0	0.1	**26.7**	*6.6*
Eastern EU	7.9	2.9	4.4	0.0	0.0	0.1	4.9	0.0	**20.2**	*7.3*
Iberian EU	0.7	0.0	0.0	6.4	0.0	0.0	0.0	3.2	**10.3**	*3.1*
British isles	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	**2.6**	*0.7*
Nordic and Baltic EU	1.9	0.0	0.0	0.0	0.0	30.0	0.0	0.0	**31.9**	*11.1*
South-east EU	0.0	0.4	2.6	0.0	0.0	0.0	18.3	2.2	**23.5**	*13.8*
non IEM regions	0.0	0.0	9.1	0.0	0.0	2.7	1.1	0.0	**13.0**	
Total	**28.0**	**65.6**	**17.0**	**13.4**	**15.1**	**33.4**	**25.4**	**5.5**	**203.3**	
as % of consumption	*2.3*	*16.3*	*6.1*	*4.1*	*4.1*	*11.6*	*15.0*			
2020	Central-western EU	Central-south EU	Eastern EU	Iberian EU	British isles	Nordic and Baltic EU	South-east EU	non IEM regions	**Total**	as % of consumption
Central-western EU	19.1	50.6	2.4	4.7	6.5	2.5	0.0	0.0	**85.9**	*7.1*
Central-south EU	4.0	21.6	2.6	0.0	0.0	0.0	4.4	0.3	**32.9**	*8.1*
Eastern EU	6.8	2.3	6.5	0.0	0.0	2.3	5.8	0.9	**24.6**	*7.9*
Iberian EU	0.6	0.0	0.0	3.2	0.0	0.0	0.0	3.1	**6.8**	*2.0*
British isles	0.0	0.0	0.0	0.0	3.9	0.1	0.0	0.0	**4.0**	*1.1*
Nordic and Baltic EU	7.9	0.0	0.2	0.0	9.6	27.4	0.0	3.7	**48.8**	*16.6*
South-east EU	0.0	3.4	2.9	0.0	0.0	0.0	27.2	7.1	**40.5**	*22.6*
non IEM regions	0.0	0.5	5.0	0.0	0.0	4.8	1.5	0.0	**11.9**	
Total	**38.4**	**78.5**	**19.6**	**8.0**	**20.0**	**37.1**	**38.9**	**15.1**	**255.5**	
as % of consumption	*3.2*	*19.4*	*6.3*	*2.4*	*5.5*	*12.6*	*21.7*			
2030	Central-western EU	Central-south EU	Eastern EU	Iberian EU	British isles	Nordic and Baltic EU	South-east EU	non IEM regions	**Total**	as % of consumption
Central-western EU	33.2	55.2	0.1	11.3	12.5	0.0	0.0	0.0	**112.2**	*8.6*
Central-south EU	3.7	38.2	2.8	0.0	0.0	0.0	3.8	0.0	**48.6**	*10.8*
Eastern EU	18.8	4.7	9.9	0.0	0.0	0.1	7.9	1.2	**42.6**	*12.5*
Iberian EU	6.3	0.0	0.0	5.9	0.0	0.0	0.0	2.6	**14.8**	*3.8*
British isles	4.4	0.0	0.0	0.0	3.2	0.1	0.0	0.0	**7.7**	*2.0*
Nordic and Baltic EU	24.3	0.0	9.1	0.0	6.3	35.8	0.0	9.0	**84.5**	*26.8*
South-east EU	0.0	3.2	3.2	0.0	0.0	0.0	30.1	7.6	**44.0**	*23.0*
non IEM regions	0.0	0.5	6.8	1.2	0.0	8.8	1.3	0.0	**18.7**	
Total	**90.6**	**101.8**	**31.9**	**18.3**	**21.9**	**44.9**	**43.2**	**20.4**	**373.0**	
as % of consumption	*7.0*	*22.6*	*9.3*	*4.7*	*5.8*	*14.2*	*22.6*			

---

[55] The table reads: a region in a row sends a flow to a region in a column.

Table 32: Planned decommissioning of dispatchable capacities, in Reference scenario

	Decommissioning of dispatchable plants				Decommissioning of base-load plants		Decommissioning of CCGT plants		Decommissioning of peak units and CHP plants		Decommissioning of dispatchable RES plants	
	2011-2020		2021-2030		2011-20	2021-30	2011-20	2021-30	2011-20	2021-30	2011-20	2021-30
	GW	% of 2010 GW	GW	% of 2010 GW	GW	GW	GW	GW	GW	GW	GW	GW
EU27	**156.8**	***21***	**154.2**	***21***	**91.7**	**106.2**	**7.3**	**13.7**	**56.0**	**34.6**	**2.2**	**5.1**
Austria	1.5	*9*	2.4	*14*	0.0	1.3	0.5	0.0	0.9	0.8	0.0	0.3
Belgium	4.1	*25*	6.5	*40*	2.8	4.0	0.0	0.9	1.2	1.6	0.0	0.5
Bulgaria	1.6	*18*	1.3	*14*	1.2	0.7	0.0	0.0	0.4	0.5	0.0	0.0
Croatia	0.2	*6*	0.4	*11*	0.1	0.0	0.0	0.0	0.1	0.3	0.0	0.0
Cyprus	0.6	*48*	0.2	*15*	0.0	0.0	0.0	0.0	0.6	0.2	0.0	0.0
Czech	5.2	*32*	5.3	*32*	4.7	5.1	0.3	0.0	0.2	0.1	0.0	0.1
Denmark	2.3	*24*	1.8	*19*	1.7	1.3	0.0	0.0	0.7	0.4	0.0	0.1
Estonia	2.1	*76*	0.3	*10*	2.0	0.2	0.0	0.0	0.1	0.1	0.0	0.0
Finland	2.0	*13*	3.9	*25*	0.7	2.3	0.1	0.4	0.7	0.5	0.5	0.7
France	10.1	*9*	42.1	*38*	4.7	37.1	0.5	0.6	4.8	4.2	0.1	0.2
Germany	43.5	*40*	29.1	*26*	31.7	20.4	1.3	1.3	10.3	6.7	0.3	0.7
Greece	2.6	*19*	3.3	*24*	1.1	3.1	0.0	0.0	1.5	0.2	0.0	0.0
Hungary	3.6	*42*	2.3	*26*	1.8	1.0	0.0	0.0	1.7	1.1	0.1	0.1
Ireland	1.3	*19*	1.0	*15*	0.0	0.2	0.0	0.1	1.3	0.8	0.0	0.0
Italy	14.9	*15*	7.4	*7*	2.5	1.6	0.9	6.5	11.5	3.9	0.0	0.4
Latvia	0.2	*7*	0.2	*9*	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
Lithuania	0.4	*15*	1.1	*37*	0.0	0.0	0.0	0.0	0.4	1.0	0.0	0.0
Luxembourg	0.0	*2*	0.0	*2*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malta	0.3	*45*	0.0	*2*	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Netherlands	7.2	*31*	5.5	*24*	1.6	1.5	3.3	2.4	2.2	1.4	0.1	0.1
Poland	5.9	*19*	6.2	*20*	5.2	5.7	0.0	0.0	0.2	0.4	0.5	0.0
Portugal	1.6	*12*	2.4	*18*	0.0	1.2	0.0	0.0	1.6	1.0	0.0	0.1
Romania	4.8	*26*	5.6	*30*	2.0	3.8	0.0	0.0	2.9	1.8	0.0	0.1
Slovakia	1.2	*15*	1.7	*21*	0.7	1.5	0.0	0.0	0.5	0.1	0.0	0.2
Slovenia	0.9	*26*	0.9	*28*	0.7	0.7	0.0	0.0	0.2	0.1	0.0	0.1
Spain	6.2	*8*	4.4	*6*	1.3	1.3	0.0	0.0	4.9	3.0	0.1	0.1
Sweden	1.1	*3*	8.7	*25*	0.0	6.2	0.0	0.0	1.1	1.3	0.1	1.1
UK	31.2	*35*	10.6	*12*	25.2	5.7	0.1	1.4	5.8	3.2	0.2	0.2

Table 33: New commissioning of plants known to be under construction, in Reference scenario

2011-2020	Dispatchable plants with known commis-sioning dates		Base-load plants	CCGT plants	peak units and CHP plants	dispatchable RES plants	All dispatchable plants	Base-load plants	CCGT plants	peak units and CHP plants	dispatchable RES plants
	GW	% of 2010 GW	GW				as a ratio over decommissioning in 2011-2020 (a blank means calculation is impossible)				
EU27	**88.3**	**12**	**31.5**	**36.9**	**3.4**	**16.6**	**0.6**	**0.3**	**5.1**	**0.1**	**7.6**
Austria	2.5	14	0.0	0.8	0.0	1.7	1.7	0.0	1.7	0.0	38.1
Belgium	1.7	10	0.0	0.9	0.5	0.4	0.4	0.0		0.4	
Bulgaria	1.4	15	1.3	0.0	0.0	0.0	0.9	1.0		0.0	
Croatia	0.3	8	0.0	0.2	0.0	0.0	1.2	0.0		0.0	23.8
Cyprus	0.8	66	0.0	0.6	0.2	0.0	1.4			0.4	
Czech	3.7	23	2.3	0.8	0.2	0.3	0.7	0.5	2.9	1.1	10.0
Denmark	0.3	3	0.0	0.0	0.0	0.3	0.1	0.0		0.0	
Estonia	0.9	34	0.6	0.0	0.4	0.0	0.4	0.3	0.0	2.9	0.5
Finland	2.4	15	1.6	0.0	0.0	0.7	1.2	2.4	0.0	0.1	1.5
France	7.3	7	1.5	5.1	0.0	0.7	0.7	0.3	9.4	0.0	5.8
Germany	21.6	20	12.3	2.5	0.7	6.1	0.5	0.4	1.9	0.1	21.1
Greece	4.0	30	0.6	2.5	0.6	0.3	1.5	0.5		0.4	
Hungary	0.8	10	0.0	0.7	0.0	0.1	0.2	0.0		0.0	0.9
Ireland	0.5	8	0.0	0.4	0.0	0.1	0.4	0.0		0.0	3.6
Italy	6.4	6	3.1	3.1	0.0	0.2	0.4	1.2	3.4	0.0	11.5
Latvia	0.5	19	0.0	0.5	0.0	0.0	2.7	0.0	2.6		
Lithuania	0.5	15	0.0	0.4	0.0	0.0	1.1			0.0	
Luxembourg	0.1	7	0.0	0.0	0.0	0.1	3.6		0.0	0.0	
Malta	0.1	23	0.0	0.0	0.1	0.0	0.5			0.5	
Netherlands	9.3	40	3.5	5.0	0.2	0.7	1.3	2.1	1.5	0.1	7.2
Poland	3.8	12	1.4	1.5	0.0	0.8	0.6	0.3		0.0	1.6
Portugal	1.8	13	0.0	1.6	0.1	0.1	1.1	0.0		0.1	1.8
Romania	3.3	18	1.2	0.6	0.0	1.4	0.7	0.6		0.0	
Slovakia	2.2	28	1.1	0.4	0.0	0.7	1.9	1.6		0.0	
Slovenia	0.8	23	0.5	0.0	0.0	0.2	0.9	0.8	0.0	0.0	39.8
Spain	4.1	5	0.0	3.3	0.2	0.6	0.7	0.0		0.0	7.7
Sweden	0.3	1	0.0	0.0	0.0	0.3	0.3			0.0	4.5
UK	7.2	8	0.4	6.2	0.0	0.5	0.2	0.0	48.2	0.0	2.8

Table 34: Investment requirements in dispatchable plants, in Reference scenario

	Remaining capacities in GW			Investment requirements in GW		as % of 2010 capacities	
	2010	2020	2030	2011-2020	2021-2030	2011-2020	2021-2030
EU27	**744.1**	**675.7**	**527.2**	**65.6**	**210.3**	***8.8***	***28.3***
Austria	17.4	18.3	16.0	0.9	2.1	*5.0*	*12.3*
Belgium	16.4	14.1	7.9	3.6	8.3	*21.6*	*50.7*
Bulgaria	9.1	8.9	7.6	2.1	4.6	*23.6*	*50.0*
Croatia	3.6	3.7	3.3	0.1	0.7	*3.7*	*20.4*
Cyprus	1.3	1.5	1.3	0.2	0.4	*16.0*	*31.7*
Czech	16.3	14.7	9.4	1.5	6.7	*9.1*	*41.3*
Denmark	9.9	7.8	6.0	0.1	2.8	*1.4*	*28.6*
Estonia	2.8	34.3	25.6	1.4	1.7	*51.8*	*60.5*
Finland	15.7	16.1	12.2	1.0	5.9	*6.1*	*37.6*
France	111.4	108.6	70.0	3.1	39.2	*2.7*	*35.2*
Germany	110.1	88.2	59.2	17.7	44.5	*16.1*	*40.4*
Greece	13.5	14.9	11.6	0.4	2.7	*2.9*	*19.9*
Hungary	8.6	5.9	3.6	1.5	4.2	*17.9*	*48.3*
Ireland	7.1	6.3	5.3	0.1	0.5	*1.9*	*6.3*
Italy	100.3	91.8	84.4	2.8	14.3	*2.8*	*14.2*
Latvia	2.6	2.9	2.7	0.5	0.7	*21.1*	*28.6*
Lithuania	3.0	3.1	2.0	0.4	2.7	*14.4*	*87.8*
Luxembourg	1.6	1.7	1.7	0.0	0.1	*2.7*	*7.4*
Malta	0.6	0.5	0.4	0.3	0.3	*43.4*	*44.0*
Netherlands	23.5	25.5	20.0	2.0	6.9	*8.6*	*29.5*
Poland	31.1	28.9	22.7	7.3	18.3	*23.6*	*58.9*
Portugal	13.7	13.8	11.9	1.3	1.8	*9.8*	*13.4*
Romania	18.8	17.3	11.6	1.9	4.9	*9.9*	*26.1*
Slovakia	7.9	9.0	7.3	0.1	2.2	*1.4*	*28.4*
Slovenia	3.3	3.2	2.3	0.3	1.7	*7.8*	*50.1*
Spain	74.4	72.2	68.3	3.5	4.5	*4.7*	*6.1*
Sweden	35.1	34.3	25.6	1.8	10.5	*5.0*	*29.8*
UK	88.7	64.6	54.8	9.7	17.7	*10.9*	*20.0*

Table 35: Reserve margin values w/o projected investment (excl. RES), in Reference scenario

	2000	2005	2010	2015	2020	2025	2030
EU27	31%	29%	34%	30%	17%	1%	-16%
Germany	28%	19%	17%	12%	-2%	-21%	-37%
France	31%	26%	18%	16%	12%	-3%	-35%
UK	21%	23%	36%	34%	4%	-4%	-16%
Italy	40%	41%	68%	69%	57%	38%	25%
Spain	23%	36%	54%	44%	39%	25%	10%
Poland	41%	38%	32%	26%	-10%	-23%	-35%
Belgium	19%	17%	15%	4%	-3%	-31%	-46%
Netherlands	18%	14%	22%	15%	21%	4%	-7%
Portugal	44%	38%	52%	62%	52%	32%	13%
Ireland	14%	17%	35%	30%	14%	9%	-10%
Greece	12%	5%	21%	22%	17%	-7%	-17%
Denmark	63%	58%	58%	33%	3%	1%	-34%
Finland	18%	12%	8%	12%	8%	-6%	-20%
Sweden	31%	31%	32%	24%	20%	-1%	-18%
Austria	38%	32%	33%	46%	34%	17%	21%
Czech	27%	30%	27%	40%	20%	-6%	-32%
Slovakia	33%	48%	58%	48%	56%	43%	9%
Slovenia	39%	32%	21%	18%	16%	-26%	-35%
Hungary	50%	37%	30%	31%	-10%	-44%	-51%
Romania	130%	93%	93%	78%	41%	14%	-9%
Bulgaria	40%	53%	18%	15%	2%	-11%	-13%
Lithuania	87%	96%	69%	69%	65%	-1%	-21%
Latvia	43%	27%	43%	56%	76%	31%	12%
Estonia	42%	67%	61%	25%	-38%	-44%	-40%
Luxembourg	8%	32%	32%	72%	65%	59%	51%
Cyprus	44%	19%	13%	5%	10%	0%	-12%
Malta	46%	31%	37%	55%	-12%	-18%	-21%
Croatia	18%	4%	11%	3%	-7%	-10%	-25%

Table 36: Projected investment (without investment under construction), in Reference scenario

	Projected investment		Base-load plants		CCGT plants		peak units and CHP plants		dispatchable RES plants		retrofitting investment		new plants	
	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30
EU27	**65.6**	**144.7**	**11.0**	**72.5**	**7.1**	**34.7**	**39.0**	**30.2**	**8.4**	**7.2**	**23.5**	**57.4**	**42.1**	**87.3**
Austria	0.9	1.3	0.0	0.2	0.0	0.0	0.5	0.7	0.4	0.4	0.4	0.5	0.5	0.7
Belgium	3.6	4.8	0.0	0.0	0.5	3.3	2.5	1.4	0.6	0.1	0.8	0.3	2.7	4.5
Bulgaria	2.1	2.4	0.9	1.6	0.3	0.6	0.9	0.3	0.0	0.0	0.3	0.5	1.8	1.9
Croatia	0.1	0.6	0.0	0.0	0.0	0.5	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.5
Cyprus	0.2	0.2	0.0	0.0	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.2
Czech	1.5	5.2	1.4	5.1	0.0	0.0	0.1	0.0	0.0	0.1	1.4	2.9	0.1	2.3
Denmark	0.1	2.7	0.0	0.2	0.0	0.3	0.0	2.1	0.1	0.1	0.0	0.5	0.1	2.2
Estonia	1.4	0.2	0.8	0.2	0.5	0.1	0.1	0.0	0.0	0.0	0.3	0.2	1.1	0.1
Finland	1.0	5.0	0.0	4.1	0.0	0.3	0.0	0.2	0.9	0.4	0.5	2.1	0.5	2.9
France	3.1	36.2	0.3	29.4	0.0	0.0	1.5	6.1	1.3	0.7	1.7	30.1	1.3	6.0
Germany	17.7	26.8	1.8	2.3	1.9	18.6	13.2	5.3	0.8	0.5	7.0	2.8	10.7	24.0
Greece	0.4	2.3	0.0	0.0	0.2	1.3	0.2	0.9	0.0	0.1	0.0	0.2	0.4	2.1
Hungary	1.5	2.6	1.2	1.7	0.0	0.6	0.1	0.2	0.2	0.1	1.3	1.1	0.3	1.6
Ireland	0.1	0.3	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.1	0.1	0.0	0.1	0.3
Italy	2.8	11.4	0.1	0.0	0.2	6.3	2.3	4.6	0.3	0.6	1.8	0.5	1.0	10.9
Latvia	0.5	0.2	0.0	0.0	0.2	0.0	0.3	0.2	0.0	0.0	0.2	0.0	0.3	0.2
Lithuania	0.4	2.2	0.0	1.3	0.0	0.0	0.4	0.8	0.0	0.1	0.3	0.2	0.1	2.0
Luxembourg	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Malta	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Netherlands	2.0	4.9	0.0	1.2	1.3	1.4	0.5	1.8	0.3	0.5	1.8	2.9	0.3	2.0
Poland	7.3	11.0	1.8	8.8	0.0	1.5	4.8	0.5	0.7	0.1	1.3	0.9	6.0	10.0
Portugal	1.3	0.5	0.0	0.0	0.0	0.0	1.2	0.2	0.2	0.3	0.5	0.1	0.9	0.4
Romania	1.9	3.0	0.1	2.2	1.5	0.1	0.1	0.7	0.1	0.1	0.1	1.9	1.7	1.2
Slovakia	0.1	2.1	0.1	1.8	0.0	0.0	0.0	0.1	0.0	0.2	0.1	1.4	0.0	0.7
Slovenia	0.3	1.4	0.1	1.1	0.1	0.1	0.1	0.0	0.0	0.2	0.2	0.8	0.1	0.6
Spain	3.5	1.0	1.2	0.0	0.0	0.0	1.7	0.6	0.6	0.4	0.4	0.0	3.1	1.0
Sweden	1.8	8.7	0.0	6.6	0.0	0.0	0.3	0.2	1.4	1.9	0.1	6.7	1.6	2.0
UK	9.7	8.0	1.2	4.8	0.0	0.1	8.1	2.9	0.3	0.2	2.8	0.6	6.9	7.4

Table 37: Outlook of projected retrofitting investment, in Reference scenario

	Projected retrofitting		base-load plants		CCGT plants		peak units and CHP plants		dispatchable RES plants		as % of dispatchable capacities in 2010	
	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30
EU27	**23.5**	**57.4**	**7.3**	**49.5**	**2.8**	**1.6**	**12.4**	**4.4**	**1.0**	**1.9**	***3.2***	***7.7***
Austria	0.4	0.5	0.0	0.2	0.0	0.0	0.4	0.1	0.0	0.2	*2.4*	*3.0*
Belgium	0.8	0.3	0.0	0.0	0.0	0.0	0.8	0.3	0.0	0.0	*5.2*	*1.9*
Bulgaria	0.3	0.5	0.0	0.4	0.0	0.0	0.3	0.1	0.0	0.0	*3.4*	*6.0*
Croatia	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	*0.5*	*1.6*
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*	*0.0*
Czech	1.4	2.9	1.3	2.9	0.0	0.0	0.1	0.0	0.0	0.1	*8.4*	*18.0*
Denmark	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.1	*0.2*	*4.9*
Estonia	0.3	0.2	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	*11.3*	*5.4*
Finland	0.5	2.1	0.0	1.2	0.0	0.3	0.0	0.2	0.4	0.4	*3.1*	*13.2*
France	1.7	30.1	0.3	29.4	0.0	0.0	1.4	0.7	0.1	0.1	*1.6*	*27.1*
Germany	7.0	2.8	1.5	2.3	1.3	0.0	4.1	0.5	0.0	0.0	*6.4*	*2.5*
Greece	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	*0.0*	*1.4*
Hungary	1.3	1.1	1.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	*14.6*	*12.3*
Ireland	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	*0.7*	*0.0*
Italy	1.8	0.5	0.0	0.0	0.0	0.0	1.8	0.2	0.0	0.3	*1.8*	*0.5*
Latvia	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	*7.7*	*0.2*
Lithuania	0.3	0.2	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	*11.1*	*6.9*
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*1.3*	*0.0*
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*	*0.0*
Netherlands	1.8	2.9	0.0	1.1	1.3	1.1	0.4	0.6	0.1	0.0	*7.5*	*12.2*
Poland	1.3	0.9	1.1	0.9	0.0	0.0	0.2	0.0	0.1	0.0	*4.3*	*3.0*
Portugal	0.5	0.1	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.1	*3.4*	*0.8*
Romania	0.1	1.9	0.0	1.6	0.0	0.0	0.1	0.3	0.0	0.0	*0.7*	*10.0*
Slovakia	0.1	1.4	0.1	1.3	0.0	0.0	0.0	0.0	0.0	0.1	*1.2*	*18.1*
Slovenia	0.2	0.8	0.1	0.7	0.0	0.0	0.1	0.0	0.0	0.1	*5.9*	*25.1*
Spain	0.4	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.1	0.0	*0.5*	*0.0*
Sweden	0.1	6.7	0.0	6.2	0.0	0.0	0.1	0.2	0.1	0.4	*0.4*	*19.2*
UK	2.8	0.6	1.2	0.0	0.0	0.1	1.5	0.4	0.1	0.1	*3.1*	*0.7*

Table 38: Outlook of projected investment in new plants, in Reference scenario

	Projected investment in new plants		base-load plants		CCGT plants		peak units and CHP plants		dispatchable RES plants		as % of dispatchable capacities in 2010	
	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30	2011-21	2021-30
EU27	**42.1**	**87.3**	**3.8**	**23.0**	**4.3**	**33.1**	**26.7**	**25.9**	**7.4**	**5.3**	***5.7***	***11.7***
Austria	0.5	0.7	0.0	0.0	0.0	0.0	0.1	0.5	0.4	0.2	*2.6*	*4.3*
Belgium	2.7	4.5	0.0	0.0	0.5	3.3	1.7	1.1	0.6	0.1	*16.4*	*27.2*
Bulgaria	1.8	1.9	0.8	1.1	0.3	0.6	0.7	0.1	0.0	0.0	*20.2*	*20.4*
Croatia	0.1	0.5	0.0	0.0	0.0	0.5	0.0	0.0	0.1	0.0	*3.2*	*15.1*
Cyprus	0.2	0.2	0.0	0.0	0.2	0.1	0.0	0.1	0.0	0.0	*16.0*	*15.7*
Czech	0.1	2.3	0.1	2.3	0.0	0.0	0.0	0.0	0.0	0.0	*0.8*	*14.1*
Denmark	0.1	2.2	0.0	0.2	0.0	0.3	0.0	1.8	0.1	0.0	*1.2*	*22.3*
Estonia	1.1	0.1	0.5	0.0	0.5	0.1	0.1	0.0	0.0	0.0	*40.5*	*3.3*
Finland	0.5	2.9	0.0	2.9	0.0	0.0	0.0	0.0	0.5	0.0	*3.0*	*18.4*
France	1.3	6.0	0.0	0.0	0.0	0.0	0.1	5.4	1.2	0.6	*1.2*	*5.4*
Germany	10.7	24.0	0.2	0.0	0.6	18.6	9.1	4.9	0.8	0.5	*9.7*	*21.8*
Greece	0.4	2.1	0.0	0.0	0.2	1.3	0.2	0.7	0.0	0.1	*2.9*	*15.6*
Hungary	0.3	1.6	0.0	0.6	0.0	0.6	0.1	0.2	0.2	0.1	*3.3*	*18.2*
Ireland	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	*1.1*	*4.5*
Italy	1.0	10.9	0.1	0.0	0.2	6.3	0.5	4.4	0.3	0.3	*1.0*	*10.9*
Latvia	0.3	0.2	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	*13.2*	*7.3*
Lithuania	0.1	2.0	0.0	1.3	0.0	0.0	0.0	0.6	0.0	0.1	*2.9*	*66.4*
Luxembourg	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	*1.4*	*4.8*
Malta	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	*43.4*	*0.6*
Netherlands	0.3	2.0	0.0	0.1	0.0	0.3	0.1	1.2	0.2	0.5	*1.1*	*8.7*
Poland	6.0	10.0	0.8	7.9	0.0	1.5	4.6	0.5	0.6	0.1	*19.3*	*32.3*
Portugal	0.9	0.4	0.0	0.0	0.0	0.0	0.8	0.2	0.1	0.2	*6.4*	*2.8*
Romania	1.7	1.2	0.1	0.6	1.5	0.1	0.0	0.4	0.1	0.1	*9.2*	*6.2*
Slovakia	0.0	0.7	0.0	0.5	0.0	0.0	0.0	0.1	0.0	0.1	*0.2*	*8.9*
Slovenia	0.1	0.6	0.0	0.3	0.1	0.1	0.0	0.0	0.0	0.2	*1.9*	*17.2*
Spain	3.1	1.0	1.2	0.0	0.0	0.0	1.4	0.6	0.5	0.4	*4.2*	*1.4*
Sweden	1.6	2.0	0.0	0.4	0.0	0.0	0.3	0.1	1.3	1.5	*4.6*	*5.6*
UK	6.9	7.4	0.0	4.8	0.0	0.0	6.6	2.5	0.3	0.1	*7.8*	*8.3*

Table 39: Shares of must-take generation in total generation (%), in Reference scenario

	2010	2020	2030
EU27	**30.6**	**47.0**	**54.6**
Austria	69.6	85.4	91.0
Belgium	14.4	33.3	58.1
Bulgaria	21.6	29.6	35.0
Croatia	78.3	71.2	63.8
Cyprus	0.7	21.2	38.8
Czech	21.4	33.6	28.8
Denmark	36.4	56.8	72.8
Estonia	16.9	28.2	46.8
Finland	64.8	46.9	39.7
France	16.8	31.5	36.9
Germany	26.7	55.3	66.5
Greece	34.1	47.5	64.3
Hungary	30.2	34.2	33.7
Ireland	16.8	52.0	63.9
Italy	40.1	51.8	61.5
Latvia	60.0	79.1	71.0
Lithuania	68.7	87.3	38.1
Luxembourg	16.2	56.4	57.7
Malta	0.0	13.6	41.0
Netherlands	37.0	54.8	63.6
Poland	27.7	34.9	32.6
Portugal	64.0	68.7	85.8
Romania	45.9	52.1	60.1
Slovakia	33.0	35.3	28.8
Slovenia	39.1	39.9	37.9
Spain	43.3	46.2	58.2
Sweden	60.9	58.8	61.8
UK	12.4	51.2	63.8

Table 40: Summary of cross border flows (sum of exports and imports), in TWh[56], under high RES conditions

2015	Central-western EU	Central-south EU	Eastern EU	Iberian EU	British isles	Nordic and Baltic EU	South-east EU	non IEM regions	**Total**	as % of consumption
Central-western EU	32.8	16.0	10.3	0.0	2.4	3.9	0.0	0.0	**65.4**	*5.3*
Central-south EU	32.4	22.7	6.5	0.0	0.0	0.0	1.4	0.5	**63.5**	*15.8*
Eastern EU	3.6	0.0	6.4	0.0	0.0	1.0	8.8	10.3	**30.0**	*10.8*
Iberian EU	21.5	0.0	0.0	0.6	0.0	0.0	0.0	5.1	**27.3**	*8.3*
British isles	0.8	0.0	0.0	0.0	12.7	0.0	0.0	0.0	**13.5**	*3.7*
Nordic and Baltic EU	2.3	0.0	0.0	0.0	0.0	19.4	0.0	8.0	**29.8**	*10.4*
South-east EU	0.0	0.5	2.6	0.0	0.0	0.0	20.3	9.7	**33.0**	*19.5*
non IEM regions	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	**1.3**	
Total	**93.5**	**39.1**	**25.8**	**0.6**	**15.1**	**25.6**	**30.5**	**33.7**	**263.9**	
as % of consumption	*7.5*	*9.7*	*9.3*	*0.2*	*4.1*	*8.9*	*18.0*			*7.4*
2020	Central-western EU	Central-south EU	Eastern EU	Iberian EU	British isles	Nordic and Baltic EU	South-east EU	non IEM regions	**Total**	as % of consumption
Central-western EU	31.0	11.5	4.7	0.0	5.4	3.4	0.0	0.0	**56.0**	*4.6*
Central-south EU	24.3	25.0	7.1	0.0	0.0	0.0	3.2	0.8	**60.4**	*14.9*
Eastern EU	2.7	0.0	8.6	0.0	0.0	1.4	6.6	13.9	**33.3**	*10.7*
Iberian EU	2.3	0.0	0.0	0.3	0.0	0.0	0.0	2.5	**5.1**	*1.5*
British isles	2.2	0.0	0.0	0.0	16.5	0.0	0.0	0.0	**18.7**	*5.2*
Nordic and Baltic EU	4.5	0.0	0.0	0.0	1.1	37.2	0.0	12.6	**55.3**	*18.8*
South-east EU	0.0	0.9	1.2	0.0	0.0	0.0	23.1	11.9	**37.1**	*20.6*
non IEM regions	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	**1.6**	
Total	**67.0**	**37.3**	**21.6**	**0.3**	**23.1**	**43.6**	**32.9**	**41.7**	**267.5**	
as % of consumption	*5.5*	*9.2*	*7.0*	*0.1*	*6.4*	*14.9*	*18.3*			*7.2*
2030	Central-western EU	Central-south EU	Eastern EU	Iberian EU	British isles	Nordic and Baltic EU	South-east EU	non IEM regions	**Total**	as % of consumption
Central-western EU	64.8	16.6	12.8	0.0	6.4	3.8	0.0	0.0	**104.5**	*8.1*
Central-south EU	43.3	33.4	6.2	0.0	0.0	0.0	3.7	0.9	**87.5**	*19.5*
Eastern EU	4.3	0.0	7.9	0.0	0.0	1.0	9.8	12.3	**35.3**	*10.3*
Iberian EU	21.5	0.0	0.0	1.7	0.0	0.0	0.0	6.0	**29.2**	*7.5*
British isles	2.1	0.0	0.0	0.0	24.4	0.0	0.0	0.0	**26.5**	*7.0*
Nordic and Baltic EU	5.3	0.0	0.0	0.0	1.3	22.9	0.0	16.2	**45.7**	*14.5*
South-east EU	0.0	1.1	2.5	0.0	0.0	0.0	29.1	13.1	**45.8**	*24.0*
non IEM regions	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	**0.6**	
Total	**141.3**	**51.2**	**29.4**	**1.7**	**32.1**	**28.2**	**42.6**	**48.5**	**375.0**	
as % of consumption	*10.9*	*11.4*	*8.6*	*0.4*	*8.4*	*8.9*	*22.3*			*9.7*

---

[56] The table reads: a region in a row sends a flow to a region in a column.

Table 41: Shares of must-take generation in total generation (%), under high RES conditions

	2010	2020	2030
EU27	**27.0**	**41.2**	**55.0**
Austria	75.5	87.3	91.6
Belgium	7.3	23.0	47.2
Bulgaria	21.7	23.4	33.8
Croatia	72.9	64.3	74.3
Cyprus	0.7	21.2	38.8
Czech	17.3	20.2	19.2
Denmark	49.9	61.2	75.6
Estonia	10.1	18.0	42.4
Finland	46.4	50.6	47.8
France	16.5	32.2	47.1
Germany	21.7	43.2	62.0
Greece	21.3	42.7	71.4
Hungary	11.4	17.3	29.0
Ireland	17.3	50.6	73.5
Italy	33.4	41.3	56.2
Latvia	69.0	65.0	75.1
Lithuania	52.9	56.9	28.3
Luxembourg	19.3	32.3	46.8
Malta	0.0	13.6	41.0
Netherlands	19.8	43.6	60.1
Poland	19.9	22.6	23.9
Portugal	58.2	66.6	82.3
Romania	46.2	43.0	54.1
Slovakia	30.9	28.6	29.6
Slovenia	36.7	32.4	39.1
Spain	37.2	40.3	56.7
Sweden	60.5	59.6	64.3
UK	6.2	40.9	60.3

Table 42: Additional investments relative to Reference under high RES conditions

Additional investments in GW under high RES conditions												
	Base-load			CCGT			Open cycle plants			All plants		
Commis-sioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	3.0	0.0	0.8	0.2	1.5	1.5	0.5	1.7	1.0	1.2	0.1	0.1
Austria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belgium	0.0	0.0	0.0	0.0	0.9	0.8	0.1	0.0	0.0	0.0	0.0	0.0
Bulgaria	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Denmark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0
Estonia	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
France	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Germany	1.4	0.0	0.8	0.0	0.0	0.0	0.0	1.3	0.5	0.6	0.0	0.0
Greece	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hungary	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Ireland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Latvia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lithuania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Poland	0.0	0.0	0.0	0.1	0.1	0.1	0.3	0.0	0.1	0.0	0.0	0.0
Portugal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Romania	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Slovakia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Slovenia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0
Sweden	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
UK	1.1	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0

Table 43: Shares of must-take generation in total generation (%), under low XB trade conditions

	2010	2020	2030
EU27	**25.8**	**39.7**	**47.1**
Austria	70.7	85.1	88.6
Belgium	7.3	23.5	33.0
Bulgaria	26.3	24.6	31.9
Croatia	55.3	47.1	39.9
Cyprus	0.7	21.2	38.8
Czech	21.3	21.8	19.4
Denmark	49.0	60.6	60.1
Estonia	12.0	19.2	33.3
Finland	39.6	46.6	46.1
France	17.4	33.5	39.9
Germany	20.2	39.8	52.1
Greece	19.0	38.1	54.6
Hungary	9.6	16.5	19.9
Ireland	15.2	44.4	55.7
Italy	29.1	39.4	44.9
Latvia	66.8	66.4	69.1
Lithuania	25.6	36.6	35.9
Luxembourg	6.7	14.9	21.6
Malta	0.0	13.6	41.0
Netherlands	18.8	41.8	50.5
Poland	20.1	20.4	20.9
Portugal	52.5	57.0	71.0
Romania	48.3	45.4	51.3
Slovakia	29.3	29.2	27.3
Slovenia	41.0	34.2	35.9
Spain	37.4	39.4	52.5
Sweden	57.0	61.5	61.5
UK	6.2	40.4	49.2

Table 44: Additional investments relative to Reference scenario under low XB trade conditions

Additional investments in GW under low XB trade conditions												
	Base-load			CCGT			Open cycle plants			All plants		
Commis-sioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	3.4	3.5	5.7	1.3	3.6	4.3	3.6	28.9	32.0	7.6	34.0	41.5
Austria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belgium	0.0	0.0	0.0	0.0	0.6	0.6	1.3	0.3	1.5	1.2	0.9	2.1
Bulgaria	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Croatia	0.0	0.0	0.0	0.5	0.0	0.0	0.6	0.9	1.5	1.1	0.5	1.5
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.0	0.5	0.5	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.6	0.6
Denmark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.4	0.0	0.1	0.0
Estonia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Finland	0.0	0.0	0.0	0.1	0.0	0.1	0.5	0.2	0.7	0.6	0.2	0.8
France	0.0	1.6	1.6	0.0	0.0	0.0	0.0	11.8	11.8	0.0	13.4	13.4
Germany	1.1	0.0	1.1	0.5	1.8	2.3	1.8	2.0	3.8	3.5	3.8	7.3
Greece	0.0	0.0	0.0	0.0	0.1	0.1	0.0	2.4	2.4	0.0	2.5	2.5
Hungary	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.9	0.9	0.2	0.7	0.8
Ireland	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.7	0.7	0.0	0.9	0.9
Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.5	0.5
Latvia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lithuania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Poland	2.0	0.0	1.1	0.4	0.0	0.0	0.0	2.6	2.2	2.1	1.3	3.4
Portugal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Romania	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Slovakia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Slovenia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1
Sweden	0.0	0.3	0.3	0.0	0.0	0.0	0.0	4.4	4.4	0.0	4.7	4.7
UK	0.0	1.2	1.2	0.0	0.8	0.8	0.0	2.5	2.5	0.0	4.5	4.5

Table 45: Summary of cross border flows (sum of exports and imports), in TWh[57]*, under low XB trade conditions*

2015	Central-western EU	Central-south EU	Eastern EU	Iberian EU	British isles	Nordic and Baltic EU	South-east EU	non IEM regions	**Total**	as % of consumption
Central-western EU	4.7	1.7	2.6	0.0	0.4	1.8	0.0	0.0	**11.3**	*0.9*
Central-south EU	6.5	4.4	1.6	0.0	0.0	0.0	1.3	0.0	**13.8**	*3.4*
Eastern EU	0.6	0.0	2.5	0.0	0.0	0.1	2.5	6.5	**12.2**	*4.4*
Iberian EU	1.1	0.0	0.0	0.1	0.0	0.0	0.0	1.1	**2.3**	*0.7*
British isles	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	**0.4**	*0.1*
Nordic and Baltic EU	0.2	0.0	0.0	0.0	0.0	8.0	0.0	4.4	**12.5**	*4.4*
South-east EU	0.0	0.2	0.0	0.0	0.0	0.0	5.2	4.1	**9.5**	*5.6*
non IEM regions	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	**0.7**	
Total	**13.0**	**6.3**	**6.7**	**0.1**	**0.9**	**10.7**	**9.1**	**16.1**	**62.7**	
as % of consumption	*1.0*	*1.6*	*2.4*	*0.0*	*0.2*	*3.7*	*5.3*			*1.5*

2020	Central-western EU	Central-south EU	Eastern EU	Iberian EU	British isles	Nordic and Baltic EU	South-east EU	non IEM regions	**Total**	as % of consumption
Central-western EU	16.6	5.4	9.8	0.0	5.2	2.9	0.0	0.0	**39.9**	*3.3*
Central-south EU	17.2	8.9	2.8	0.0	0.0	0.0	2.4	0.0	**31.3**	*7.7*
Eastern EU	0.9	0.0	7.1	0.0	0.0	0.3	6.7	13.6	**28.5**	*9.2*
Iberian EU	4.6	0.0	0.0	1.7	0.0	0.0	0.0	2.0	**8.3**	*2.4*
British isles	0.0	0.0	0.0	0.0	5.9	0.0	0.0	0.0	**5.9**	*1.6*
Nordic and Baltic EU	0.3	0.0	0.0	0.0	0.0	17.4	0.0	7.6	**25.2**	*8.6*
South-east EU	0.0	0.3	0.0	0.0	0.0	0.0	10.5	9.5	**20.3**	*11.3*
non IEM regions	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	**0.9**	
Total	**39.7**	**14.6**	**19.7**	**1.7**	**11.1**	**21.5**	**19.6**	**32.7**	**160.5**	
as % of consumption	*3.3*	*3.6*	*6.4*	*0.5*	*3.1*	*7.3*	*10.9*			*4.1*

2030	Central-western EU	Central-south EU	Eastern EU	Iberian EU	British isles	Nordic and Baltic EU	South-east EU	non IEM regions	**Total**	as % of consumption
Central-western EU	13.6	2.1	5.1	0.0	2.1	4.3	0.0	0.0	**27.3**	*2.1*
Central-south EU	10.8	6.4	2.5	0.0	0.0	0.0	1.9	0.0	**21.6**	*4.8*
Eastern EU	1.5	0.0	3.9	0.0	0.0	0.2	9.0	13.7	**28.4**	*8.3*
Iberian EU	1.8	0.0	0.0	1.1	0.0	0.0	0.0	1.8	**4.8**	*1.2*
British isles	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	**2.9**	*0.8*
Nordic and Baltic EU	0.3	0.0	0.0	0.0	0.0	10.8	0.0	7.3	**18.3**	*5.8*
South-east EU	0.0	0.2	0.0	0.0	0.0	0.0	8.6	11.0	**19.8**	*10.3*
non IEM regions	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	**0.2**	
Total	**28.1**	**8.8**	**11.5**	**1.1**	**5.0**	**15.5**	**19.5**	**33.8**	**123.3**	
as % of consumption	*2.2*	*2.0*	*3.4*	*0.3*	*1.3*	*4.9*	*10.2*			*2.7*

---

[57] The table reads: a region in a row sends a flow to a region in a column.

Results of wholesale market simulation - Reference scenario

Table 46: Capital recovery index in the marginal cost bidding case, in Reference scenario

Capital recovery index - Marginal cost bidding case - All projected investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.6	1.0	2.4	1.8	0.1	0.2	0.3	0.2	0.1	0.1	0.0	0.1	0.2	0.6	1.7	1.1
Austria	0.3	1.0	1.3	1.2	0.0	0.0	1.0	0.0	0.2	0.2	0.3	0.3	0.1	0.1	0.4	0.3
Belgium	1.5	1.0	1.0	1.0	0.5	0.3	0.8	0.6	-0.2	0.8	0.2	0.5	0.5	0.6	0.5	0.5
Bulgaria	1.0	0.5	0.8	0.6	1.0	-0.2	0.1	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.4	0.7	0.5
Croatia	1.0	4.7	1.0	4.7	0.1	0.2	-0.2	-0.1	1.0	1.0	-2.2	-2.2	0.1	0.4	-0.3	-0.1
Cyprus	1.0	1.0	1.0	1.0	1.0	0.2	1.0	0.2	0.8	0.0	-0.3	-0.1	0.8	0.1	0.1	0.1
Czech	1.2	0.9	2.3	1.7	0.0	0.1	1.0	0.1	0.4	0.2	0.0	0.2	1.1	0.8	2.3	1.6
Denmark	0.1	0.5	0.6	0.6	0.3	1.0	1.5	1.5	0.1	0.0	-0.2	-0.2	0.2	0.0	0.1	0.1
Estonia	0.6	0.9	0.5	0.9	1.0	0.1	0.1	0.1	-0.1	0.1	0.0	0.0	0.6	0.7	0.3	0.7
Finland	0.4	0.7	1.4	1.2	0.1	1.0	-0.1	-0.1	0.3	3.4	0.0	1.6	0.2	0.7	1.4	1.2
France	0.1	0.3	4.0	3.4	0.4	0.4	1.0	0.4	-0.8	-0.3	-0.2	-0.2	0.0	0.3	3.5	2.7
Germany	0.6	1.0	0.6	1.0	0.0	0.0	0.2	0.2	0.3	0.0	0.0	0.0	0.4	0.5	0.2	0.4
Greece	0.9	1.3	1.0	1.3	0.1	0.2	0.8	0.4	0.0	0.1	0.0	0.1	0.3	0.5	0.5	0.5
Hungary	1.6	3.3	1.4	1.9	0.4	0.4	0.3	0.3	0.2	3.2	0.2	1.1	0.9	2.4	1.2	1.6
Ireland	0.6	1.2	1.0	1.2	0.1	-0.1	0.1	-0.1	-0.1	-0.4	-0.1	-0.2	0.2	-0.1	-0.1	-0.1
Italy	1.3	1.8	2.2	1.8	0.0	0.2	1.0	0.2	0.2	2.2	0.0	0.2	0.2	1.4	0.0	0.7
Latvia	1.4	2.3	1.1	1.3	0.0	0.0	1.0	0.0	0.6	0.2	0.8	0.4	0.2	0.1	0.8	0.3
Lithuania	1.0	1.0	1.3	1.3	0.4	0.3	1.0	0.3	-0.1	-0.5	-0.4	-0.4	0.3	0.0	1.0	0.9
Luxembourg	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.6	1.0	0.9
Malta	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	0.3	-0.3	1.0	-0.3	0.3	1.0	1.0	1.0
Netherlands	1.0	0.8	2.5	1.1	0.2	0.1	0.2	0.1	1.6	1.1	0.3	0.4	0.6	0.6	1.1	0.7
Poland	0.4	0.9	1.4	1.3	0.1	0.1	0.4	0.3	0.1	0.4	2.9	0.5	0.3	0.6	1.4	1.1
Portugal	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.1	0.7	0.2	0.0	0.1	0.7	0.1
Romania	0.9	1.1	2.0	1.6	-0.6	0.2	0.2	0.2	0.1	0.1	0.0	0.0	0.8	0.8	1.7	1.2
Slovakia	0.7	0.6	2.9	1.5	0.0	0.1	1.0	0.1	0.1	1.0	0.0	0.0	0.3	0.5	2.8	1.4
Slovenia	0.6	2.0	3.2	2.8	1.0	1.4	2.0	1.8	0.1	-0.1	0.0	-0.1	0.3	1.9	3.2	2.7
Spain	0.6	1.2	1.0	1.2	0.0	0.1	1.0	0.1	0.1	0.0	0.2	0.1	0.1	0.4	0.2	0.4
Sweden	0.5	0.3	2.9	2.9	0.5	1.0	1.0	1.0	0.2	-0.3	-0.6	-0.4	0.3	-0.2	2.8	2.6
UK	0.5	1.0	2.0	1.8	0.1	0.2	0.1	0.2	0.4	0.0	-0.1	0.0	0.1	0.2	1.5	0.9

Capital recovery index - Marginal cost bidding case - Retrofitting investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	1.6	3.5	3.3	1.0	-0.1	-0.1	-0.1	1.0	0.5	0.4	0.5	1.0	1.1	3.4	3.0
Austria	1.0	1.0	1.3	1.2	1.0	1.0	1.0	1.0	1.0	0.2	4.3	0.9	1.0	0.2	1.7	1.1
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.9	4.6	4.1	1.0	3.9	4.6	4.1
Bulgaria	1.0	0.5	-1.2	-1.0	1.0	1.0	1.0	1.0	1.0	0.0	-0.4	-0.1	1.0	0.1	-1.1	-0.8
Croatia	1.0	4.7	1.0	4.7	1.0	1.0	1.0	1.0	1.0	1.0	-2.2	-2.2	1.0	4.7	-2.2	0.4
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	0.3	3.0	2.4	1.0	1.0	1.0	1.0	1.0	11.3	-1.8	11.1	1.0	0.4	3.0	2.5
Denmark	1.0	0.5	0.1	0.1	1.0	1.0	1.0	1.0	1.0	0.0	-0.2	-0.2	1.0	0.0	-0.1	-0.1
Estonia	1.0	1.4	0.5	1.1	1.0	1.0	1.0	1.0	1.0	0.8	1.0	0.8	1.0	1.4	0.5	1.1
Finland	1.0	0.9	0.4	0.4	1.0	1.0	-0.1	-0.1	1.0	5.7	0.0	0.2	1.0	1.3	0.3	0.3
France	1.0	0.8	4.0	4.0	1.0	1.0	1.0	1.0	1.0	-0.2	0.1	-0.1	1.0	0.1	4.0	3.9
Germany	1.0	1.2	0.6	0.9	1.0	-0.1	1.0	-0.1	1.0	0.0	-0.1	0.0	1.0	0.5	0.6	0.5
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0
Hungary	1.0	3.3	2.3	2.8	1.0	1.0	1.0	1.0	1.0	0.4	-0.1	0.1	1.0	3.3	2.2	2.8
Ireland	1.0	1.2	1.0	1.2	1.0	1.0	1.0	1.0	1.0	-0.2	1.0	-0.2	1.0	-0.2	1.0	-0.2
Italy	1.0	1.0	2.2	2.2	1.0	1.0	1.0	1.0	1.0	0.1	-0.1	0.1	1.0	0.1	0.1	0.1
Latvia	1.0	1.0	1.0	1.0	1.0	-0.2	1.0	-0.2	1.0	1.0	0.0	0.0	1.0	-0.2	0.0	-0.2
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	-0.9	-0.3	1.0	0.0	-0.9	-0.3
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	2.5	2.5	1.0	0.0	-0.1	0.0	1.0	1.5	0.0	0.6	1.0	0.4	1.7	1.4
Poland	1.0	0.2	-0.1	0.1	1.0	0.1	0.0	0.1	1.0	2.2	1.0	2.2	1.0	0.3	-0.1	0.1
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.6	0.0	0.5	1.0	0.6	0.0	0.5
Romania	1.0	1.7	1.8	1.8	1.0	1.0	1.0	1.0	1.0	0.0	0.1	0.1	1.0	0.9	1.7	1.7
Slovakia	1.0	0.5	3.6	3.5	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.5	3.6	3.5
Slovenia	1.0	3.2	4.6	4.5	1.0	1.0	1.0	1.0	1.0	-0.1	0.0	-0.1	1.0	2.3	4.6	4.4
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	2.3	0.2	1.0	0.1	2.3	0.2
Sweden	1.0	1.0	3.3	3.3	1.0	1.0	1.0	1.0	1.0	0.0	-1.4	-1.0	1.0	0.0	3.2	3.2
UK	1.0	2.0	1.0	2.0	1.0	1.0	0.1	0.1	1.0	1.2	1.9	1.4	1.0	1.7	1.5	1.7

Capital recovery index - Marginal cost bidding case - New plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.6	0.9	1.6	1.2	0.1	0.2	0.3	0.2	0.1	0.1	0.0	0.1	0.2	0.6	0.9	0.7
Austria	0.3	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.2	0.2	0.1	0.2	0.1	0.0	0.1	0.1
Belgium	1.5	1.0	1.0	1.0	0.5	0.3	0.8	0.6	-0.2	0.4	0.1	0.3	0.5	0.4	0.4	0.4
Bulgaria	1.0	0.5	1.0	0.7	1.0	-0.2	0.1	0.0	-0.1	0.0	0.0	0.0	-0.1	0.4	0.9	0.6
Croatia	1.0	1.0	1.0	1.0	0.1	0.2	-0.2	-0.1	1.0	1.0	1.0	1.0	0.1	0.2	-0.2	-0.1
Cyprus	1.0	1.0	1.0	1.0	1.0	0.2	1.0	0.2	0.8	0.0	-0.3	-0.1	0.8	0.1	0.1	0.1
Czech	1.2	1.0	1.8	1.4	0.0	0.1	1.0	0.1	0.4	-0.1	0.0	-0.1	1.1	0.8	1.8	1.3
Denmark	0.1	1.0	0.6	0.6	0.3	1.0	1.5	1.5	0.1	1.0	-0.2	-0.2	0.2	1.0	0.1	0.1
Estonia	0.6	0.9	1.0	0.9	1.0	0.1	0.1	0.1	-0.1	0.0	0.0	0.0	0.6	0.7	0.1	0.7
Finland	0.4	0.7	1.5	1.2	0.1	1.0	1.0	1.0	0.3	3.3	1.0	3.3	0.2	0.7	1.5	1.2
France	0.1	0.3	1.0	0.3	0.4	0.4	1.0	0.4	-0.8	-0.7	-0.2	-0.2	0.0	0.3	-0.2	0.2
Germany	0.6	1.0	1.0	1.0	0.0	0.0	0.2	0.2	0.3	0.0	0.0	0.0	0.4	0.5	0.2	0.4
Greece	0.9	1.3	1.0	1.3	0.1	0.2	0.8	0.4	0.0	0.1	0.0	0.1	0.3	0.5	0.5	0.5
Hungary	1.6	1.0	0.9	0.9	0.4	0.4	0.3	0.3	0.2	3.5	0.3	1.2	0.9	0.7	0.8	0.8
Ireland	0.6	1.0	1.0	1.0	0.1	-0.1	0.1	-0.1	-0.1	-0.4	-0.1	-0.2	0.2	-0.1	-0.1	-0.1
Italy	1.3	1.8	1.0	1.8	0.0	0.2	1.0	0.2	0.2	4.6	0.0	0.2	0.2	1.4	0.0	0.7
Latvia	1.4	2.3	1.1	1.3	0.0	0.0	1.0	0.0	0.6	0.2	0.8	0.4	0.2	0.1	0.8	0.3
Lithuania	1.0	1.0	1.3	1.3	0.4	0.3	1.0	0.3	-0.1	-1.2	-0.3	-0.4	0.3	0.0	1.0	1.0
Luxembourg	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0
Malta	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	0.3	-0.3	1.0	-0.3	0.3	1.0	1.0	1.0
Netherlands	1.0	0.8	2.2	0.9	0.2	0.1	0.7	0.2	1.6	0.8	0.3	0.4	0.6	0.6	0.6	0.6
Poland	0.4	1.0	1.4	1.3	0.1	0.1	0.4	0.3	0.1	0.3	2.9	0.5	0.3	0.6	1.4	1.2
Portugal	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.1	0.7	0.2	0.0	0.0	0.7	0.1
Romania	0.9	1.1	2.0	1.5	-0.6	0.2	0.2	0.2	0.1	0.1	0.0	0.0	0.8	0.8	1.6	1.1
Slovakia	0.7	0.6	2.0	0.9	0.0	0.1	1.0	0.1	0.1	1.0	0.0	0.0	0.3	0.5	1.9	0.8
Slovenia	0.6	1.9	2.0	2.0	1.0	1.4	2.0	1.8	0.1	0.6	1.0	0.6	0.3	1.9	2.0	2.0
Spain	0.6	1.2	1.0	1.2	0.0	0.1	1.0	0.1	0.1	0.0	0.2	0.1	0.1	0.4	0.2	0.4
Sweden	0.5	0.3	1.1	1.1	0.5	1.0	1.0	1.0	0.2	-0.3	-0.2	-0.3	0.3	-0.2	1.0	0.6
UK	0.5	0.5	2.0	1.8	0.1	0.2	1.0	0.2	0.4	0.0	-0.2	-0.1	0.1	0.1	1.5	0.9

Table 47: Capital recovery index in the supply function equilibrium case, in Reference scenario

Capital recovery index - Supply function equilibrium case - All projected investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.1	2.5	1.9	0.2	0.3	0.6	0.4	0.2	0.2	0.0	0.1	0.4	0.7	1.8	1.3
Austria	0.3	1.0	1.3	1.3	0.0	0.0	1.0	0.0	0.2	0.3	0.3	0.3	0.1	0.1	0.5	0.3
Belgium	1.5	1.0	1.0	1.0	0.7	0.5	1.0	0.8	0.1	0.8	0.3	0.5	0.7	0.7	0.6	0.6
Bulgaria	1.0	1.0	1.5	1.2	1.0	0.5	0.6	0.6	-0.1	0.2	-0.1	0.1	-0.1	0.8	1.3	1.0
Croatia	1.0	5.1	1.0	5.1	0.6	0.8	0.5	0.6	1.0	1.0	-3.7	-3.7	0.6	1.0	0.3	0.5
Cyprus	1.0	1.0	1.0	1.0	1.0	2.6	3.0	2.6	1.3	0.5	0.2	0.4	1.3	2.0	1.1	1.8
Czech	1.5	1.1	2.3	1.8	0.1	0.2	1.0	0.2	0.6	0.4	-0.5	0.3	1.4	1.0	2.3	1.7
Denmark	0.2	0.6	0.7	0.7	0.3	1.0	1.8	1.8	0.1	-2.8	-0.3	-0.3	0.2	-2.6	0.0	0.0
Estonia	0.7	1.0	0.3	1.0	1.0	0.1	0.1	0.1	-0.2	0.1	-0.2	0.0	0.7	0.8	0.2	0.8
Finland	0.6	0.9	1.6	1.3	0.1	1.0	0.0	0.0	0.3	4.3	0.0	2.0	0.4	0.9	1.6	1.3
France	0.1	0.3	4.1	3.5	0.3	0.3	1.0	0.3	-0.5	-1.0	-0.4	-0.5	0.1	0.3	3.5	2.8
Germany	0.8	1.1	0.9	1.1	0.1	0.1	0.5	0.4	0.4	0.0	-0.2	0.0	0.5	0.6	0.3	0.6
Greece	1.1	1.5	1.0	1.5	0.2	0.3	1.3	0.6	0.0	0.0	0.0	0.0	0.4	0.6	0.8	0.7
Hungary	1.7	3.5	1.7	2.2	0.8	0.7	0.3	0.5	0.7	3.4	0.0	1.1	1.2	2.7	1.5	1.9
Ireland	0.9	1.2	1.0	1.2	0.3	0.1	0.0	0.1	0.0	-0.4	-0.2	-0.2	0.3	0.0	-0.2	0.0
Italy	1.4	1.8	2.2	1.8	0.1	0.2	1.0	0.2	0.2	1.8	0.0	0.2	0.2	1.4	0.0	0.7
Latvia	1.8	2.5	1.2	1.5	0.3	0.2	1.0	0.2	0.6	0.4	0.7	0.5	0.4	0.3	0.7	0.4
Lithuania	1.0	1.0	1.2	1.2	0.6	0.6	1.0	0.6	-0.2	-0.4	-0.6	-0.5	0.4	0.2	0.9	0.9
Luxembourg	1.0	1.0	1.0	1.0	0.0	1.0	1.1	1.1	0.0	0.0	1.0	0.0	0.0	0.6	1.1	0.9
Malta	1.0	1.0	1.0	1.0	1.0	3.2	1.0	3.2	1.4	-0.3	1.0	-0.3	1.4	2.1	1.0	2.1
Netherlands	1.0	1.1	3.1	1.4	0.3	0.2	0.7	0.3	1.8	1.4	0.5	0.6	0.7	0.8	1.5	1.0
Poland	0.8	1.4	1.5	1.5	0.1	0.1	0.6	0.4	0.1	0.5	3.6	0.7	0.7	0.9	1.5	1.3
Portugal	1.0	1.0	1.0	1.0	0.1	0.1	1.0	0.1	0.1	0.0	0.2	0.0	0.1	0.1	0.2	0.1
Romania	0.8	1.0	1.5	1.3	0.1	0.1	-0.3	0.0	0.0	-0.7	-0.5	-0.5	0.8	0.6	1.2	0.9
Slovakia	0.8	0.6	3.6	1.8	0.2	0.5	1.0	0.5	0.5	1.0	1.2	1.2	0.4	0.6	3.5	1.7
Slovenia	0.6	1.9	3.4	2.9	1.0	0.8	1.0	0.9	0.1	0.5	0.0	0.5	0.2	1.8	3.3	2.8
Spain	0.8	1.4	1.0	1.4	0.3	0.4	1.0	0.4	0.1	0.1	0.1	0.1	0.3	0.6	0.1	0.6
Sweden	0.7	0.4	3.9	3.9	0.7	1.0	1.0	1.0	0.2	0.2	-1.2	-0.2	0.3	0.2	3.8	3.5
UK	0.7	1.2	2.1	1.9	0.3	0.3	0.1	0.3	0.5	0.1	0.0	0.1	0.3	0.3	1.6	1.0

Capital recovery index - Supply function equilibrium case - Retrofitting investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	1.9	3.7	3.6	1.0	0.1	0.2	0.1	1.0	0.1	0.0	0.1	1.0	1.1	3.6	3.2
Austria	1.0	1.0	1.3	1.3	1.0	1.0	1.0	1.0	1.0	0.2	4.5	0.9	1.0	0.2	1.7	1.1
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.6	4.6	3.9	1.0	3.6	4.6	3.9
Bulgaria	1.0	1.3	-0.1	0.0	1.0	1.0	1.0	1.0	1.0	0.0	-0.1	0.0	1.0	0.4	-0.1	0.0
Croatia	1.0	5.1	1.0	5.1	1.0	1.0	1.0	1.0	1.0	1.0	-3.7	-3.7	1.0	5.1	-3.7	-0.5
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	0.6	3.1	2.6	1.0	1.0	1.0	1.0	1.0	13.6	-1.4	13.4	1.0	0.8	3.1	2.6
Denmark	1.0	0.6	0.1	0.1	1.0	1.0	1.0	1.0	1.0	-2.8	-2.7	-2.7	1.0	-2.6	-2.2	-2.3
Estonia	1.0	1.1	0.3	0.8	1.0	1.0	1.0	1.0	1.0	0.4	1.0	0.4	1.0	1.1	0.3	0.8
Finland	1.0	1.9	0.7	0.8	1.0	1.0	0.0	0.0	1.0	6.8	0.0	0.3	1.0	2.3	0.6	0.7
France	1.0	0.9	4.1	4.1	1.0	1.0	1.0	1.0	1.0	-0.7	0.0	-0.4	1.0	-0.2	4.1	4.0
Germany	1.0	1.5	0.9	1.2	1.0	0.0	1.0	0.0	1.0	-0.6	-0.8	-0.6	1.0	0.4	0.8	0.5
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0
Hungary	1.0	3.5	2.7	3.1	1.0	1.0	1.0	1.0	1.0	0.0	-2.7	-1.3	1.0	3.5	2.6	3.1
Ireland	1.0	1.2	1.0	1.2	1.0	1.0	1.0	1.0	1.0	-0.9	1.0	-0.9	1.0	-0.8	1.0	-0.8
Italy	1.0	1.0	2.2	2.2	1.0	1.0	1.0	1.0	1.0	-0.6	-1.4	-0.6	1.0	-0.6	-1.1	-0.6
Latvia	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	1.0	1.0	0.0	0.0	1.0	0.1	0.0	0.1
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.4	-1.0	-0.6	1.0	-0.4	-1.0	-0.6
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	3.2	3.2	1.0	0.2	0.2	0.2	1.0	2.0	0.3	1.0	1.0	0.6	2.3	2.0
Poland	1.0	1.2	0.0	0.6	1.0	-0.4	0.0	-0.2	1.0	4.2	1.0	4.2	1.0	1.3	0.0	0.7
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.3	0.5	-0.3	1.0	-0.3	0.5	-0.3
Romania	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-1.1	-1.5	-1.4	1.0	0.2	0.8	0.7
Slovakia	1.0	0.7	4.5	4.4	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.5	1.0	0.7	4.5	4.4
Slovenia	1.0	3.1	4.8	4.7	1.0	1.0	1.0	1.0	1.0	0.5	0.0	0.5	1.0	2.3	4.8	4.6
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	5.0	1.0	1.0	0.9	5.0	1.0
Sweden	1.0	1.0	4.4	4.4	1.0	1.0	1.0	1.0	1.0	-3.0	-2.6	-2.7	1.0	-3.0	4.3	4.3
UK	1.0	2.3	1.0	2.3	1.0	1.0	0.1	0.1	1.0	1.2	2.2	1.5	1.0	1.9	1.8	1.9

Capital recovery index - Supply function equilibrium case - New plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.1	1.7	1.4	0.2	0.3	0.6	0.4	0.2	0.2	0.0	0.1	0.4	0.7	1.0	0.8
Austria	0.3	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.2	0.3	0.2	0.2	0.1	0.1	0.2	0.1
Belgium	1.5	1.0	1.0	1.0	0.7	0.5	1.0	0.8	0.1	0.5	0.1	0.3	0.7	0.5	0.5	0.5
Bulgaria	1.0	1.0	1.6	1.2	1.0	0.5	0.6	0.6	-0.1	0.2	-0.1	0.1	-0.1	0.8	1.4	1.0
Croatia	1.0	1.0	1.0	1.0	0.6	0.8	0.5	0.6	1.0	1.0	1.0	1.0	0.6	0.8	0.5	0.6
Cyprus	1.0	1.0	1.0	1.0	1.0	2.6	3.0	2.6	1.3	0.5	0.2	0.4	1.3	2.0	1.1	1.8
Czech	1.5	1.1	1.8	1.5	0.1	0.2	1.0	0.2	0.6	0.1	-0.5	0.0	1.4	1.0	1.8	1.4
Denmark	0.2	1.0	0.7	0.7	0.3	1.0	1.8	1.8	0.1	1.0	-0.1	-0.1	0.2	1.0	0.2	0.2
Estonia	0.7	1.0	1.0	1.0	1.0	0.1	0.1	0.1	-0.2	0.1	-0.2	0.0	0.7	0.8	0.0	0.8
Finland	0.6	0.9	1.7	1.4	0.1	1.0	1.0	1.0	0.3	4.2	1.0	4.2	0.4	0.9	1.7	1.4
France	0.1	0.3	1.0	0.3	0.3	0.3	1.0	0.3	-0.5	-1.7	-0.4	-0.5	0.1	0.3	-0.4	0.1
Germany	0.8	1.1	1.0	1.1	0.1	0.1	0.5	0.4	0.4	0.1	-0.1	0.0	0.5	0.7	0.3	0.6
Greece	1.1	1.5	1.0	1.5	0.2	0.3	1.3	0.6	0.0	0.0	0.0	0.0	0.4	0.6	0.9	0.7
Hungary	1.7	1.0	1.1	1.1	0.8	0.7	0.3	0.5	0.7	3.9	0.1	1.2	1.2	1.0	0.9	1.0
Ireland	0.9	1.0	1.0	1.0	0.3	0.1	0.0	0.1	0.0	-0.3	-0.2	-0.2	0.3	0.1	-0.2	0.0
Italy	1.4	1.8	1.0	1.8	0.1	0.2	1.0	0.2	0.2	4.6	0.0	0.2	0.2	1.5	0.0	0.7
Latvia	1.8	2.5	1.2	1.5	0.3	0.2	1.0	0.2	0.6	0.4	0.7	0.5	0.4	0.4	0.7	0.4
Lithuania	1.0	1.0	1.2	1.2	0.6	0.6	1.0	0.6	-0.2	-0.5	-0.5	-0.5	0.4	0.4	0.9	0.9
Luxembourg	1.0	1.0	1.0	1.0	0.0	1.0	1.1	1.1	0.0	1.0	1.0	1.0	0.0	1.0	1.1	1.1
Malta	1.0	1.0	1.0	1.0	1.0	3.2	1.0	3.2	1.4	-0.3	1.0	-0.3	1.4	2.1	1.0	2.1
Netherlands	1.0	1.1	2.7	1.2	0.3	0.2	1.4	0.3	1.8	1.0	0.5	0.5	0.7	0.8	0.9	0.8
Poland	0.8	1.5	1.5	1.5	0.1	0.1	0.6	0.4	0.1	0.5	3.6	0.7	0.7	0.9	1.5	1.3
Portugal	1.0	1.0	1.0	1.0	0.1	0.1	1.0	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1
Romania	0.8	1.0	1.7	1.3	0.1	0.1	-0.3	0.0	0.0	0.0	-0.3	-0.3	0.8	0.6	1.4	0.9
Slovakia	0.8	0.6	2.5	1.0	0.2	0.5	1.0	0.5	0.5	1.0	1.2	1.2	0.4	0.6	2.4	1.0
Slovenia	0.6	1.8	2.1	2.0	1.0	0.8	1.0	0.9	0.1	0.2	1.0	0.2	0.2	1.8	2.1	1.9
Spain	0.8	1.4	1.0	1.4	0.3	0.4	1.0	0.4	0.1	0.0	0.1	0.1	0.3	0.6	0.1	0.5
Sweden	0.7	0.4	1.5	1.5	0.7	1.0	1.0	1.0	0.2	0.3	-0.5	0.1	0.3	0.3	1.3	1.0
UK	0.7	0.5	2.1	1.9	0.3	0.3	1.0	0.3	0.5	0.0	-0.1	0.0	0.3	0.2	1.6	1.0

Table 48: Capital recovery index in the Cournot competition case, in Reference scenario

Capital recovery index - Cournot competition case - All projected investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	2.4	4.4	4.2	1.0	0.5	0.6	0.5	1.0	0.5	0.4	0.4	1.0	1.6	4.3	3.9
Austria	1.0	1.2	0.6	0.6	1.0	1.0	1.0	1.0	1.0	0.3	4.5	0.9	1.0	0.3	1.1	0.8
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.8	5.9	5.1	1.0	4.8	5.9	5.1
Bulgaria	1.0	2.2	0.4	0.6	1.0	1.0	1.0	1.0	1.0	0.0	0.1	0.0	1.0	0.7	0.4	0.4
Croatia	1.0	5.9	1.0	5.9	1.0	1.0	1.0	1.0	1.0	1.0	-3.4	-3.4	1.0	5.9	-3.4	0.0
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	1.4	4.3	3.7	1.0	1.0	1.0	1.0	1.0	20.6	-0.8	20.3	1.0	1.6	4.3	3.7
Denmark	1.0	1.6	0.8	0.8	1.0	1.0	1.0	1.0	1.0	-3.3	-2.4	-2.4	1.0	-3.0	-1.8	-1.9
Estonia	1.0	0.8	0.3	0.6	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.9	1.0	0.8	0.3	0.6
Finland	1.0	2.8	1.6	1.6	1.0	1.0	0.8	0.8	1.0	10.0	0.3	0.7	1.0	3.4	1.4	1.5
France	1.0	1.3	4.7	4.6	1.0	1.0	1.0	1.0	1.0	-0.5	0.0	-0.3	1.0	0.0	4.6	4.6
Germany	1.0	2.2	1.4	1.7	1.0	0.2	1.0	0.2	1.0	-0.3	-0.2	-0.3	1.0	0.8	1.3	1.0
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0
Hungary	1.0	4.0	3.2	3.6	1.0	1.0	1.0	1.0	1.0	0.3	-2.2	-0.9	1.0	4.0	3.1	3.6
Ireland	1.0	1.9	1.0	1.9	1.0	1.0	1.0	1.0	1.0	-0.5	1.0	-0.5	1.0	-0.4	1.0	-0.4
Italy	1.0	1.0	3.0	3.0	1.0	1.0	1.0	1.0	1.0	-0.3	-1.8	-0.4	1.0	-0.3	-1.4	-0.4
Latvia	1.0	1.0	1.0	1.0	1.0	0.5	1.0	0.5	1.0	1.0	0.0	0.0	1.0	0.5	0.0	0.5
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	-0.3	-0.1	1.0	0.0	-0.3	-0.1
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	3.7	3.7	1.0	0.7	0.6	0.7	1.0	2.8	0.6	1.5	1.0	1.3	2.8	2.5
Poland	1.0	1.4	0.3	0.9	1.0	0.8	0.1	0.4	1.0	4.8	1.0	4.8	1.0	1.6	0.3	1.0
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.4	1.1	0.4	1.0	0.4	1.1	0.4
Romania	1.0	2.6	2.0	2.0	1.0	1.0	1.0	1.0	1.0	-0.9	-0.9	-0.9	1.0	0.9	1.8	1.8
Slovakia	1.0	1.8	6.3	6.1	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.8	1.0	1.8	6.3	6.1
Slovenia	1.0	4.1	5.3	5.2	1.0	1.0	1.0	1.0	1.0	0.7	0.0	0.6	1.0	3.1	5.2	5.1
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.3	5.3	1.3	1.0	1.3	5.3	1.3
Sweden	1.0	1.0	5.5	5.5	1.0	1.0	1.0	1.0	1.0	-2.7	-2.4	-2.5	1.0	-2.7	5.4	5.4
UK	1.0	2.5	1.0	2.5	1.0	1.0	0.2	0.2	1.0	1.4	2.5	1.7	1.0	2.2	2.1	2.1

Capital recovery index - Cournot competition case - Retrofitting investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commissioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	2.4	4.4	4.2	1.0	0.5	0.6	0.5	1.0	0.5	0.4	0.4	1.0	1.6	4.3	3.9
Austria	1.0	1.2	0.6	0.6	1.0	1.0	1.0	1.0	1.0	0.3	4.5	0.9	1.0	0.3	1.1	0.8
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.8	5.9	5.1	1.0	4.8	5.9	5.1
Bulgaria	1.0	2.2	0.4	0.6	1.0	1.0	1.0	1.0	1.0	0.0	0.1	0.0	1.0	0.7	0.4	0.4
Croatia	1.0	5.9	1.0	5.9	1.0	1.0	1.0	1.0	1.0	1.0	-3.4	-3.4	1.0	5.9	-3.4	0.0
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	1.4	4.3	3.7	1.0	1.0	1.0	1.0	1.0	20.6	-0.8	20.3	1.0	1.6	4.3	3.7
Denmark	1.0	1.6	0.8	0.8	1.0	1.0	1.0	1.0	1.0	-3.3	-2.4	-2.4	1.0	-3.0	-1.8	-1.9
Estonia	1.0	0.8	0.3	0.6	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.9	1.0	0.8	0.3	0.6
Finland	1.0	2.8	1.6	1.6	1.0	1.0	0.8	0.8	1.0	10.0	0.3	0.7	1.0	3.4	1.4	1.5
France	1.0	1.3	4.7	4.6	1.0	1.0	1.0	1.0	1.0	-0.5	0.0	-0.3	1.0	0.0	4.6	4.6
Germany	1.0	2.2	1.4	1.7	1.0	0.2	1.0	0.2	1.0	-0.3	-0.2	-0.3	1.0	0.8	1.3	1.0
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0
Hungary	1.0	4.0	3.2	3.6	1.0	1.0	1.0	1.0	1.0	0.3	-2.2	-0.9	1.0	4.0	3.1	3.6
Ireland	1.0	1.9	1.0	1.9	1.0	1.0	1.0	1.0	1.0	-0.5	1.0	-0.5	1.0	-0.4	1.0	-0.4
Italy	1.0	1.0	3.0	3.0	1.0	1.0	1.0	1.0	1.0	-0.3	-1.8	-0.4	1.0	-0.3	-1.4	-0.4
Latvia	1.0	1.0	1.0	1.0	1.0	0.5	1.0	0.5	1.0	1.0	0.0	0.0	1.0	0.5	0.0	0.5
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	-0.3	-0.1	1.0	0.0	-0.3	-0.1
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	3.7	3.7	1.0	0.7	0.6	0.7	1.0	2.8	0.6	1.5	1.0	1.3	2.8	2.5
Poland	1.0	1.4	0.3	0.9	1.0	0.8	0.1	0.4	1.0	4.8	1.0	4.8	1.0	1.6	0.3	1.0
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.4	1.1	0.4	1.0	0.4	1.1	0.4
Romania	1.0	2.6	2.0	2.0	1.0	1.0	1.0	1.0	1.0	-0.9	-0.9	-0.9	1.0	0.9	1.8	1.8
Slovakia	1.0	1.8	6.3	6.1	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.8	1.0	1.8	6.3	6.1
Slovenia	1.0	4.1	5.3	5.2	1.0	1.0	1.0	1.0	1.0	0.7	0.0	0.6	1.0	3.1	5.2	5.1
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.3	5.3	1.3	1.0	1.3	5.3	1.3
Sweden	1.0	1.0	5.5	5.5	1.0	1.0	1.0	1.0	1.0	-2.7	-2.4	-2.5	1.0	-2.7	5.4	5.4
UK	1.0	2.5	1.0	2.5	1.0	1.0	0.2	0.2	1.0	1.4	2.5	1.7	1.0	2.2	2.1	2.1

Capital recovery index - Cournot competition case - New plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.9	1.4	1.9	1.6	0.5	0.6	1.0	0.8	0.4	0.3	0.1	0.2	0.6	0.9	1.3	1.1
Austria	0.3	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.2	0.5	0.2	0.2	0.1	0.1	0.2	0.2
Belgium	1.9	1.0	1.0	1.0	1.5	1.0	2.0	1.6	0.5	0.7	0.2	0.4	1.3	0.8	1.0	0.9
Bulgaria	1.0	1.3	2.0	1.5	1.0	0.9	1.0	0.9	0.2	0.4	0.0	0.3	0.2	1.1	1.7	1.4
Croatia	1.0	1.0	1.0	1.0	1.0	1.3	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.3	1.0	1.1
Cyprus	1.0	1.0	1.0	1.0	1.0	3.6	3.8	3.6	2.2	0.8	0.4	0.7	2.2	2.8	1.5	2.6
Czech	2.1	1.8	2.5	2.2	0.2	0.4	1.0	0.4	0.8	0.1	-0.2	0.1	2.0	1.5	2.5	2.0
Denmark	0.3	1.0	1.1	1.1	0.5	1.0	2.8	2.8	0.3	1.0	-0.1	-0.1	0.3	1.0	0.4	0.4
Estonia	1.2	1.4	1.0	1.4	1.0	0.3	0.1	0.2	0.0	0.1	-0.1	0.1	1.2	1.1	0.0	1.1
Finland	0.9	1.1	2.0	1.6	0.4	1.0	1.0	1.0	0.4	4.8	1.0	4.8	0.6	1.1	2.0	1.6
France	0.1	0.3	1.0	0.3	0.7	0.7	1.0	0.7	-0.2	-1.5	-0.2	-0.2	0.1	0.4	-0.2	0.2
Germany	1.1	1.5	1.0	1.5	0.2	0.1	0.8	0.7	0.5	0.1	-0.1	0.1	0.7	0.9	0.6	0.8
Greece	1.6	2.1	1.0	2.1	0.6	0.8	2.5	1.3	0.0	0.0	0.0	0.0	0.7	1.0	1.7	1.1
Hungary	2.0	1.0	1.5	1.5	1.3	0.9	0.4	0.7	0.8	4.6	0.1	1.5	1.5	1.3	1.2	1.2
Ireland	1.3	1.0	1.0	1.0	0.8	0.5	0.1	0.5	0.3	-0.2	-0.1	-0.2	0.8	0.4	-0.1	0.2
Italy	1.7	2.2	1.0	2.2	0.5	0.8	1.0	0.8	0.3	5.2	0.1	0.3	0.6	1.9	0.1	0.9
Latvia	2.8	3.3	1.9	2.2	0.6	1.4	1.0	1.4	1.1	0.7	1.0	0.8	0.8	1.0	1.0	1.0
Lithuania	1.0	1.0	1.5	1.5	1.5	1.5	1.0	1.5	0.0	0.3	-0.1	0.0	1.2	1.3	1.3	1.3
Luxembourg	1.0	1.0	1.0	1.0	0.4	1.9	2.2	2.1	0.2	1.0	1.0	1.0	0.4	1.9	2.2	2.1
Malta	1.0	1.0	1.0	1.0	1.0	4.4	1.0	4.4	2.1	-0.3	1.0	-0.3	2.1	2.9	1.0	2.9
Netherlands	1.0	1.5	3.0	1.6	0.8	0.7	2.1	0.7	2.4	1.3	0.6	0.7	1.2	1.2	1.1	1.2
Poland	0.9	1.6	1.7	1.7	0.1	0.1	0.7	0.4	0.2	0.5	3.8	0.8	0.8	1.0	1.7	1.5
Portugal	1.0	1.0	1.0	1.0	0.4	0.3	1.0	0.3	0.1	0.2	0.4	0.2	0.3	0.3	0.4	0.3
Romania	1.1	1.5	2.2	1.8	0.2	0.1	0.2	0.1	0.0	0.0	-0.1	-0.1	1.0	1.0	1.7	1.3
Slovakia	1.1	0.8	3.5	1.5	0.3	0.7	1.0	0.7	0.8	1.0	1.5	1.5	0.6	0.8	3.4	1.4
Slovenia	0.8	2.2	2.3	2.3	1.0	1.2	1.6	1.5	0.1	0.3	1.0	0.3	0.3	2.2	2.3	2.2
Spain	0.9	1.6	1.0	1.6	0.5	0.6	1.0	0.6	0.2	0.1	0.3	0.1	0.5	0.8	0.3	0.7
Sweden	0.8	0.4	1.9	1.8	0.8	1.0	1.0	1.0	0.3	0.8	0.3	0.7	0.4	0.7	1.7	1.4
UK	0.9	0.6	2.2	2.0	0.6	0.5	1.0	0.5	0.7	0.0	-0.1	0.0	0.6	0.3	1.7	1.1

Table 49: Capacity factor for the three bidding regimes, in Reference scenario

Capacity factor - Marginal cost bidding case - All projected investments									
	Base-load			CCGT			Open cycle plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.6	0.8	0.8	0.3	0.3	0.3	0.2	0.1	0.2
Austria	0.8	0.5	0.5	0.3	1.0	0.3	0.1	0.2	0.2
Belgium	1.0	1.0	1.0	0.2	0.7	0.5	0.2	0.1	0.2
Bulgaria	0.5	0.7	0.6	0.1	0.0	0.1	0.1	0.1	0.1
Croatia	1.0	1.0	1.0	0.4	0.5	0.4	1.0	0.1	0.1
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.6	0.8	0.7	0.1	1.0	0.1	0.4	0.2	0.3
Denmark	0.3	0.5	0.5	1.0	0.7	0.7	0.0	0.1	0.1
Estonia	0.6	0.2	0.5	0.1	0.1	0.1	0.1	0.0	0.1
Finland	0.7	0.8	0.7	1.0	0.1	0.1	0.5	0.2	0.3
France	0.3	0.9	0.8	0.2	1.0	0.2	0.4	0.3	0.3
Germany	0.7	0.6	0.6	0.1	0.3	0.3	0.1	0.1	0.1
Greece	0.6	1.0	0.6	0.2	0.4	0.2	0.0	0.0	0.0
Hungary	1.0	0.9	0.9	0.3	0.3	0.3	0.5	0.2	0.3
Ireland	0.6	1.0	0.6	0.2	0.1	0.2	0.1	0.0	0.1
Italy	0.8	0.9	0.8	0.6	1.0	0.6	0.3	0.0	0.1
Latvia	0.7	0.8	0.8	0.2	1.0	0.2	0.1	0.3	0.2
Lithuania	1.0	0.9	0.9	0.5	1.0	0.5	0.1	0.2	0.2
Luxembourg	1.0	1.0	1.0	1.0	1.5	1.4	0.2	1.0	0.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.5	0.6	0.6	0.3	0.3	0.3	0.2	0.3	0.3
Poland	0.6	0.8	0.8	0.1	0.3	0.2	0.2	0.5	0.2
Portugal	1.0	1.0	1.0	0.3	1.0	0.3	0.1	0.2	0.1
Romania	0.9	0.9	0.9	0.1	0.1	0.1	0.0	0.2	0.1
Slovakia	0.6	0.8	0.7	0.2	1.0	0.2	1.0	0.4	0.4
Slovenia	0.7	0.9	0.8	0.6	0.5	0.5	0.5	0.4	0.5
Spain	0.7	1.0	0.7	0.6	1.0	0.6	0.1	0.2	0.1
Sweden	0.2	0.8	0.8	1.0	1.0	1.0	1.0	0.4	0.7
UK	0.8	0.8	0.8	0.4	0.1	0.4	0.2	0.2	0.2

Capacity factor - Supply function equilibrium case - All projected investments									
	Base-load			CCGT			Open cycle plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.6	0.8	0.7	0.2	0.4	0.3	0.2	0.2	0.2
Austria	0.8	0.5	0.5	0.3	1.0	0.3	0.4	0.3	0.3
Belgium	1.0	1.0	1.0	0.3	0.6	0.5	0.3	0.2	0.3
Bulgaria	0.4	0.7	0.5	0.2	0.1	0.2	0.1	0.1	0.1
Croatia	1.0	1.0	1.0	0.3	0.7	0.6	1.0	0.3	0.3
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.5	0.8	0.7	0.1	1.0	0.1	0.3	0.3	0.3
Denmark	0.6	0.6	0.6	1.0	0.7	0.7	0.2	0.1	0.1
Estonia	0.6	0.1	0.6	0.0	0.0	0.0	0.0	0.1	0.0
Finland	0.7	0.8	0.8	1.0	0.3	0.3	0.6	0.3	0.4
France	0.4	0.8	0.8	0.2	1.0	0.2	0.4	0.2	0.2
Germany	0.7	0.6	0.7	0.1	0.4	0.3	0.1	0.1	0.1
Greece	0.6	1.0	0.6	0.2	0.5	0.3	0.0	0.0	0.0
Hungary	1.0	0.9	0.9	0.3	0.3	0.3	0.7	0.3	0.4
Ireland	0.5	1.0	0.5	0.1	0.2	0.1	0.2	0.1	0.1
Italy	0.7	0.8	0.7	0.4	1.0	0.4	0.4	0.1	0.1
Latvia	0.8	0.8	0.8	0.2	1.0	0.2	0.2	0.3	0.2
Lithuania	1.0	0.9	0.9	0.4	1.0	0.4	0.2	0.3	0.3
Luxembourg	1.0	1.0	1.0	1.0	1.5	1.4	0.2	1.0	0.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.7	0.7	0.7	0.3	0.4	0.3	0.3	0.2	0.2
Poland	0.7	0.8	0.8	0.2	0.4	0.3	0.2	0.5	0.2
Portugal	1.0	1.0	1.0	0.2	1.0	0.2	0.2	0.1	0.2
Romania	0.8	0.7	0.7	0.1	0.3	0.1	0.1	0.2	0.2
Slovakia	0.5	0.8	0.7	0.2	1.0	0.2	1.0	0.4	0.4
Slovenia	0.6	0.9	0.8	0.2	0.2	0.2	0.3	0.4	0.3
Spain	0.7	1.0	0.7	0.4	1.0	0.4	0.1	0.3	0.2
Sweden	0.3	0.9	0.9	1.0	1.0	1.0	1.0	0.6	0.8
UK	0.8	0.8	0.8	0.3	0.1	0.3	0.2	0.3	0.2

Capacity factor - Cournot competition case - All projected investments									
	Base-load			CCGT			Open cycle plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.6	0.8	0.8	0.3	0.4	0.3	0.2	0.2	0.2
Austria	0.8	0.5	0.5	0.3	1.0	0.3	0.4	0.3	0.3
Belgium	1.0	1.0	1.0	0.3	0.7	0.6	0.2	0.2	0.2
Bulgaria	0.4	0.7	0.5	0.2	0.2	0.2	0.1	0.1	0.1
Croatia	1.0	1.0	1.0	0.4	0.7	0.6	1.0	0.3	0.3
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.5	0.8	0.6	0.1	1.0	0.1	0.2	0.3	0.2
Denmark	0.6	0.6	0.6	1.0	0.8	0.8	0.2	0.1	0.1
Estonia	0.6	0.1	0.5	0.1	0.0	0.1	0.0	0.1	0.0
Finland	0.7	0.8	0.8	1.0	0.3	0.3	0.6	0.5	0.5
France	0.3	0.8	0.8	0.2	1.0	0.2	0.4	0.2	0.2
Germany	0.7	0.6	0.7	0.1	0.4	0.3	0.1	0.1	0.1
Greece	0.6	1.0	0.6	0.2	0.5	0.3	0.0	0.0	0.0
Hungary	1.0	0.9	0.9	0.2	0.2	0.2	0.6	0.2	0.3
Ireland	0.5	1.0	0.5	0.1	0.2	0.2	0.2	0.1	0.1
Italy	0.8	0.8	0.8	0.5	1.0	0.5	0.5	0.1	0.1
Latvia	0.7	0.6	0.6	0.3	1.0	0.3	0.2	0.3	0.2
Lithuania	1.0	0.7	0.7	0.3	1.0	0.3	0.2	0.3	0.2
Luxembourg	1.0	1.0	1.0	1.0	1.5	1.4	0.2	1.0	0.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.7	0.8	0.7	0.3	0.3	0.3	0.3	0.2	0.2
Poland	0.7	0.8	0.8	0.1	0.3	0.2	0.1	0.5	0.2
Portugal	1.0	1.0	1.0	0.2	1.0	0.2	0.1	0.1	0.1
Romania	0.9	0.8	0.8	0.1	0.3	0.1	0.1	0.2	0.2
Slovakia	0.5	0.8	0.7	0.2	1.0	0.2	1.0	0.4	0.4
Slovenia	0.7	0.9	0.8	0.3	0.3	0.3	0.3	0.4	0.3
Spain	0.7	1.0	0.7	0.4	1.0	0.4	0.1	0.3	0.2
Sweden	0.2	0.9	0.9	1.0	1.0	1.0	1.2	0.6	1.0
UK	0.8	0.8	0.8	0.4	0.1	0.3	0.2	0.3	0.2

Table 50: Simulated average wholesale market marginal prices (SMP), in Reference scenario

Average SMP (EUR/MWh)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	40	65	76	69	82	79	90
Austria	45	56	91	59	91	64	91
Belgium	69	93	99	95	110	110	118
Bulgaria	38	44	64	61	101	78	113
Croatia	36	83	68	100	89	107	98
Cyprus	165	127	140	165	167	179	175
Czech	47	68	101	73	113	93	139
Denmark	43	75	91	75	92	84	99
Estonia	36	79	65	82	66	101	79
Finland	34	61	81	71	89	86	106
France	44	68	68	64	72	82	84
Germany	45	70	90	77	94	87	100
Greece	51	80	99	84	102	93	119
Hungary	42	74	74	81	77	91	83
Ireland	44	76	79	79	85	92	92
Italy	57	96	110	98	112	109	121
Latvia	38	87	101	94	104	120	124
Lithuania	62	82	95	86	93	111	135
Luxembourg	47	89	95	92	99	95	107
Malta	166	144	144	144	161	172	168
Netherlands	42	75	84	79	93	91	101
Poland	27	58	79	79	96	83	100
Portugal	42	77	95	82	102	97	109
Romania	24	56	98	58	81	68	108
Slovakia	23	45	89	50	110	70	126
Slovenia	32	99	119	98	121	110	129
Spain	42	79	93	87	102	91	105
Sweden	43	49	58	65	80	71	87
UK	42	82	95	86	99	89	103

Table 51: Average SMP mark-up indicators, in Reference scenario

Mark-up (% change over marginal cost bidding)	Supply function equilibrium		Cournot competition			Supply function equilibrium		Cournot competition	
	2020	2030	2020	2030		2020	2030	2020	2030
EU27	6.5	8.1	21.4	18.5					
Austria	5.5	0.4	15.5	0.5	Italy	1.9	1.5	13.3	10.0
Belgium	1.9	10.6	18.1	18.6	Latvia	8.1	3.0	38.2	22.7
Bulgaria	38.0	58.5	76.7	77.7	Lithuania	5.5	-1.8	36.2	43.1
Croatia	19.5	31.5	28.6	44.7	Luxembourg	4.0	4.4	7.3	12.7
Cyprus	30.1	19.1	41.1	24.9	Malta	0.0	11.6	19.9	17.1
Czech	7.8	12.4	36.4	37.8	Netherlands	5.1	10.5	21.3	20.3
Denmark	0.3	1.0	12.0	9.4	Poland	36.3	21.2	43.7	26.4
Estonia	3.1	2.1	27.1	21.0	Portugal	6.0	6.8	26.6	13.8
Finland	15.3	9.4	40.3	30.4	Romania	3.2	-17.3	20.4	9.4
France	-6.6	5.8	19.6	22.5	Slovakia	9.8	22.5	55.3	41.4
Germany	9.2	4.8	23.4	10.8	Slovenia	-0.9	2.0	10.6	8.4
Greece	5.4	3.0	16.5	20.0	Spain	9.4	8.8	15.3	12.9
Hungary	10.5	4.5	23.7	11.6	Sweden	32.8	38.6	46.7	50.7
Ireland	4.4	8.1	21.2	16.1	UK	4.8	4.1	8.2	8.1

Table 52: Payment for electricity, in Reference scenario

Payment for electricity in bn€	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	130.3	225.7	293.5	241.5	317.0	275.1	346.6
Austria	2.1	2.6	4.7	2.7	4.7	3.0	4.7
Belgium	6.2	8.5	9.2	8.5	9.6	10.0	10.9
Bulgaria	1.1	1.5	2.3	2.2	3.7	2.8	4.1
Croatia	0.5	1.4	1.2	1.6	1.6	1.7	1.7
Cyprus	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Czech	3.0	4.9	8.1	5.3	9.1	6.7	11.3
Denmark	1.5	2.6	3.4	2.7	3.5	3.1	3.9
Estonia	0.3	0.9	0.8	1.0	0.9	1.2	1.0
Finland	2.7	5.1	6.9	5.8	7.5	7.1	9.0
France	20.8	32.0	36.8	30.4	40.5	39.3	46.7
Germany	25.4	38.6	51.4	41.7	53.5	47.7	57.0
Greece	2.6	4.7	6.3	5.1	6.7	5.7	7.9
Hungary	1.7	3.1	3.5	3.4	3.7	3.9	4.0
Ireland	1.2	2.0	2.4	2.1	2.7	2.4	2.8
Italy	16.9	30.0	39.3	30.5	39.9	33.9	43.1
Latvia	0.1	0.4	0.6	0.5	0.6	0.6	0.7
Lithuania	0.6	0.9	1.2	1.0	1.2	1.2	1.8
Luxembourg	0.3	0.6	0.7	0.6	0.7	0.6	0.7
Malta	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Netherlands	4.9	9.4	10.0	10.0	11.9	11.6	12.9
Poland	3.9	10.9	16.2	14.8	19.7	15.7	20.5
Portugal	2.0	3.9	5.8	4.1	6.2	5.0	6.6
Romania	1.0	3.0	5.4	3.0	4.3	3.6	5.9
Slovakia	0.5	1.2	2.8	1.3	3.3	1.8	4.0
Slovenia	0.3	1.2	1.6	1.3	1.7	1.4	1.8
Spain	10.5	22.2	30.6	24.3	33.1	25.6	34.4
Sweden	5.6	6.4	8.4	8.5	11.6	9.4	12.7
UK	15.0	29.0	35.0	30.6	36.7	31.6	38.1

Results of wholesale market simulation – High RES

Table 53: Capital recovery index in the marginal cost bidding case, under high RES conditions

Capital recovery index - Marginal cost bidding case - All projected investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.5	0.8	2.1	1.5	0.1	0.1	0.2	0.2	0.1	0.2	0.0	0.1	0.2	0.5	1.4	0.9
Austria	0.2	0.8	0.9	0.9	0.0	0.0	1.0	0.0	0.1	0.3	0.1	0.1	0.1	0.1	0.2	0.1
Belgium	1.5	1.0	1.0	1.0	0.5	0.4	0.2	0.3	-0.1	0.8	0.4	0.7	0.5	0.7	0.3	0.5
Bulgaria	1.0	0.3	1.0	0.6	1.0	-0.3	0.3	0.0	0.0	0.0	-0.3	0.0	0.0	0.2	0.9	0.5
Croatia	1.0	4.4	1.0	4.4	0.1	0.2	0.1	0.1	1.0	1.0	1.0	1.0	0.1	0.3	0.1	0.2
Cyprus	1.0	1.0	1.0	1.0	1.0	0.2	1.0	0.2	0.8	0.0	-0.3	-0.1	0.8	0.1	0.1	0.1
Czech	1.1	0.8	2.1	1.5	0.0	0.1	1.0	0.1	0.4	0.4	-0.2	0.3	1.0	0.7	2.1	1.4
Denmark	0.1	1.0	0.0	0.0	0.2	1.0	1.2	1.2	0.1	1.0	-0.3	-0.3	0.1	1.0	-0.3	-0.3
Estonia	0.6	0.9	0.4	0.9	1.0	0.2	0.1	0.2	-0.1	0.1	0.0	0.1	0.6	0.7	0.2	0.7
Finland	0.4	0.9	1.9	1.3	0.0	1.0	0.1	0.1	0.3	3.3	0.0	1.9	0.2	0.9	1.8	1.3
France	0.1	0.3	3.0	2.5	0.3	0.3	1.0	0.3	-0.8	0.1	-0.2	-0.1	0.0	0.3	2.7	2.0
Germany	0.5	0.8	0.2	0.8	0.0	0.0	0.2	0.2	0.3	-0.1	0.0	0.0	0.3	0.5	0.1	0.4
Greece	0.8	0.8	1.0	0.8	0.1	0.2	0.5	0.2	0.0	0.1	0.0	0.1	0.3	0.3	0.3	0.3
Hungary	1.5	2.7	1.9	2.3	0.4	0.3	0.2	0.3	0.2	2.7	0.5	1.5	0.9	2.0	1.6	1.8
Ireland	0.5	1.0	1.0	1.0	0.1	-0.1	1.0	-0.1	-0.1	-0.3	-0.3	-0.3	0.1	-0.1	-0.3	-0.2
Italy	1.2	1.7	1.8	1.7	0.0	0.1	1.0	0.1	0.2	2.4	0.0	0.2	0.2	1.3	0.0	0.7
Latvia	1.2	1.1	1.0	1.1	0.0	0.0	1.0	0.0	0.2	0.2	0.0	0.2	0.1	0.1	0.0	0.1
Lithuania	1.0	1.0	0.7	0.7	0.4	0.2	1.0	0.2	-0.1	-1.0	-0.7	-0.8	0.3	-0.2	0.6	0.6
Luxembourg	1.0	1.0	1.0	1.0	0.0	0.3	-0.9	-0.2	0.0	0.0	1.0	0.0	0.0	0.2	-0.9	-0.1
Malta	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	0.3	-0.3	1.0	-0.3	0.3	1.0	1.0	1.0
Netherlands	1.0	0.6	2.0	0.8	0.2	0.1	0.2	0.1	1.6	0.8	0.0	0.3	0.5	0.4	1.1	0.5
Poland	0.3	0.7	1.2	1.1	0.0	0.1	0.3	0.2	0.2	0.3	2.9	0.4	0.3	0.4	1.2	0.9
Portugal	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.1	-0.2	0.1	0.0	0.0	-0.2	0.0
Romania	0.8	0.8	1.5	1.0	0.2	0.2	1.0	0.2	0.1	0.1	0.0	0.0	0.8	0.6	1.3	0.8
Slovakia	0.7	0.5	3.4	1.4	0.1	0.4	1.0	0.4	0.2	1.0	3.3	3.3	0.3	0.5	3.4	1.3
Slovenia	0.5	1.6	3.6	2.7	1.0	0.9	2.1	1.5	0.1	0.0	0.0	0.0	0.2	1.6	3.5	2.6
Spain	0.6	1.3	1.0	1.3	0.0	0.1	1.0	0.1	0.1	0.0	0.5	0.2	0.1	0.3	0.5	0.3
Sweden	0.5	0.2	3.1	2.8	0.5	1.0	1.0	1.0	0.1	-0.1	0.3	0.0	0.2	0.1	3.0	2.6
UK	0.5	1.2	2.0	1.7	0.1	0.2	0.1	0.2	0.4	0.1	-0.1	0.0	0.1	0.4	1.3	0.7

Capital recovery index - Marginal cost bidding case - Retrofitting investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	1.4	2.8	2.6	1.0	-0.2	-0.1	-0.2	1.0	0.5	0.3	0.5	1.0	1.0	2.7	2.4
Austria	1.0	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.2	2.2	0.5	1.0	0.2	1.1	0.7
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.2	3.9	4.1	1.0	4.2	3.9	4.1
Bulgaria	1.0	0.3	-1.2	-1.1	1.0	1.0	1.0	1.0	1.0	0.0	-0.3	-0.1	1.0	0.0	-1.1	-0.8
Croatia	1.0	4.4	1.0	4.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.4	1.0	4.4
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	0.2	2.7	2.2	1.0	1.0	1.0	1.0	1.0	10.6	1.0	10.6	1.0	0.3	2.7	2.3
Denmark	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.4	-0.4	1.0	1.0	-0.3	-0.3
Estonia	1.0	1.4	0.4	1.1	1.0	1.0	1.0	1.0	1.0	1.5	1.0	1.5	1.0	1.4	0.4	1.2
Finland	1.0	0.8	0.8	0.8	1.0	1.0	0.1	0.1	1.0	6.0	0.0	0.4	1.0	1.2	0.4	0.6
France	1.0	0.7	3.0	3.0	1.0	1.0	1.0	1.0	1.0	0.2	0.1	0.2	1.0	0.4	3.0	2.9
Germany	1.0	1.1	0.2	0.7	1.0	-0.2	1.0	-0.2	1.0	-0.2	-0.3	-0.2	1.0	0.4	0.1	0.3
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0
Hungary	1.0	2.7	2.3	2.6	1.0	1.0	1.0	1.0	1.0	0.1	0.1	0.1	1.0	2.7	2.3	2.5
Ireland	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.2	1.0	-0.2	1.0	-0.2	1.0	-0.2
Italy	1.0	1.0	1.8	1.8	1.0	1.0	1.0	1.0	1.0	0.3	-0.1	0.3	1.0	0.3	0.1	0.3
Latvia	1.0	1.0	1.0	1.0	1.0	-0.2	1.0	-0.2	1.0	1.0	0.0	0.0	1.0	-0.2	0.0	-0.2
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	-0.8	-0.4	1.0	0.0	-0.8	-0.4
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	2.0	2.0	1.0	-0.2	-0.2	-0.2	1.0	1.0	-0.5	0.1	1.0	0.1	1.3	1.1
Poland	1.0	0.2	0.0	0.1	1.0	0.1	0.0	0.0	1.0	2.0	1.0	2.0	1.0	0.3	0.0	0.2
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.3	-0.2	0.2	1.0	0.3	-0.2	0.2
Romania	1.0	1.0	1.2	1.2	1.0	1.0	1.0	1.0	1.0	0.0	0.3	0.2	1.0	0.7	1.2	1.1
Slovakia	1.0	0.4	3.8	3.6	1.0	1.0	1.0	1.0	1.0	1.0	11.1	11.1	1.0	0.4	3.8	3.7
Slovenia	1.0	2.4	4.3	4.2	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.8	4.3	4.1
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	2.5	0.5	1.0	0.5	2.5	0.5
Sweden	1.0	1.0	3.1	3.1	1.0	1.0	1.0	1.0	1.0	-0.1	0.3	0.1	1.0	-0.1	3.0	3.0
UK	1.0	1.9	1.0	1.9	1.0	1.0	0.1	0.1	1.0	1.3	2.1	1.5	1.0	1.8	1.1	1.7

Capital recovery index - Marginal cost bidding case -New plants

	Base-load				CCGT				Open cycle plants				All plants			
Commissioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.5	0.8	1.4	1.0	0.1	0.2	0.2	0.2	0.1	0.1	0.0	0.1	0.2	0.5	0.7	0.6
Austria	0.2	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.1	0.4	0.0	0.1	0.1	0.1	0.0	0.0
Belgium	1.5	1.0	1.0	1.0	0.5	0.4	0.2	0.3	-0.1	0.5	0.1	0.4	0.5	0.5	0.2	0.3
Bulgaria	1.0	0.3	1.2	0.6	1.0	-0.3	0.3	0.0	0.0	0.0	1.0	0.0	0.0	0.2	1.1	0.5
Croatia	1.0	1.0	1.0	1.0	0.1	0.2	0.1	0.1	1.0	1.0	1.0	1.0	0.1	0.2	0.1	0.1
Cyprus	1.0	1.0	1.0	1.0	1.0	0.2	1.0	0.2	0.8	0.0	-0.3	-0.1	0.8	0.1	0.1	0.1
Czech	1.1	0.8	1.7	1.2	0.0	0.1	1.0	0.1	0.4	0.2	-0.2	0.1	1.0	0.7	1.7	1.1
Denmark	0.1	1.0	1.0	1.0	0.2	1.0	1.2	1.2	0.1	1.0	-0.3	-0.3	0.1	1.0	-0.3	-0.3
Estonia	0.6	0.9	1.0	0.9	1.0	0.2	0.1	0.2	-0.1	0.1	0.0	0.1	0.6	0.6	0.1	0.6
Finland	0.4	0.9	1.9	1.3	0.0	1.0	1.0	1.0	0.3	3.2	1.0	3.2	0.2	0.9	1.9	1.3
France	0.1	0.3	1.0	0.3	0.3	0.3	1.0	0.3	-0.8	0.0	-0.2	-0.2	0.0	0.3	-0.2	0.2
Germany	0.5	0.8	1.0	0.8	0.0	0.0	0.2	0.2	0.3	0.0	0.0	0.0	0.3	0.5	0.1	0.4
Greece	0.8	0.8	1.0	0.8	0.1	0.2	0.5	0.2	0.0	0.1	0.0	0.1	0.3	0.3	0.4	0.3
Hungary	1.5	1.0	1.2	1.2	0.4	0.3	0.2	0.3	0.2	3.0	0.6	1.6	0.9	0.6	0.8	0.8
Ireland	0.5	1.0	1.0	1.0	0.1	-0.1	1.0	-0.1	-0.1	-0.4	-0.3	-0.4	0.1	-0.1	-0.3	-0.2
Italy	1.2	1.7	1.0	1.7	0.0	0.1	1.0	0.1	0.2	5.0	0.0	0.2	0.2	1.4	0.0	0.7
Latvia	1.2	1.1	1.0	1.1	0.0	0.0	1.0	0.0	0.2	0.2	1.0	0.2	0.1	0.1	1.0	0.1
Lithuania	1.0	1.0	0.7	0.7	0.4	0.2	1.0	0.2	-0.1	-2.0	-0.7	-1.0	0.3	-0.3	0.7	0.6
Luxembourg	1.0	1.0	1.0	1.0	0.0	0.3	-0.9	-0.2	0.0	1.0	1.0	1.0	0.0	0.3	-0.9	-0.2
Malta	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	0.3	-0.3	1.0	-0.3	0.3	1.0	1.0	1.0
Netherlands	1.0	0.6	2.0	0.7	0.2	0.1	0.7	0.1	1.6	0.7	0.2	0.4	0.5	0.4	0.8	0.5
Poland	0.3	0.9	1.3	1.2	0.0	0.1	0.3	0.2	0.2	0.3	2.9	0.4	0.3	0.4	1.2	1.0
Portugal	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.1	1.0	0.1	0.0	0.0	1.0	0.0
Romania	0.8	0.8	2.8	1.0	0.2	0.2	1.0	0.2	0.1	0.2	-0.1	-0.1	0.8	0.6	1.4	0.7
Slovakia	0.7	0.5	2.1	0.7	0.1	0.4	1.0	0.4	0.2	1.0	1.9	1.9	0.3	0.5	2.1	0.7
Slovenia	0.5	1.6	2.2	1.8	1.0	0.9	2.1	1.5	0.1	0.4	1.0	0.4	0.2	1.6	2.2	1.8
Spain	0.6	1.3	1.0	1.3	0.0	0.1	1.0	0.1	0.1	0.0	0.5	0.1	0.1	0.3	0.5	0.3
Sweden	0.5	0.2	1.0	0.2	0.5	1.0	1.0	1.0	0.1	-0.1	0.5	-0.1	0.2	0.1	0.5	0.1
UK	0.5	0.5	2.0	1.6	0.1	0.2	1.0	0.2	0.4	0.0	-0.2	-0.1	0.1	0.1	1.3	0.5

Table 54: Capital recovery index in the supply function equilibrium case, under high RES conditions

Capital recovery index - Supply function equilibrium case - All projected investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.0	2.1	1.6	0.2	0.2	0.3	0.2	0.2	0.2	0.0	0.1	0.3	0.6	1.4	1.0
Austria	0.3	1.0	0.9	0.9	0.0	0.0	1.0	0.0	0.2	0.3	0.1	0.2	0.1	0.1	0.2	0.2
Belgium	1.5	1.0	1.0	1.0	0.6	0.6	0.0	0.1	0.1	0.8	0.2	0.6	0.6	0.7	0.0	0.4
Bulgaria	1.0	0.7	1.0	0.8	1.0	0.2	0.4	0.3	-0.1	0.1	-0.2	0.1	-0.1	0.6	0.9	0.7
Croatia	1.0	4.7	1.0	4.7	0.5	0.6	-0.3	0.1	1.0	1.0	1.0	1.0	0.5	0.7	-0.3	0.2
Cyprus	1.0	1.0	1.0	1.0	1.0	2.6	3.0	2.6	1.3	0.5	0.2	0.4	1.3	2.0	1.1	1.8
Czech	1.4	0.9	1.8	1.4	0.1	0.1	1.0	0.1	0.5	0.6	-0.7	0.4	1.3	0.8	1.8	1.3
Denmark	0.2	1.0	-0.1	-0.1	0.3	1.0	1.7	1.7	0.1	1.0	-0.4	-0.4	0.2	1.0	-0.3	-0.3
Estonia	0.7	0.9	0.3	0.9	1.0	0.1	0.0	0.1	-0.3	0.1	-0.2	0.0	0.7	0.7	0.1	0.6
Finland	0.5	1.0	2.0	1.4	0.1	1.0	0.1	0.1	0.3	4.2	0.1	2.5	0.3	1.0	1.9	1.4
France	0.1	0.3	2.9	2.4	0.3	0.2	1.0	0.2	-0.5	-0.3	-0.5	-0.4	0.0	0.2	2.5	1.9
Germany	0.7	1.0	0.5	1.0	0.1	0.0	0.3	0.2	0.4	0.0	-0.1	0.0	0.4	0.6	0.2	0.5
Greece	1.0	1.4	1.0	1.4	0.2	0.2	0.8	0.4	0.0	0.0	0.0	0.0	0.3	0.5	0.5	0.5
Hungary	1.6	3.1	2.1	2.5	0.7	0.5	0.1	0.4	0.7	2.8	0.1	1.2	1.1	2.3	1.7	2.0
Ireland	0.8	1.0	1.0	1.0	0.2	0.1	1.0	0.1	0.0	-0.6	-0.3	-0.3	0.3	0.0	-0.3	-0.1
Italy	1.3	1.8	1.8	1.8	0.1	0.2	1.0	0.2	0.2	1.9	0.0	0.2	0.2	1.3	0.0	0.6
Latvia	1.6	1.1	1.0	1.1	0.3	0.1	1.0	0.1	0.5	0.1	0.0	0.1	0.4	0.1	0.0	0.1
Lithuania	1.0	1.0	0.8	0.8	0.6	0.4	1.0	0.4	-0.2	-0.6	-1.2	-1.0	0.4	0.0	0.7	0.6
Luxembourg	1.0	1.0	1.0	1.0	-0.1	0.4	-0.9	-0.1	0.0	0.0	1.0	0.0	-0.1	0.2	-0.9	-0.1
Malta	1.0	1.0	1.0	1.0	1.0	3.2	1.0	3.2	1.4	-0.3	1.0	-0.3	1.4	2.1	1.0	2.1
Netherlands	1.0	1.0	2.8	1.3	0.3	0.2	0.5	0.2	1.8	1.1	0.7	0.8	0.7	0.7	1.8	0.9
Poland	0.7	1.3	1.3	1.3	0.0	0.1	0.3	0.2	0.1	0.4	3.4	0.6	0.6	0.7	1.3	1.1
Portugal	1.0	1.0	1.0	1.0	0.1	0.1	1.0	0.1	0.0	0.0	0.2	0.0	0.1	0.0	0.2	0.0
Romania	0.7	0.5	0.4	0.5	0.2	0.0	1.0	0.0	0.0	-1.2	-0.4	-0.4	0.6	0.3	0.3	0.3
Slovakia	0.6	0.5	3.9	1.5	0.2	0.4	1.0	0.4	0.4	1.0	4.3	4.3	0.4	0.5	3.9	1.5
Slovenia	0.5	1.5	3.9	2.8	1.0	0.4	0.9	0.6	0.0	0.5	0.0	0.5	0.2	1.4	3.9	2.8
Spain	0.7	1.5	1.0	1.5	0.3	0.3	1.0	0.3	0.1	0.1	0.5	0.2	0.3	0.5	0.5	0.5
Sweden	0.7	0.3	3.3	3.1	0.6	1.0	1.0	1.0	0.2	0.0	-0.7	-0.1	0.3	0.1	3.3	2.8
UK	0.6	1.4	2.1	1.8	0.2	0.2	0.1	0.2	0.5	0.1	0.1	0.1	0.3	0.5	1.4	0.8

Capital recovery index - Supply function equilibrium case - Retrofitting investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commissioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	1.8	2.8	2.6	1.0	0.0	0.0	0.0	1.0	0.2	-0.1	0.1	1.0	1.2	2.7	2.4
Austria	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.2	2.3	0.5	1.0	0.2	1.1	0.7
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.1	3.0	3.8	1.0	4.1	3.0	3.8
Bulgaria	1.0	1.3	-1.1	-1.0	1.0	1.0	1.0	1.0	1.0	0.0	-0.2	-0.1	1.0	0.2	-1.0	-0.7
Croatia	1.0	4.7	1.0	4.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.7	1.0	4.7
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	0.3	2.3	1.9	1.0	1.0	1.0	1.0	1.0	12.8	1.0	12.8	1.0	0.5	2.3	1.9
Denmark	1.0	1.0	-0.1	-0.1	1.0	1.0	1.0	1.0	1.0	1.0	-4.1	-4.1	1.0	1.0	-3.3	-3.3
Estonia	1.0	1.2	0.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	0.3	1.0
Finland	1.0	1.7	1.4	1.5	1.0	1.0	0.1	0.1	1.0	7.7	0.1	0.6	1.0	2.2	0.7	1.0
France	1.0	0.8	2.9	2.9	1.0	1.0	1.0	1.0	1.0	0.2	0.0	0.1	1.0	0.4	2.9	2.8
Germany	1.0	1.4	0.5	0.9	1.0	-0.1	1.0	-0.1	1.0	-0.6	-0.7	-0.6	1.0	0.3	0.3	0.3
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.1	-0.1	1.0	1.0	-0.1	-0.1
Hungary	1.0	3.1	2.6	2.9	1.0	1.0	1.0	1.0	1.0	-0.3	-2.3	-1.3	1.0	3.1	2.5	2.8
Ireland	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	-1.0
Italy	1.0	1.0	1.8	1.8	1.0	1.0	1.0	1.0	1.0	-0.6	-1.3	-0.6	1.0	-0.6	-1.1	-0.6
Latvia	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	1.0	1.0	0.0	0.0	1.0	0.1	0.0	0.1
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.5	-0.7	-0.6	1.0	-0.5	-0.7	-0.6
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	2.9	2.9	1.0	0.1	0.0	0.0	1.0	1.5	0.0	0.5	1.0	0.4	2.0	1.7
Poland	1.0	1.2	-0.2	0.7	1.0	-0.4	0.0	-0.2	1.0	4.5	1.0	4.5	1.0	1.3	-0.2	0.8
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.4	0.2	-0.4	1.0	-0.4	0.2	-0.4
Romania	1.0	0.5	-0.1	0.0	1.0	1.0	1.0	1.0	1.0	-2.9	-1.8	-2.0	1.0	-0.4	-0.1	-0.1
Slovakia	1.0	0.2	4.4	4.2	1.0	1.0	1.0	1.0	1.0	1.0	11.9	11.9	1.0	0.2	4.4	4.3
Slovenia	1.0	2.2	4.7	4.6	1.0	1.0	1.0	1.0	1.0	0.6	0.0	0.5	1.0	1.8	4.7	4.4
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	4.1	1.3	1.0	1.2	4.1	1.3
Sweden	1.0	1.0	3.3	3.3	1.0	1.0	1.0	1.0	1.0	-2.9	-0.7	-1.4	1.0	-2.9	3.3	3.3
UK	1.0	2.2	1.0	2.2	1.0	1.0	0.1	0.1	1.0	1.2	2.3	1.4	1.0	2.0	1.2	1.9

Capital recovery index - Supply function equilibrium case - New plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	0.9	1.5	1.1	0.2	0.2	0.3	0.3	0.2	0.2	0.0	0.1	0.3	0.6	0.8	0.7
Austria	0.3	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.2	0.4	0.0	0.1	0.1	0.1	0.0	0.1
Belgium	1.5	1.0	1.0	1.0	0.6	0.6	0.0	0.1	0.1	0.5	0.0	0.3	0.6	0.5	0.0	0.2
Bulgaria	1.0	0.7	1.2	0.8	1.0	0.2	0.4	0.3	-0.1	0.1	1.0	0.1	-0.1	0.6	1.0	0.7
Croatia	1.0	1.0	1.0	1.0	0.5	0.6	-0.3	0.1	1.0	1.0	1.0	1.0	0.5	0.6	-0.3	0.1
Cyprus	1.0	1.0	1.0	1.0	1.0	2.6	3.0	2.6	1.3	0.5	0.2	0.4	1.3	2.0	1.1	1.8
Czech	1.4	0.9	1.5	1.2	0.1	0.1	1.0	0.1	0.5	0.2	-0.7	0.1	1.3	0.8	1.5	1.1
Denmark	0.2	1.0	1.0	1.0	0.3	1.0	1.7	1.7	0.1	1.0	-0.2	-0.2	0.2	1.0	-0.1	-0.1
Estonia	0.7	0.9	1.0	0.9	1.0	0.1	0.0	0.1	-0.3	0.1	-0.2	0.0	0.7	0.6	0.0	0.6
Finland	0.5	1.0	2.0	1.4	0.1	1.0	1.0	1.0	0.3	4.0	1.0	4.0	0.3	1.0	2.0	1.4
France	0.1	0.3	1.0	0.3	0.3	0.2	1.0	0.2	-0.5	-1.1	-0.5	-0.5	0.0	0.2	-0.5	0.0
Germany	0.7	1.0	1.0	1.0	0.1	0.0	0.3	0.3	0.4	0.0	0.0	0.0	0.4	0.6	0.2	0.5
Greece	1.0	1.4	1.0	1.4	0.2	0.2	0.8	0.4	0.0	0.0	0.0	0.0	0.3	0.5	0.5	0.5
Hungary	1.6	1.0	1.3	1.3	0.7	0.5	0.1	0.4	0.7	3.2	0.3	1.5	1.1	0.8	0.9	0.9
Ireland	0.8	1.0	1.0	1.0	0.2	0.1	1.0	0.1	0.0	-0.4	-0.3	-0.3	0.3	0.1	-0.3	-0.1
Italy	1.3	1.8	1.0	1.8	0.1	0.2	1.0	0.2	0.2	5.1	0.0	0.2	0.2	1.4	0.0	0.7
Latvia	1.6	1.1	1.0	1.1	0.3	0.2	1.0	0.2	0.5	0.1	1.0	0.1	0.4	0.1	1.0	0.1
Lithuania	1.0	1.0	0.8	0.8	0.6	0.4	1.0	0.4	-0.2	-0.7	-1.3	-1.2	0.4	0.1	0.7	0.6
Luxembourg	1.0	1.0	1.0	1.0	-0.1	0.4	-0.9	-0.1	0.0	1.0	1.0	1.0	-0.1	0.4	-0.9	-0.1
Malta	1.0	1.0	1.0	1.0	1.0	3.2	1.0	3.2	1.4	-0.3	1.0	-0.3	1.4	2.1	1.0	2.1
Netherlands	1.0	1.0	2.6	1.0	0.3	0.2	1.0	0.2	1.8	0.9	0.9	0.9	0.7	0.7	1.4	0.7
Poland	0.7	1.3	1.4	1.4	0.0	0.1	0.3	0.2	0.1	0.4	3.4	0.5	0.6	0.7	1.3	1.1
Portugal	1.0	1.0	1.0	1.0	0.1	0.1	1.0	0.1	0.0	0.0	1.0	0.0	0.1	0.1	1.0	0.1
Romania	0.7	0.5	2.1	0.6	0.2	0.0	1.0	0.0	0.0	0.0	-0.2	-0.2	0.6	0.3	1.1	0.4
Slovakia	0.6	0.6	2.5	0.7	0.2	0.4	1.0	0.4	0.4	1.0	2.9	2.9	0.4	0.5	2.6	0.7
Slovenia	0.5	1.4	2.4	1.7	1.0	0.4	0.9	0.6	0.0	0.1	1.0	0.1	0.2	1.4	2.3	1.7
Spain	0.7	1.5	1.0	1.5	0.3	0.3	1.0	0.3	0.1	0.0	0.4	0.1	0.3	0.4	0.4	0.4
Sweden	0.7	0.3	1.0	0.3	0.6	1.0	1.0	1.0	0.2	0.1	-0.6	0.1	0.3	0.2	-0.6	0.2
UK	0.6	0.5	2.1	1.7	0.2	0.2	1.0	0.2	0.5	0.1	0.0	0.0	0.3	0.2	1.4	0.6

Table 55: Capital recovery index in the Cournot competition case, under high RES conditions

Capital recovery index - Cournot competition case - All projected investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.9	1.3	2.7	2.0	0.5	0.5	0.6	0.6	0.4	0.3	0.1	0.2	0.6	0.9	1.8	1.3
Austria	0.3	1.1	0.6	0.6	0.0	0.0	1.0	0.0	0.2	0.4	0.2	0.3	0.1	0.1	0.3	0.2
Belgium	1.8	1.0	1.0	1.0	1.4	1.2	1.0	1.1	0.6	1.2	0.7	1.0	1.2	1.2	0.9	1.0
Bulgaria	1.0	0.9	1.7	1.2	1.0	0.6	0.7	0.6	0.2	0.2	0.0	0.2	0.2	0.8	1.6	1.1
Croatia	1.0	5.5	1.0	5.5	0.9	1.0	0.3	0.6	1.0	1.0	1.0	1.0	0.9	1.2	0.3	0.7
Cyprus	1.0	1.0	1.0	1.0	1.0	3.6	3.8	3.6	2.2	0.8	0.4	0.7	2.2	2.8	1.5	2.6
Czech	2.1	1.4	2.6	2.1	0.2	0.3	1.0	0.3	0.8	0.9	-0.4	0.7	1.9	1.3	2.6	2.0
Denmark	0.3	1.0	0.5	0.5	0.4	1.0	2.3	2.3	0.2	1.0	-0.3	-0.3	0.3	1.0	-0.2	-0.2
Estonia	1.2	1.0	0.2	1.0	1.0	0.2	0.0	0.2	-0.1	0.1	-0.2	0.1	1.2	0.8	0.1	0.7
Finland	0.8	1.2	2.3	1.6	0.4	1.0	0.7	0.7	0.4	4.7	0.1	2.8	0.6	1.2	2.2	1.6
France	0.1	0.3	3.7	3.0	0.5	0.4	1.0	0.4	-0.2	-0.1	-0.3	-0.3	0.1	0.3	3.2	2.4
Germany	0.9	1.2	0.9	1.2	0.1	0.1	0.6	0.5	0.5	0.0	0.0	0.0	0.5	0.8	0.4	0.7
Greece	1.5	1.8	1.0	1.8	0.5	0.5	1.4	0.7	0.0	0.0	0.0	0.0	0.6	0.8	1.0	0.8
Hungary	1.9	3.5	2.7	3.1	1.1	0.7	0.1	0.5	0.7	3.5	0.4	1.7	1.4	2.7	2.2	2.5
Ireland	1.3	1.8	1.0	1.8	0.8	0.5	1.0	0.5	0.3	-0.4	-0.2	-0.2	0.8	0.4	-0.2	0.2
Italy	1.7	2.1	2.5	2.1	0.4	0.7	1.0	0.7	0.3	2.3	0.0	0.2	0.5	1.7	0.0	0.9
Latvia	2.7	2.2	1.0	2.2	0.6	1.2	1.0	1.2	1.0	0.3	0.0	0.3	0.8	0.7	0.0	0.7
Lithuania	1.0	1.0	1.0	1.0	1.4	1.4	1.0	1.4	0.1	-0.1	-0.8	-0.5	1.1	0.8	0.8	0.8
Luxembourg	1.0	1.0	1.0	1.0	0.3	0.9	-0.2	0.5	0.1	0.0	1.0	0.0	0.3	0.5	-0.2	0.3
Malta	1.0	1.0	1.0	1.0	1.0	4.4	1.0	4.4	2.1	-0.3	1.0	-0.3	2.1	2.9	1.0	2.9
Netherlands	1.0	1.3	3.3	1.6	0.7	0.6	1.0	0.6	2.5	1.5	1.0	1.1	1.2	1.0	2.2	1.2
Poland	0.8	1.4	1.4	1.4	0.1	0.1	0.4	0.2	0.2	0.4	3.6	0.6	0.7	0.8	1.4	1.2
Portugal	1.0	1.0	1.0	1.0	0.4	0.2	1.0	0.2	0.1	0.2	0.4	0.2	0.3	0.2	0.4	0.2
Romania	0.9	1.1	1.3	1.2	0.3	0.0	1.0	0.0	0.0	-1.0	-0.2	-0.3	0.9	0.7	1.1	0.8
Slovakia	0.9	0.8	6.2	2.4	0.4	0.9	1.0	0.9	0.8	1.0	7.9	7.9	0.6	0.8	6.3	2.4
Slovenia	0.6	1.9	4.3	3.2	1.0	0.6	1.3	0.9	0.1	0.7	0.0	0.6	0.2	1.8	4.2	3.1
Spain	0.9	1.6	1.0	1.6	0.5	0.6	1.0	0.6	0.2	0.1	0.6	0.2	0.5	0.6	0.6	0.6
Sweden	0.8	0.3	4.8	4.4	0.8	1.0	1.0	1.0	0.3	0.4	-0.3	0.3	0.4	0.4	4.7	4.1
UK	0.9	1.5	2.2	1.9	0.6	0.5	0.1	0.5	0.7	0.2	0.1	0.1	0.6	0.6	1.4	0.9

Capital recovery index - Cournot competition case - Retrofitting investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	2.1	3.6	3.5	1.0	0.4	0.4	0.4	1.0	0.5	0.2	0.4	1.0	1.5	3.5	3.1
Austria	1.0	1.1	0.6	0.6	1.0	1.0	1.0	1.0	1.0	0.2	3.6	0.8	1.0	0.3	1.0	0.7
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	5.2	5.4	5.3	1.0	5.2	5.4	5.3
Bulgaria	1.0	2.2	-0.4	-0.3	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.4	-0.4	-0.2
Croatia	1.0	5.5	1.0	5.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	5.5	1.0	5.5
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	1.0	3.3	2.9	1.0	1.0	1.0	1.0	1.0	19.9	1.0	19.9	1.0	1.2	3.3	2.9
Denmark	1.0	1.0	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	-4.2	-4.2	1.0	1.0	-3.3	-3.3
Estonia	1.0	0.9	0.2	0.7	1.0	1.0	1.0	1.0	1.0	1.5	1.0	1.5	1.0	0.9	0.2	0.7
Finland	1.0	2.4	1.9	2.0	1.0	1.0	0.7	0.7	1.0	10.6	0.1	0.8	1.0	3.0	1.1	1.5
France	1.0	1.0	3.7	3.6	1.0	1.0	1.0	1.0	1.0	0.3	0.0	0.1	1.0	0.5	3.6	3.6
Germany	1.0	1.8	0.9	1.3	1.0	0.1	1.0	0.1	1.0	-0.4	-0.5	-0.4	1.0	0.6	0.6	0.6
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.1	-0.1	1.0	1.0	-0.1	-0.1
Hungary	1.0	3.5	3.2	3.4	1.0	1.0	1.0	1.0	1.0	0.0	-1.9	-0.9	1.0	3.5	3.2	3.4
Ireland	1.0	1.8	1.0	1.8	1.0	1.0	1.0	1.0	1.0	-0.6	1.0	-0.6	1.0	-0.6	1.0	-0.6
Italy	1.0	1.0	2.5	2.5	1.0	1.0	1.0	1.0	1.0	-0.3	-1.6	-0.4	1.0	-0.3	-1.3	-0.4
Latvia	1.0	1.0	1.0	1.0	1.0	0.5	1.0	0.5	1.0	1.0	0.0	0.0	1.0	0.5	0.0	0.5
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	-0.5	-0.2	1.0	0.0	-0.5	-0.2
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	3.4	3.4	1.0	0.6	0.4	0.5	1.0	2.1	0.3	1.0	1.0	1.0	2.5	2.2
Poland	1.0	1.4	-0.1	0.9	1.0	-0.3	0.0	-0.1	1.0	4.8	1.0	4.8	1.0	1.5	-0.1	1.0
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.4	0.7	1.0	0.7	0.4	0.7
Romania	1.0	1.4	0.9	0.9	1.0	1.0	1.0	1.0	1.0	-2.5	-1.2	-1.5	1.0	0.3	0.8	0.8
Slovakia	1.0	1.1	7.0	6.8	1.0	1.0	1.0	1.0	1.0	1.0	19.9	19.9	1.0	1.1	7.1	6.9
Slovenia	1.0	3.1	5.2	5.0	1.0	1.0	1.0	1.0	1.0	0.7	0.0	0.6	1.0	2.5	5.2	4.9
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5	4.3	1.6	1.0	1.5	4.3	1.6
Sweden	1.0	1.0	4.8	4.8	1.0	1.0	1.0	1.0	1.0	-2.7	-0.4	-1.2	1.0	-2.7	4.7	4.7
UK	1.0	2.4	1.0	2.4	1.0	1.0	0.1	0.1	1.0	1.4	2.6	1.6	1.0	2.2	1.4	2.1

Capital recovery index - Cournot competition case - New plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.9	1.2	1.7	1.4	0.5	0.5	0.7	0.6	0.4	0.3	0.1	0.2	0.6	0.8	1.0	0.9
Austria	0.3	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.2	0.6	0.1	0.2	0.1	0.1	0.1	0.1
Belgium	1.8	1.0	1.0	1.0	1.4	1.2	1.0	1.1	0.6	0.7	0.3	0.6	1.2	0.9	0.8	0.9
Bulgaria	1.0	0.9	1.9	1.3	1.0	0.6	0.7	0.6	0.2	0.3	1.0	0.3	0.2	0.8	1.7	1.1
Croatia	1.0	1.0	1.0	1.0	0.9	1.0	0.3	0.6	1.0	1.0	1.0	1.0	0.9	1.0	0.3	0.6
Cyprus	1.0	1.0	1.0	1.0	1.0	3.6	3.8	3.6	2.2	0.8	0.4	0.7	2.2	2.8	1.5	2.6
Czech	2.1	1.5	2.1	1.8	0.2	0.3	1.0	0.3	0.8	0.4	-0.4	0.3	1.9	1.3	2.0	1.6
Denmark	0.3	1.0	1.0	1.0	0.4	1.0	2.3	2.3	0.2	1.0	-0.1	-0.1	0.3	1.0	-0.1	-0.1
Estonia	1.2	1.0	1.0	1.0	1.0	0.2	0.0	0.2	-0.1	0.1	-0.2	0.1	1.2	0.7	0.0	0.7
Finland	0.8	1.2	2.3	1.6	0.4	1.0	1.0	1.0	0.4	4.4	1.0	4.4	0.6	1.2	2.3	1.6
France	0.1	0.2	1.0	0.2	0.5	0.4	1.0	0.4	-0.2	-0.7	-0.3	-0.4	0.1	0.3	-0.3	0.2
Germany	0.9	1.2	1.0	1.2	0.1	0.1	0.6	0.5	0.5	0.1	0.1	0.1	0.5	0.8	0.4	0.7
Greece	1.5	1.8	1.0	1.8	0.5	0.5	1.4	0.7	0.0	0.0	0.0	0.0	0.6	0.8	1.0	0.8
Hungary	1.9	1.0	1.9	1.9	1.1	0.7	0.1	0.5	0.7	3.9	0.6	2.0	1.4	1.1	1.2	1.2
Ireland	1.3	1.0	1.0	1.0	0.8	0.5	1.0	0.5	0.3	-0.3	-0.2	-0.2	0.8	0.4	-0.2	0.2
Italy	1.7	2.1	1.0	2.1	0.4	0.7	1.0	0.7	0.3	5.7	0.0	0.3	0.5	1.9	0.0	0.9
Latvia	2.7	2.2	1.0	2.2	0.6	1.3	1.0	1.3	1.0	0.3	1.0	0.3	0.8	0.7	1.0	0.7
Lithuania	1.0	1.0	1.0	1.0	1.4	1.4	1.0	1.4	0.1	-0.3	-0.8	-0.7	1.1	1.0	0.9	0.9
Luxembourg	1.0	1.0	1.0	1.0	0.3	0.9	-0.2	0.5	0.1	1.0	1.0	1.0	0.3	0.9	-0.2	0.5
Malta	1.0	1.0	1.0	1.0	1.0	4.4	1.0	4.4	2.1	-0.3	1.0	-0.3	2.1	2.9	1.0	2.9
Netherlands	1.0	1.3	2.9	1.4	0.7	0.6	1.6	0.6	2.5	1.2	1.2	1.2	1.2	1.0	1.8	1.1
Poland	0.8	1.4	1.4	1.4	0.1	0.1	0.4	0.2	0.2	0.4	3.6	0.6	0.7	0.7	1.4	1.2
Portugal	1.0	1.0	1.0	1.0	0.4	0.2	1.0	0.2	0.1	0.1	1.0	0.1	0.3	0.2	1.0	0.2
Romania	0.9	1.1	2.9	1.2	0.3	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.9	0.7	1.5	0.8
Slovakia	0.9	0.8	3.9	1.1	0.4	0.9	1.0	0.9	0.8	1.0	5.6	5.6	0.6	0.8	4.0	1.1
Slovenia	0.6	1.8	2.7	2.1	1.0	0.6	1.3	0.9	0.1	0.2	1.0	0.2	0.2	1.8	2.6	2.0
Spain	0.9	1.6	1.0	1.6	0.5	0.6	1.0	0.6	0.2	0.0	0.6	0.2	0.5	0.6	0.6	0.6
Sweden	0.8	0.3	1.0	0.3	0.8	1.0	1.0	1.0	0.3	0.6	0.2	0.5	0.4	0.4	0.2	0.4
UK	0.9	0.6	2.2	1.8	0.6	0.5	1.0	0.5	0.7	0.0	0.0	0.0	0.6	0.3	1.4	0.7

Table 56: Capacity factor for the three bidding regimes, under high RES conditions

Capacity factor - Marginal cost bidding case - All projected investments									
	Base-load			CCGT			Open cycle plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.6	0.8	0.7	0.3	0.3	0.3	0.2	0.1	0.1
Austria	0.8	0.5	0.5	0.3	1.0	0.3	0.2	0.2	0.2
Belgium	1.0	1.0	1.0	0.3	0.5	0.5	0.2	0.2	0.2
Bulgaria	0.4	0.8	0.5	0.2	0.1	0.1	0.1	0.0	0.1
Croatia	1.0	1.0	1.0	0.3	0.3	0.3	1.0	1.0	1.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.5	0.8	0.6	0.1	1.0	0.1	0.3	0.2	0.3
Denmark	1.0	0.2	0.2	1.0	0.7	0.7	1.0	0.1	0.1
Estonia	0.5	0.1	0.4	0.2	0.1	0.2	0.1	0.0	0.1
Finland	0.8	0.9	0.8	1.0	0.1	0.1	0.5	0.3	0.4
France	0.3	0.8	0.8	0.2	1.0	0.2	0.4	0.2	0.3
Germany	0.6	0.4	0.6	0.1	0.2	0.2	0.1	0.1	0.1
Greece	0.6	1.0	0.6	0.1	0.2	0.2	0.0	0.0	0.0
Hungary	0.9	0.9	0.9	0.3	0.1	0.2	0.5	0.4	0.4
Ireland	0.5	1.0	0.5	0.2	1.0	0.2	0.1	0.1	0.1
Italy	0.7	0.9	0.7	0.5	1.0	0.5	0.3	0.0	0.1
Latvia	0.5	1.0	0.5	0.2	1.0	0.2	0.1	0.2	0.1
Lithuania	1.0	0.9	0.9	0.3	1.0	0.3	0.1	0.2	0.2
Luxembourg	1.0	1.0	1.0	0.7	0.7	0.7	0.2	1.0	0.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.4	0.6	0.5	0.3	0.2	0.2	0.3	0.3	0.3
Poland	0.5	0.8	0.7	0.1	0.2	0.2	0.1	0.5	0.1
Portugal	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.2	0.1
Romania	0.8	0.7	0.8	0.2	1.0	0.2	0.0	0.2	0.1
Slovakia	0.6	0.9	0.7	0.2	1.0	0.2	1.0	0.6	0.6
Slovenia	0.6	0.9	0.8	0.5	0.5	0.5	0.4	0.3	0.4
Spain	0.6	1.0	0.6	0.6	1.0	0.6	0.1	0.2	0.1
Sweden	0.1	0.7	0.7	1.0	1.0	1.0	1.0	0.1	0.8
UK	0.8	0.8	0.8	0.4	0.1	0.3	0.2	0.3	0.2

Capacity factor - Supply function equilibrium case - All projected investments									
	Base-load			CCGT			Open cycle plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.6	0.8	0.7	0.2	0.3	0.2	0.2	0.1	0.2
Austria	0.8	0.5	0.5	0.3	1.0	0.3	0.4	0.2	0.3
Belgium	1.0	1.0	1.0	0.3	0.5	0.4	0.2	0.2	0.2
Bulgaria	0.3	0.8	0.5	0.1	0.1	0.1	0.1	0.1	0.1
Croatia	1.0	1.0	1.0	0.3	0.4	0.4	1.0	1.0	1.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.4	0.8	0.6	0.1	1.0	0.1	0.3	0.3	0.3
Denmark	1.0	0.4	0.4	1.0	0.5	0.5	1.0	0.1	0.1
Estonia	0.5	0.1	0.5	0.0	0.0	0.0	0.0	0.1	0.0
Finland	0.8	0.9	0.8	1.0	0.3	0.3	0.6	0.4	0.5
France	0.3	0.8	0.8	0.1	1.0	0.1	0.4	0.2	0.2
Germany	0.6	0.5	0.6	0.1	0.3	0.2	0.1	0.1	0.1
Greece	0.6	1.0	0.6	0.1	0.3	0.2	0.0	0.0	0.0
Hungary	1.0	0.9	1.0	0.2	0.1	0.2	0.6	0.4	0.5
Ireland	0.4	1.0	0.4	0.1	1.0	0.1	0.2	0.1	0.2
Italy	0.7	0.7	0.7	0.3	1.0	0.3	0.4	0.1	0.1
Latvia	0.6	1.0	0.6	0.1	1.0	0.1	0.1	0.5	0.1
Lithuania	1.0	0.9	0.9	0.3	1.0	0.3	0.2	0.3	0.2
Luxembourg	1.0	1.0	1.0	0.7	0.5	0.6	0.2	1.0	0.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.5	0.7	0.6	0.2	0.3	0.2	0.3	0.3	0.3
Poland	0.6	0.8	0.7	0.1	0.2	0.2	0.1	0.6	0.2
Portugal	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.2	0.1
Romania	0.7	0.5	0.6	0.1	1.0	0.1	0.1	0.1	0.1
Slovakia	0.5	0.8	0.7	0.1	1.0	0.1	1.0	0.6	0.6
Slovenia	0.4	0.9	0.7	0.2	0.2	0.2	0.3	0.2	0.3
Spain	0.6	1.0	0.6	0.3	1.0	0.3	0.1	0.3	0.2
Sweden	0.1	0.8	0.8	1.0	1.0	1.0	0.8	0.2	0.7
UK	0.8	0.8	0.8	0.3	0.1	0.2	0.2	0.3	0.2

Capacity factor - Cournot competition case - All projected investments									
	Base-load			CCGT			Open cycle plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.6	0.8	0.7	0.2	0.3	0.2	0.2	0.1	0.2
Austria	0.8	0.5	0.5	0.3	1.0	0.3	0.4	0.2	0.3
Belgium	1.0	1.0	1.0	0.3	0.5	0.5	0.2	0.2	0.2
Bulgaria	0.3	0.8	0.5	0.1	0.1	0.1	0.1	0.1	0.1
Croatia	1.0	1.0	1.0	0.3	0.4	0.4	1.0	1.0	1.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.4	0.8	0.6	0.1	1.0	0.1	0.2	0.3	0.3
Denmark	1.0	0.5	0.5	1.0	0.6	0.6	1.0	0.1	0.1
Estonia	0.4	0.0	0.4	0.1	0.0	0.1	0.0	0.1	0.0
Finland	0.8	0.9	0.8	1.0	0.3	0.3	0.6	0.5	0.6
France	0.2	0.8	0.8	0.1	1.0	0.1	0.4	0.2	0.2
Germany	0.6	0.5	0.6	0.1	0.3	0.2	0.1	0.1	0.1
Greece	0.6	1.0	0.6	0.1	0.3	0.2	0.0	0.0	0.0
Hungary	0.9	0.9	0.9	0.2	0.0	0.1	0.6	0.4	0.5
Ireland	0.5	1.0	0.5	0.1	1.0	0.1	0.2	0.1	0.1
Italy	0.7	0.8	0.7	0.4	1.0	0.4	0.5	0.1	0.1
Latvia	0.6	1.0	0.6	0.2	1.0	0.2	0.1	0.5	0.1
Lithuania	1.0	0.7	0.7	0.2	1.0	0.2	0.2	0.3	0.2
Luxembourg	1.0	1.0	1.0	0.7	0.6	0.7	0.2	1.0	0.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.6	0.7	0.6	0.2	0.3	0.2	0.3	0.3	0.3
Poland	0.6	0.8	0.7	0.0	0.1	0.1	0.1	0.6	0.1
Portugal	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.3	0.1
Romania	0.7	0.6	0.6	0.1	1.0	0.1	0.1	0.1	0.1
Slovakia	0.5	0.8	0.7	0.2	1.0	0.2	1.0	0.6	0.6
Slovenia	0.5	0.9	0.7	0.2	0.3	0.2	0.3	0.2	0.3
Spain	0.6	1.0	0.6	0.4	1.0	0.4	0.1	0.3	0.2
Sweden	0.1	0.8	0.8	1.0	1.0	1.0	1.0	0.2	0.8
UK	0.8	0.9	0.8	0.3	0.1	0.3	0.2	0.3	0.2

Table 57: % change in capital revenues under high RES conditions relative to Reference scenario, for the three bidding regimes

% change of capital revenues relative to Reference - Marginal cost bidding case - All projected investments												
	Base-load			CCGT			Open cycle plants			All plants		
Commis-sioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	-11	-36	-31	-13	-38	-26	-1	-33	-11	-11	-36	-30
Austria	-18	-32	-32	32	0	32	8	-68	-53	9	-51	-42
Belgium	0	0	0	37	-67	-50	2	-15	-1	7	-54	-23
Bulgaria	-37	7	-13	0	354	354	-100	0	-100	-38	12	-11
Croatia	-20	0	-20	-9	0	63	0	0	0	-15	0	16
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0
Czech	-15	-21	-20	-15	0	-15	100	-100	95	-13	-21	-19
Denmark	-100	-100	-100	0	-79	-79	0	0	0	-100	-88	-88
Estonia	-10	-12	-10	12	83	20	48	235	49	-9	2	-9
Finland	23	-42	-27	0	0	0	-2	0	-2	22	-42	-27
France	-12	-36	-36	-27	0	-27	0	0	0	-18	-36	-36
Germany	-10	-77	-13	0	-23	-23	0	0	0	-10	-36	-14
Greece	-39	0	-39	-20	-59	-44	-30	-92	-40	-34	-60	-41
Hungary	-9	-24	-17	-8	-50	-22	-13	43	-6	-9	-24	-17
Ireland	-57	0	-57	0	-100	-100	0	0	0	-57	-100	-85
Italy	-3	-16	-3	-16	0	-16	1	-59	-6	-3	-57	-4
Latvia	-52	-100	-83	0	0	0	-28	-100	-73	-30	-100	-74
Lithuania	0	-42	-42	-29	0	-29	0	0	0	-29	-42	-42
Luxembourg	0	0	0	-67	-100	-94	0	0	0	-67	-100	-94
Malta	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	-24	-18	-22	-30	-19	-28	-28	-96	-70	-25	-28	-26
Poland	-40	-35	-36	-32	-24	-25	-14	-26	-19	-34	-35	-35
Portugal	0	0	0	-1	0	-1	-32	-100	-63	-30	-100	-60
Romania	-16	-69	-51	21	-100	17	-12	-100	-39	-12	-69	-49
Slovakia	-9	-23	-20	258	0	258	0	4771	4771	-6	-21	-17
Slovenia	-18	-22	-21	-43	-56	-53	0	0	0	-18	-23	-22
Spain	-43	0	-43	-6	0	-6	38	128	112	-39	128	-30
Sweden	600	-17	-17	0	0	0	0	0	0	600	-17	-17
UK	58	-66	-56	-7	350	-6	80	0	80	43	-66	-53

% change of capital revenues relative to Reference - Supply function equilibrium case - All projected investments												
	Base-load			CCGT			Open cycle plants			All plants		
Commis-sioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	-11	-41	-33	-21	-54	-39	-14	-27	-18	-12	-41	-33
Austria	-7	-30	-30	4	0	4	-3	-63	-50	-2	-49	-40
Belgium	0	0	0	5	-100	-76	-3	-60	-16	-1	-91	-46
Bulgaria	-32	-41	-36	-51	-40	-44	-58	0	-58	-33	-41	-37
Croatia	-21	0	-21	-20	-100	-62	0	0	0	-21	-100	-56
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0
Czech	-21	-33	-30	-52	0	-52	41	0	41	-21	-33	-30
Denmark	-100	-100	-100	0	-76	-76	0	0	0	-100	-86	-86
Estonia	-22	-13	-22	-8	-23	-9	16	0	16	-21	-14	-21
Finland	14	-46	-31	0	0	0	-3	0	-2	13	-46	-31
France	-23	-41	-40	-47	0	-47	0	0	0	-33	-41	-40
Germany	-5	-60	-7	-59	-43	-44	-100	0	-100	-7	-46	-15
Greece	-12	0	-12	-28	-63	-50	-74	-100	-79	-17	-64	-32
Hungary	-4	-31	-19	-21	-78	-36	-19	0	-16	-6	-32	-20
Ireland	-59	0	-59	-16	0	-16	0	0	0	-17	0	-17
Italy	-3	-19	-3	-14	0	-14	-3	-100	-7	-3	-89	-4
Latvia	-56	-100	-85	-27	0	-27	-69	-100	-82	-58	-100	-73
Lithuania	0	-36	-36	-34	0	-34	0	0	0	-34	-36	-36
Luxembourg	0	0	0	-65	-100	-93	0	0	0	-65	-100	-93
Malta	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	-14	-10	-12	-28	-30	-29	-24	-47	-39	-16	-16	-16
Poland	-30	-36	-35	-32	-42	-40	-8	-28	-15	-25	-36	-34
Portugal	0	0	0	-39	0	-39	-100	-98	-99	-47	-98	-53
Romania	-43	-89	-73	-100	0	-100	0	0	0	-45	-89	-73
Slovakia	-11	-27	-24	-16	0	-16	0	98	98	-11	-26	-23
Slovenia	-21	-19	-20	-52	-65	-61	4	0	4	-21	-20	-20
Spain	-45	0	-45	-11	0	-11	-6	249	104	-37	249	-29
Sweden	527	-32	-32	0	0	0	-100	0	-100	10	-32	-32
UK	56	-66	-55	-8	234	-7	-6	377	13	28	-65	-51

% change of capital revenues relative to Reference - Cournot competition case - All projected investments												
	Base-load			CCGT			Open cycle plants			All plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	-11	-36	-29	-18	-40	-29	-15	-16	-15	-12	-36	-29
Austria	-7	2	1	-10	0	-10	8	-39	-27	3	-28	-21
Belgium	0	0	0	5	-28	-20	4	-18	-1	4	-26	-13
Bulgaria	-26	-18	-22	-27	-27	-27	-49	-100	-49	-27	-19	-23
Croatia	-21	0	-21	-16	-72	-47	0	0	0	-17	-72	-45
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0
Czech	-18	-31	-27	-33	0	-33	42	0	42	-17	-31	-27
Denmark	-100	-97	-97	0	-79	-79	0	0	0	-100	-86	-86
Estonia	-36	-37	-36	-22	-45	-23	-18	0	-18	-35	-39	-35
Finland	9	-49	-34	0	-50	-50	-7	-84	-12	9	-49	-34
France	-25	-34	-34	-39	0	-39	0	0	0	-33	-34	-34
Germany	-7	-55	-10	-42	-38	-38	-51	0	-41	-9	-39	-17
Greece	-14	0	-14	-35	-64	-52	0	0	0	-23	-64	-37
Hungary	-3	-28	-17	-24	-83	-39	-14	544	-4	-6	-29	-18
Ireland	-53	0	-53	-6	-100	-7	0	0	0	-6	-100	-7
Italy	-3	-14	-3	-13	0	-13	-4	-51	-12	-4	-49	-6
Latvia	-34	-100	-79	-9	0	-9	-55	-100	-73	-27	-100	-43
Lithuania	0	-37	-37	-10	0	-10	-100	0	-100	-13	-37	-35
Luxembourg	0	0	0	-53	-100	-92	0	0	0	-53	-100	-92
Malta	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	-12	-8	-11	-17	-16	-17	-21	-43	-35	-14	-15	-14
Poland	-32	-38	-37	-39	-45	-44	-14	-29	-20	-28	-38	-36
Portugal	0	0	0	-41	0	-41	-9	-98	-28	-31	-98	-36
Romania	-21	-75	-55	-52	-100	-55	0	0	0	-22	-75	-55
Slovakia	-6	-18	-15	32	0	32	0	196	196	-4	-16	-13
Slovenia	-18	-18	-18	-57	-64	-62	4	0	4	-19	-19	-19
Spain	-47	0	-47	-12	0	-12	-4	108	55	-35	108	-29
Sweden	592	-22	-22	0	0	0	-34	0	-34	2	-22	-22
UK	55	-66	-55	-12	125	-12	-9	94	2	18	-66	-50

Table 58: Simulated average wholesale market marginal prices (SMP), under high RES conditions

Average SMP (EUR/MWh)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	40	59	70	64	72	73	81
Austria	45	45	90	53	90	58	91
Belgium	68	89	85	92	87	105	108
Bulgaria	39	31	48	52	68	70	89
Croatia	36	80	62	95	66	103	75
Cyprus	165	127	140	165	167	179	175
Czech	47	54	94	60	102	86	121
Denmark	42	68	88	68	91	76	97
Estonia	35	77	57	77	53	93	50
Finland	33	57	87	65	89	81	100
France	43	64	59	61	53	78	67
Germany	43	63	86	69	91	74	97
Greece	51	68	92	74	98	79	112
Hungary	41	65	68	73	70	82	76
Ireland	44	69	66	69	70	88	82
Italy	57	92	107	95	108	104	117
Latvia	38	83	97	87	99	119	115
Lithuania	62	77	57	79	63	101	91
Luxembourg	47	85	102	87	102	91	109
Malta	166	144	144	144	161	172	168
Netherlands	40	67	76	73	86	83	96
Poland	25	51	77	74	92	77	95
Portugal	41	70	95	73	100	90	106
Romania	27	43	82	44	61	53	79
Slovakia	23	39	82	33	77	53	130
Slovenia	33	84	110	86	110	96	120
Spain	42	74	92	82	95	86	99
Sweden	43	47	47	64	61	69	69
UK	41	78	94	81	98	84	100

Table 59: Average SMP mark-up indicators, under high RES conditions

Mark-up (% change over marginal cost bidding)	Supply function equilibrium		Cournot competition			Supply function equilibrium		Cournot competition	
	2020	2030	2020	2030		2020	2030	2020	2030
EU27	7.8	2.9	22.5	15.3					
Austria	16.7	0.2	27.7	0.7	Italy	2.5	0.5	13.4	9.2
Belgium	3.2	3.4	18.2	27.7	Latvia	4.6	2.7	43.2	19.2
Bulgaria	70.6	40.6	129.9	83.4	Lithuania	2.5	9.7	31.5	58.9
Croatia	19.5	5.5	29.6	20.6	Luxembourg	2.3	0.4	7.3	7.2
Cyprus	30.1	19.1	41.1	24.9	Malta	0.0	11.6	19.9	17.1
Czech	11.1	9.2	59.1	29.1	Netherlands	8.8	12.9	25.3	25.6
Denmark	0.9	3.4	12.6	10.0	Poland	45.2	18.9	52.0	22.6
Estonia	0.8	-7.8	21.3	-13.1	Portugal	3.2	5.7	27.1	12.2
Finland	13.9	2.9	42.5	15.5	Romania	3.6	-25.6	22.5	-2.9
France	-5.5	-10.1	22.4	13.9	Slovakia	-15.7	-5.9	35.8	59.4
Germany	9.4	5.2	17.2	12.0	Slovenia	2.2	0.0	13.5	8.6
Greece	8.0	7.0	15.1	22.2	Spain	10.5	3.5	16.0	7.8
Hungary	10.9	2.9	25.7	11.3	Sweden	38.2	30.1	48.3	48.1
Ireland	0.1	5.9	28.1	24.5	UK	4.8	3.6	8.7	5.5

Table 60: Payment for electricity, under high RES conditions

	Payment for electricity in bn€						
	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	127.7	206.6	268.4	223.6	283.2	253.4	313.8
Austria	2.1	2.1	4.6	2.4	4.6	2.6	4.7
Belgium	6.1	8.1	7.1	8.2	6.8	9.6	9.6
Bulgaria	1.1	1.1	1.8	1.9	2.4	2.5	3.2
Croatia	0.5	1.3	1.0	1.5	1.0	1.7	1.2
Cyprus	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Czech	3.0	3.9	7.5	4.3	8.3	6.2	9.7
Denmark	1.5	2.3	3.3	2.4	3.4	2.8	3.7
Estonia	0.3	0.9	0.7	0.9	0.7	1.1	0.6
Finland	2.6	4.7	7.4	5.3	7.6	6.7	8.4
France	20.5	30.1	30.5	29.0	28.8	37.7	36.2
Germany	24.1	33.9	46.9	37.0	50.7	40.1	54.2
Greece	2.6	4.0	5.3	4.5	6.4	4.8	7.3
Hungary	1.6	2.7	3.1	3.0	3.3	3.5	3.6
Ireland	1.1	1.7	1.8	1.8	2.2	2.3	2.4
Italy	16.9	28.9	38.1	29.5	38.4	32.7	41.7
Latvia	0.1	0.4	0.6	0.4	0.6	0.6	0.7
Lithuania	0.6	0.9	0.7	0.9	0.8	1.1	1.1
Luxembourg	0.3	0.5	0.7	0.6	0.7	0.6	0.8
Malta	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Netherlands	4.7	8.4	8.2	9.2	10.8	10.6	12.1
Poland	3.5	9.6	15.8	13.9	18.7	14.6	19.4
Portugal	2.0	3.5	5.7	3.6	6.1	4.5	6.5
Romania	1.1	2.3	4.2	2.2	3.1	2.7	4.2
Slovakia	0.5	1.0	2.5	0.8	2.3	1.2	3.7
Slovenia	0.3	1.1	1.4	1.1	1.5	1.2	1.6
Spain	10.5	20.7	29.5	22.9	30.5	24.1	31.8
Sweden	5.5	6.1	6.5	8.4	8.6	9.0	9.8
UK	14.8	27.5	34.2	29.0	35.8	30.1	36.5

Results of wholesale market simulation - Low XB trade

Table 61: Capital recovery index in the marginal cost bidding case, under low XB trade conditions

Capital recovery index - Marginal cost bidding case - All projected investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.2	2.2	1.7	0.2	0.4	0.7	0.5	0.2	0.3	0.0	0.1	0.3	0.8	1.4	1.1
Austria	0.3	0.8	-0.1	0.0	0.1	0.2	1.0	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.1
Belgium	1.6	1.0	1.0	1.0	0.7	0.5	1.6	1.3	0.1	0.6	0.3	0.5	0.7	0.6	0.9	0.8
Bulgaria	1.0	0.9	1.4	1.1	1.0	0.4	0.5	0.5	0.1	0.8	0.2	0.6	0.1	0.9	1.2	1.0
Croatia	1.0	5.3	1.0	5.3	1.1	1.4	2.0	1.5	1.0	0.0	0.0	0.0	1.1	0.8	0.2	0.6
Cyprus	1.0	1.0	1.0	1.0	1.0	0.2	1.0	0.2	0.8	0.0	-0.3	-0.1	0.8	0.1	0.1	0.1
Czech	0.8	0.7	2.2	1.7	0.0	0.1	0.5	0.2	0.5	0.6	0.4	0.5	0.7	0.6	2.2	1.6
Denmark	0.2	0.4	0.2	0.2	0.3	1.0	1.0	1.0	0.4	1.0	-0.2	-0.2	0.2	0.4	-0.2	-0.2
Estonia	0.5	0.9	0.4	0.9	1.0	0.1	0.1	0.1	0.0	0.1	0.2	0.1	0.5	0.7	0.3	0.7
Finland	0.6	0.7	1.2	1.0	0.2	-0.1	-0.4	-0.3	0.3	1.0	-0.6	0.1	0.4	0.7	1.2	1.0
France	0.1	0.2	3.2	2.7	0.2	0.3	1.0	0.3	-0.7	-0.3	-0.1	-0.1	0.0	0.2	2.3	1.9
Germany	0.8	1.3	0.8	1.3	0.1	0.1	0.5	0.4	0.4	0.1	-0.1	0.0	0.5	0.9	0.4	0.7
Greece	1.4	2.4	1.0	2.4	0.6	1.1	3.3	1.8	0.4	0.8	0.5	0.6	0.7	1.4	1.4	1.4
Hungary	1.9	3.7	2.4	2.8	1.0	0.9	0.3	0.7	1.0	4.2	0.1	0.5	1.4	2.8	1.8	2.1
Ireland	0.9	1.7	1.0	1.7	0.2	0.3	0.6	0.4	0.0	-0.1	0.0	0.0	0.3	0.2	0.1	0.2
Italy	1.4	1.9	2.6	2.0	0.2	0.5	1.0	0.5	0.3	2.2	0.0	0.2	0.3	1.6	0.0	0.8
Latvia	1.1	0.9	0.8	0.8	0.7	0.4	1.0	0.4	0.9	0.0	-0.8	-0.2	0.7	0.2	-0.7	0.0
Lithuania	1.0	1.0	0.6	0.6	1.0	1.0	1.0	1.0	-0.1	-0.6	-0.6	-0.6	0.7	0.5	0.4	0.4
Luxembourg	1.0	1.0	1.0	1.0	2.3	3.9	2.8	3.0	1.1	0.0	1.0	0.0	2.1	2.3	2.8	2.7
Malta	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	0.3	-0.3	1.0	-0.3	0.3	1.0	1.0	1.0
Netherlands	1.0	0.9	2.5	1.1	0.3	0.2	0.4	0.2	1.8	1.2	0.2	0.3	0.7	0.6	1.1	0.7
Poland	0.7	1.2	1.3	1.3	0.3	0.2	0.3	0.2	0.4	0.6	0.5	0.6	0.7	1.0	1.2	1.1
Portugal	1.0	1.0	1.0	1.0	0.2	0.1	1.0	0.1	0.1	0.3	1.0	0.3	0.1	0.2	1.0	0.2
Romania	1.4	2.3	3.3	2.8	0.7	1.2	1.4	1.2	0.8	1.0	2.0	1.9	1.4	1.9	3.2	2.4
Slovakia	0.7	0.4	2.8	1.3	0.0	0.1	1.0	0.1	0.2	1.0	0.1	0.1	0.3	0.4	2.7	1.3
Slovenia	0.4	1.1	2.6	2.0	1.0	0.3	0.7	0.5	0.1	-0.3	0.0	-0.2	0.2	1.1	2.5	2.0
Spain	0.6	1.2	1.0	1.2	0.1	0.2	1.0	0.2	0.1	0.0	0.0	0.0	0.1	0.5	0.0	0.4
Sweden	0.8	0.2	3.0	3.0	0.8	1.0	1.0	1.0	0.5	1.3	0.0	0.2	0.6	1.2	2.0	2.0
UK	0.6	1.0	1.9	1.8	0.1	0.3	0.7	0.3	0.5	0.2	0.0	0.1	0.2	0.3	1.4	1.0

Capital recovery index - Marginal cost bidding case - Retrofitting investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	2.0	3.1	3.0	1.0	0.1	0.1	0.1	1.0	0.3	0.5	0.3	1.0	1.3	3.0	2.7
Austria	1.0	0.8	-0.1	0.0	1.0	1.0	1.0	1.0	1.0	-0.1	0.3	0.0	1.0	0.0	0.0	0.0
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.0	5.2	4.3	1.0	4.0	5.2	4.3
Bulgaria	1.0	1.0	0.2	0.2	1.0	1.0	1.0	1.0	1.0	0.0	-0.5	-0.2	1.0	0.2	0.1	0.1
Croatia	1.0	5.3	1.0	5.3	1.0	1.0	1.0	1.0	1.0	-0.1	-0.5	-0.4	1.0	3.2	-0.5	0.4
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	0.2	3.1	2.5	1.0	1.0	1.0	1.0	1.0	10.4	0.0	8.0	1.0	0.3	3.1	2.5
Denmark	1.0	0.4	0.2	0.2	1.0	1.0	1.0	1.0	1.0	1.0	0.4	0.4	1.0	0.4	0.3	0.3
Estonia	1.0	0.7	0.4	0.6	1.0	1.0	1.0	1.0	1.0	0.2	1.0	0.2	1.0	0.6	0.4	0.6
Finland	1.0	0.9	0.0	0.0	1.0	-0.1	-0.4	-0.3	1.0	0.2	-0.3	0.0	1.0	0.3	-0.1	0.0
France	1.0	0.4	3.2	3.2	1.0	1.0	1.0	1.0	1.0	-0.3	-0.1	-0.2	1.0	-0.1	3.2	3.1
Germany	1.0	2.4	0.8	1.6	1.0	0.0	1.0	0.0	1.0	-0.5	-0.2	-0.5	1.0	1.1	0.7	1.0
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	0.1	1.0	1.0	0.1	0.1
Hungary	1.0	3.7	3.3	3.5	1.0	1.0	1.0	1.0	1.0	0.9	-0.1	0.5	1.0	3.7	3.3	3.5
Ireland	1.0	1.7	1.0	1.7	1.0	1.0	1.0	1.0	1.0	-0.2	1.0	-0.2	1.0	-0.1	1.0	-0.1
Italy	1.0	1.0	2.6	2.6	1.0	1.0	1.0	1.0	1.0	-0.1	-0.4	-0.1	1.0	-0.1	0.0	-0.1
Latvia	1.0	1.0	1.0	1.0	1.0	0.3	1.0	0.3	1.0	1.0	0.0	0.0	1.0	0.3	0.0	0.3
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	-1.2	-0.4	1.0	0.0	-1.2	-0.4
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	2.6	2.6	1.0	0.1	0.2	0.1	1.0	1.2	0.0	0.5	1.0	0.4	1.8	1.5
Poland	1.0	0.2	-0.1	0.1	1.0	0.3	0.1	0.2	1.0	3.4	1.0	3.4	1.0	0.5	-0.1	0.2
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	21.5	1.0	21.5	1.0	21.5	1.0	21.5
Romania	1.0	2.1	3.9	3.8	1.0	1.0	1.0	1.0	1.0	-0.2	1.2	1.1	1.0	1.5	3.7	3.6
Slovakia	1.0	0.1	3.6	3.4	1.0	1.0	1.0	1.0	1.0	1.0	0.2	0.2	1.0	0.1	3.6	3.4
Slovenia	1.0	1.4	3.5	3.4	1.0	1.0	1.0	1.0	1.0	-0.3	0.0	-0.3	1.0	0.9	3.5	3.3
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	3.2	0.2	1.0	0.1	3.2	0.2
Sweden	1.0	1.0	3.8	3.8	1.0	1.0	1.0	1.0	1.0	-0.8	-0.3	-0.4	1.0	-0.8	3.7	3.7
UK	1.0	1.9	1.0	1.9	1.0	1.0	1.0	1.0	1.0	1.3	2.3	1.5	1.0	1.7	2.3	1.8

Capital recovery index - Marginal cost bidding case - New plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.1	1.5	1.3	0.2	0.4	0.7	0.5	0.2	0.3	0.0	0.1	0.3	0.8	0.9	0.8
Austria	0.3	1.0	1.0	1.0	0.1	0.2	1.0	0.2	0.2	0.3	0.0	0.0	0.1	0.2	0.0	0.1
Belgium	1.6	1.0	1.0	1.0	0.7	0.5	1.6	1.3	0.1	0.4	0.1	0.3	0.7	0.4	0.9	0.6
Bulgaria	1.0	0.9	1.6	1.1	1.0	0.4	0.5	0.5	0.1	0.9	0.3	0.7	0.1	0.9	1.3	1.0
Croatia	1.0	1.0	1.0	1.0	1.1	1.4	2.0	1.5	1.0	0.0	0.1	0.0	1.1	0.8	0.3	0.6
Cyprus	1.0	1.0	1.0	1.0	1.0	0.2	1.0	0.2	0.8	0.0	-0.3	-0.1	0.8	0.1	0.1	0.1
Czech	0.8	0.8	1.8	1.4	0.0	0.1	0.5	0.2	0.5	0.3	0.4	0.3	0.7	0.7	1.8	1.3
Denmark	0.2	1.0	0.3	0.3	0.3	1.0	1.0	1.0	0.4	1.0	-0.2	-0.2	0.2	1.0	-0.2	-0.2
Estonia	0.5	1.0	1.0	1.0	1.0	0.1	0.1	0.1	0.0	0.1	0.2	0.1	0.5	0.7	0.1	0.7
Finland	0.6	0.7	1.3	1.1	0.2	1.0	1.0	1.0	0.3	1.6	-0.7	0.2	0.4	0.7	1.3	1.1
France	0.1	0.2	1.0	0.2	0.2	0.3	1.0	0.3	-0.7	-0.4	-0.1	-0.1	0.0	0.2	-0.1	0.1
Germany	0.8	1.3	1.0	1.3	0.1	0.1	0.5	0.4	0.4	0.1	-0.1	0.0	0.5	0.9	0.3	0.7
Greece	1.4	2.4	1.0	2.4	0.6	1.1	3.3	1.8	0.4	0.8	0.6	0.6	0.7	1.4	1.4	1.4
Hungary	1.9	1.0	1.8	1.8	1.0	0.9	0.3	0.7	1.0	4.8	0.1	0.5	1.4	1.3	1.1	1.2
Ireland	0.9	1.0	1.0	1.0	0.2	0.3	0.6	0.4	0.0	0.0	0.0	0.0	0.3	0.2	0.1	0.2
Italy	1.4	1.9	1.0	1.9	0.2	0.5	1.0	0.5	0.3	4.9	0.1	0.3	0.3	1.7	0.1	0.8
Latvia	1.1	0.9	0.8	0.8	0.7	0.5	1.0	0.5	0.9	0.0	-0.8	-0.2	0.7	0.2	-0.7	0.0
Lithuania	1.0	1.0	0.6	0.6	1.0	1.0	1.0	1.0	-0.1	-1.5	-0.6	-0.7	0.7	0.6	0.4	0.4
Luxembourg	1.0	1.0	1.0	1.0	2.3	3.9	2.8	3.0	1.1	1.0	1.0	1.0	2.1	3.9	2.8	3.0
Malta	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	0.3	-0.3	1.0	-0.3	0.3	1.0	1.0	1.0
Netherlands	1.0	0.9	2.1	0.9	0.3	0.2	0.8	0.2	1.8	1.2	0.2	0.3	0.7	0.6	0.5	0.6
Poland	0.7	1.3	1.3	1.3	0.3	0.2	0.3	0.2	0.4	0.6	0.5	0.6	0.7	1.0	1.2	1.1
Portugal	1.0	1.0	1.0	1.0	0.2	0.1	1.0	0.1	0.1	0.1	1.0	0.1	0.1	0.1	1.0	0.1
Romania	1.4	2.3	3.0	2.6	0.7	1.2	1.4	1.2	0.8	1.8	2.2	2.2	1.4	1.9	2.9	2.2
Slovakia	0.7	0.4	1.9	0.8	0.0	0.1	1.0	0.1	0.2	1.0	0.1	0.1	0.3	0.4	1.8	0.7
Slovenia	0.4	1.1	1.7	1.4	1.0	0.3	0.7	0.5	0.1	0.4	1.0	0.4	0.2	1.1	1.6	1.4
Spain	0.6	1.2	1.0	1.2	0.1	0.2	1.0	0.2	0.1	0.0	0.0	0.0	0.1	0.5	0.0	0.4
Sweden	0.8	0.2	0.6	0.6	0.8	1.0	1.0	1.0	0.5	1.4	0.0	0.2	0.6	1.3	0.2	0.3
UK	0.6	0.5	1.9	1.8	0.1	0.3	0.7	0.3	0.5	0.1	-0.1	0.0	0.2	0.2	1.4	1.0

Table 62: Capital recovery index in the supply function equilibrium case, under low XB trade conditions

Capital recovery index - Supply function equilibrium case - All projected investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.8	1.3	2.3	1.8	0.5	0.5	0.9	0.7	0.5	0.5	0.1	0.2	0.6	0.9	1.5	1.3
Austria	0.3	1.0	0.2	0.2	0.1	0.2	1.0	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1
Belgium	1.6	1.0	1.0	1.0	0.8	0.6	1.8	1.4	0.1	0.6	0.3	0.5	0.8	0.6	1.0	0.8
Bulgaria	1.0	1.0	1.5	1.2	1.0	0.6	0.6	0.6	0.5	0.9	0.1	0.7	0.5	1.0	1.2	1.1
Croatia	1.0	5.5	1.0	5.5	1.3	1.7	2.3	1.7	1.0	0.1	0.1	0.1	1.3	1.0	0.3	0.7
Cyprus	1.0	1.0	1.0	1.0	1.0	2.6	3.0	2.6	1.3	0.5	0.2	0.4	1.3	2.0	1.1	1.8
Czech	1.2	1.1	2.7	2.1	0.2	0.6	1.4	0.6	1.0	1.1	0.2	1.0	1.1	1.1	2.7	2.0
Denmark	0.2	1.4	0.6	0.6	0.5	1.0	1.0	1.0	0.7	1.0	0.0	0.0	0.3	1.4	0.0	0.0
Estonia	0.4	1.0	0.5	1.0	1.0	0.1	0.2	0.1	0.0	0.1	0.2	0.1	0.4	0.8	0.3	0.7
Finland	0.9	0.8	1.4	1.2	0.4	-0.2	-0.2	-0.2	0.5	0.9	-0.3	0.2	0.6	0.8	1.4	1.1
France	0.1	0.2	3.3	2.8	0.3	0.3	1.0	0.3	-0.2	-0.8	-0.1	-0.2	0.1	0.2	2.4	1.9
Germany	0.9	1.4	0.9	1.4	0.1	0.1	0.6	0.5	0.5	0.1	-0.1	0.0	0.5	0.9	0.4	0.7
Greece	1.7	2.5	1.0	2.5	1.0	1.3	4.0	2.1	0.4	0.9	0.6	0.7	1.0	1.6	1.7	1.6
Hungary	1.9	3.8	2.4	2.8	1.1	1.0	0.4	0.7	1.1	4.2	0.1	0.5	1.5	2.9	1.8	2.2
Ireland	1.1	1.8	1.0	1.8	0.4	0.4	1.0	0.5	0.2	-0.1	0.0	0.0	0.5	0.3	0.2	0.2
Italy	1.8	2.3	3.2	2.3	0.6	0.9	1.0	0.9	0.5	2.5	0.3	0.4	0.7	2.0	0.3	1.1
Latvia	1.5	1.1	1.0	1.0	1.0	0.7	1.0	0.7	1.0	-0.1	-0.3	-0.2	1.0	0.2	-0.3	0.1
Lithuania	1.0	1.0	0.6	0.6	1.2	1.2	1.0	1.2	0.0	-0.1	-0.9	-0.8	0.9	0.8	0.4	0.4
Luxembourg	1.0	1.0	1.0	1.0	2.7	4.4	3.3	3.5	1.4	0.0	1.0	0.0	2.6	2.5	3.3	3.1
Malta	1.0	1.0	1.0	1.0	1.0	3.2	1.0	3.2	1.4	-0.3	1.0	-0.3	1.4	2.1	1.0	2.1
Netherlands	1.0	1.1	2.8	1.4	0.7	0.5	0.7	0.5	2.4	1.5	0.3	0.5	1.2	0.9	1.3	1.0
Poland	1.0	1.6	1.5	1.6	0.5	0.3	0.6	0.4	0.6	0.9	0.9	0.9	0.9	1.3	1.4	1.4
Portugal	1.0	1.0	1.0	1.0	0.3	0.2	1.0	0.2	0.2	0.4	1.0	0.4	0.3	0.3	1.0	0.3
Romania	0.9	0.8	0.3	0.5	0.1	0.4	-1.7	0.3	0.6	-0.3	-1.0	-0.9	0.9	0.7	0.1	0.4
Slovakia	0.9	0.5	3.5	1.7	0.1	0.2	1.0	0.2	0.4	1.0	0.4	0.4	0.4	0.5	3.3	1.6
Slovenia	0.5	1.6	3.1	2.6	1.0	0.6	0.9	0.8	0.2	-0.2	0.0	-0.1	0.3	1.5	3.0	2.5
Spain	0.7	1.4	1.0	1.4	0.3	0.4	1.0	0.4	0.1	0.1	0.2	0.1	0.3	0.6	0.2	0.6
Sweden	0.9	0.2	3.0	3.0	0.8	1.0	1.0	1.0	0.6	1.4	0.0	0.1	0.6	1.3	2.0	2.0
UK	0.9	1.2	2.1	2.0	0.5	0.4	1.1	0.5	1.1	0.5	0.1	0.3	0.5	0.6	1.6	1.2

Capital recovery index - Supply function equilibrium case - Retrofitting investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	2.2	3.2	3.1	1.0	0.3	0.3	0.3	1.0	0.1	0.0	0.1	1.0	1.4	3.1	2.8
Austria	1.0	1.0	0.2	0.2	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.2	1.0	0.0	0.3	0.2
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.9	5.2	4.2	1.0	3.9	5.2	4.2
Bulgaria	1.0	2.4	0.2	0.3	1.0	1.0	1.0	1.0	1.0	0.0	-0.2	-0.1	1.0	0.4	0.1	0.2
Croatia	1.0	5.5	1.0	5.5	1.0	1.0	1.0	1.0	1.0	-0.8	-0.9	-0.9	1.0	3.0	-0.9	0.0
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	0.7	3.7	3.1	1.0	1.0	1.0	1.0	1.0	16.6	-0.4	12.7	1.0	0.9	3.7	3.1
Denmark	1.0	1.4	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.4	0.4	1.0	1.4	0.7	0.7
Estonia	1.0	0.6	0.5	0.5	1.0	1.0	1.0	1.0	1.0	-0.3	1.0	-0.3	1.0	0.5	0.5	0.5
Finland	1.0	1.8	0.3	0.4	1.0	-0.2	-0.2	-0.2	1.0	-0.6	-0.3	-0.4	1.0	0.0	0.2	0.2
France	1.0	0.6	3.3	3.3	1.0	1.0	1.0	1.0	1.0	-0.5	-0.2	-0.4	1.0	-0.2	3.3	3.2
Germany	1.0	2.5	0.9	1.7	1.0	0.1	1.0	0.1	1.0	-0.9	-0.7	-0.9	1.0	1.0	0.8	0.9
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.2	0.2	1.0	1.0	0.2	0.2
Hungary	1.0	3.8	3.4	3.6	1.0	1.0	1.0	1.0	1.0	0.6	-2.0	-0.4	1.0	3.8	3.3	3.6
Ireland	1.0	1.8	1.0	1.8	1.0	1.0	1.0	1.0	1.0	-0.7	1.0	-0.7	1.0	-0.6	1.0	-0.6
Italy	1.0	1.0	3.2	3.2	1.0	1.0	1.0	1.0	1.0	-0.1	-1.8	-0.2	1.0	-0.1	-1.2	-0.2
Latvia	1.0	1.0	1.0	1.0	1.0	0.5	1.0	0.5	1.0	1.0	0.0	0.0	1.0	0.5	0.0	0.4
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	-1.1	-0.3	1.0	0.1	-1.1	-0.3
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	2.9	2.9	1.0	0.6	0.4	0.5	1.0	1.3	-0.7	0.1	1.0	0.8	2.0	1.7
Poland	1.0	1.0	0.0	0.5	1.0	0.4	0.2	0.3	1.0	3.8	1.0	3.8	1.0	1.2	0.0	0.6
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	24.5	1.0	24.5	1.0	24.5	1.0	24.5
Romania	1.0	1.4	-0.4	-0.4	1.0	1.0	1.0	1.0	1.0	-2.3	-2.9	-2.8	1.0	0.4	-0.6	-0.6
Slovakia	1.0	0.8	4.4	4.3	1.0	1.0	1.0	1.0	1.0	1.0	-0.1	-0.1	1.0	0.8	4.4	4.2
Slovenia	1.0	2.4	4.3	4.2	1.0	1.0	1.0	1.0	1.0	-0.2	0.0	-0.2	1.0	1.6	4.3	4.1
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	3.2	0.9	1.0	0.8	3.2	0.9
Sweden	1.0	1.0	3.7	3.7	1.0	1.0	1.0	1.0	1.0	-2.7	-0.9	-1.2	1.0	-2.7	3.6	3.6
UK	1.0	2.4	1.0	2.4	1.0	1.0	1.0	1.0	1.0	1.4	2.8	1.7	1.0	2.1	2.8	2.1

Capital recovery index - Supply function equilibrium case - New plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.8	1.2	1.7	1.4	0.5	0.5	0.9	0.7	0.5	0.5	0.1	0.2	0.6	0.9	1.0	0.9
Austria	0.3	1.0	1.0	1.0	0.1	0.2	1.0	0.2	0.2	0.2	0.0	0.0	0.2	0.2	0.0	0.1
Belgium	1.6	1.0	1.0	1.0	0.8	0.6	1.8	1.4	0.1	0.4	0.1	0.2	0.8	0.4	0.9	0.7
Bulgaria	1.0	1.0	1.6	1.2	1.0	0.6	0.6	0.6	0.5	1.0	0.2	0.8	0.5	1.0	1.4	1.1
Croatia	1.0	1.0	1.0	1.0	1.3	1.7	2.3	1.7	1.0	0.2	0.2	0.2	1.3	1.0	0.4	0.8
Cyprus	1.0	1.0	1.0	1.0	1.0	2.6	3.0	2.6	1.3	0.5	0.2	0.4	1.3	2.0	1.1	1.8
Czech	1.2	1.2	2.2	1.8	0.2	0.6	1.4	0.6	1.0	0.7	0.2	0.6	1.1	1.1	2.2	1.7
Denmark	0.2	1.0	0.3	0.3	0.5	1.0	1.0	1.0	0.7	1.0	0.0	0.0	0.3	1.0	0.0	0.0
Estonia	0.4	1.0	1.0	1.0	1.0	0.1	0.2	0.1	0.0	0.1	0.2	0.1	0.4	0.8	0.2	0.8
Finland	0.9	0.8	1.5	1.2	0.4	1.0	1.0	1.0	0.5	2.0	-0.4	0.6	0.6	0.8	1.4	1.2
France	0.1	0.2	1.0	0.2	0.3	0.3	1.0	0.3	-0.2	-1.4	-0.1	-0.2	0.1	0.2	-0.1	0.0
Germany	0.9	1.3	1.0	1.3	0.1	0.1	0.6	0.5	0.5	0.2	-0.1	0.1	0.5	0.9	0.4	0.7
Greece	1.7	2.5	1.0	2.5	1.0	1.3	4.0	2.1	0.4	0.9	0.6	0.7	1.0	1.6	1.7	1.6
Hungary	1.9	1.0	1.8	1.8	1.1	1.0	0.4	0.7	1.1	4.8	0.1	0.6	1.5	1.3	1.2	1.2
Ireland	1.1	1.0	1.0	1.0	0.4	0.4	1.0	0.5	0.2	0.1	0.0	0.1	0.5	0.3	0.2	0.2
Italy	1.8	2.3	1.0	2.3	0.6	0.9	1.0	0.9	0.5	5.6	0.3	0.5	0.7	2.1	0.3	1.1
Latvia	1.5	1.1	1.0	1.0	1.0	0.7	1.0	0.7	1.0	-0.1	-0.3	-0.2	1.0	0.2	-0.3	0.1
Lithuania	1.0	1.0	0.6	0.6	1.2	1.2	1.0	1.2	0.0	-0.3	-0.9	-0.8	0.9	1.0	0.4	0.4
Luxembourg	1.0	1.0	1.0	1.0	2.7	4.4	3.3	3.5	1.4	1.0	1.0	1.0	2.6	4.4	3.3	3.5
Malta	1.0	1.0	1.0	1.0	1.0	3.2	1.0	3.2	1.4	-0.3	1.0	-0.3	1.4	2.1	1.0	2.1
Netherlands	1.0	1.1	2.3	1.1	0.7	0.4	1.1	0.5	2.4	1.7	0.4	0.6	1.2	0.9	0.7	0.8
Poland	1.0	1.6	1.6	1.6	0.5	0.3	0.6	0.4	0.6	0.9	0.9	0.9	0.9	1.3	1.5	1.4
Portugal	1.0	1.0	1.0	1.0	0.3	0.2	1.0	0.2	0.2	0.2	1.0	0.2	0.3	0.2	1.0	0.2
Romania	0.9	0.8	0.7	0.8	0.1	0.4	-1.7	0.3	0.6	1.0	-0.3	-0.2	0.9	0.7	0.5	0.6
Slovakia	0.9	0.5	2.4	0.9	0.1	0.2	1.0	0.2	0.4	1.0	0.4	0.4	0.4	0.5	2.2	0.9
Slovenia	0.5	1.6	2.0	1.8	1.0	0.6	0.9	0.8	0.2	0.4	1.0	0.4	0.3	1.5	1.9	1.7
Spain	0.7	1.4	1.0	1.4	0.3	0.4	1.0	0.4	0.1	0.0	0.2	0.1	0.3	0.6	0.2	0.6
Sweden	0.9	0.2	1.1	1.1	0.8	1.0	1.0	1.0	0.6	1.6	0.0	0.2	0.6	1.5	0.4	0.5
UK	0.9	0.6	2.1	2.0	0.5	0.4	1.1	0.5	1.1	0.4	0.0	0.2	0.5	0.4	1.5	1.1

Table 63: Capital recovery index in the Cournot competition case, under low XB trade conditions

Capital recovery index - Cournot competition case - All projected investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	1.5	2.6	2.1	0.8	0.8	1.3	1.0	0.8	0.6	0.2	0.4	0.8	1.2	1.8	1.5
Austria	0.3	1.1	0.3	0.3	0.1	0.2	1.0	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.1
Belgium	2.0	1.0	1.0	1.0	1.7	1.3	3.1	2.5	0.9	1.0	0.7	0.9	1.5	1.1	1.8	1.5
Bulgaria	1.0	1.2	1.7	1.4	1.0	0.8	0.7	0.7	0.6	1.0	0.2	0.8	0.6	1.2	1.5	1.3
Croatia	1.0	6.7	1.0	6.7	2.6	2.9	3.6	3.0	1.0	0.9	0.6	0.7	2.6	2.1	0.9	1.6
Cyprus	1.0	1.0	1.0	1.0	1.0	3.6	3.8	3.6	2.2	0.8	0.4	0.7	2.2	2.8	1.5	2.6
Czech	1.5	1.6	3.3	2.7	0.3	0.6	2.0	0.7	1.5	1.8	0.7	1.6	1.4	1.5	3.3	2.6
Denmark	0.4	2.3	1.3	1.3	1.0	1.0	1.0	1.0	2.1	1.0	0.5	0.5	0.7	2.3	0.5	0.5
Estonia	0.6	1.3	0.6	1.2	1.0	0.3	0.4	0.3	-0.2	0.4	0.4	0.4	0.6	1.0	0.5	1.0
Finland	1.2	0.9	1.7	1.4	0.7	0.3	0.4	0.4	0.6	1.4	-0.1	0.6	0.9	1.0	1.6	1.4
France	0.1	0.2	3.7	3.2	0.5	0.5	1.0	0.5	0.1	-0.6	0.0	-0.1	0.2	0.3	2.7	2.2
Germany	1.1	1.6	1.3	1.6	0.2	0.2	0.8	0.7	0.6	0.2	-0.1	0.1	0.7	1.1	0.6	0.9
Greece	2.5	3.4	1.0	3.4	1.9	2.4	5.3	3.3	0.7	1.2	0.8	0.9	1.7	2.4	2.3	2.3
Hungary	2.3	4.6	2.9	3.4	2.1	1.7	0.7	1.4	2.5	5.7	0.6	1.1	2.3	3.7	2.3	2.8
Ireland	1.5	2.4	1.0	2.4	0.9	0.7	1.3	0.8	0.7	0.2	0.2	0.2	1.0	0.6	0.4	0.4
Italy	2.2	2.7	3.9	2.7	1.2	1.6	1.0	1.6	0.7	3.0	0.4	0.6	1.2	2.4	0.4	1.4
Latvia	2.2	1.9	1.8	1.8	1.6	1.7	1.0	1.7	1.7	0.2	0.3	0.2	1.7	0.9	0.3	0.8
Lithuania	1.0	1.0	0.9	0.9	4.3	3.5	1.0	3.5	0.8	2.0	-0.6	-0.2	3.5	3.0	0.6	0.8
Luxembourg	1.0	1.0	1.0	1.0	5.2	7.0	5.5	5.7	3.1	0.0	1.0	0.0	5.0	4.0	5.5	5.0
Malta	1.0	1.0	1.0	1.0	1.0	4.4	1.0	4.4	2.1	-0.3	1.0	-0.3	2.1	2.9	1.0	2.9
Netherlands	1.0	1.2	3.0	1.5	0.8	0.6	0.9	0.6	2.7	1.9	0.5	0.7	1.3	1.0	1.5	1.1
Poland	1.1	1.7	1.6	1.6	0.6	0.3	0.6	0.4	0.8	1.0	0.9	1.0	1.0	1.4	1.5	1.5
Portugal	1.0	1.0	1.0	1.0	0.7	0.4	1.0	0.4	0.4	0.5	1.0	0.5	0.6	0.4	1.0	0.4
Romania	1.3	1.7	1.7	1.7	0.3	0.6	-0.3	0.6	0.6	-0.1	-0.3	-0.3	1.2	1.3	1.5	1.4
Slovakia	1.3	0.7	4.1	2.0	0.1	0.3	1.0	0.3	0.7	1.0	0.7	0.7	0.6	0.7	4.0	1.9
Slovenia	0.7	2.0	3.4	2.9	1.0	1.0	1.6	1.4	0.3	0.0	0.0	0.0	0.4	1.9	3.4	2.8
Spain	0.8	1.5	1.0	1.5	0.4	0.5	1.0	0.5	0.1	0.1	0.2	0.1	0.4	0.7	0.2	0.6
Sweden	0.9	0.2	3.4	3.4	0.8	1.0	1.0	1.0	0.6	1.5	0.0	0.2	0.7	1.4	2.3	2.3
UK	1.1	1.4	2.2	2.1	0.7	0.6	1.4	0.7	1.4	0.7	0.1	0.4	0.7	0.8	1.6	1.3

Capital recovery index - Cournot competition case - Retrofitting investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	2.7	3.7	3.6	1.0	0.5	0.6	0.6	1.0	0.5	0.5	0.5	1.0	1.8	3.6	3.3
Austria	1.0	1.1	0.3	0.3	1.0	1.0	1.0	1.0	1.0	0.0	1.2	0.2	1.0	0.0	0.4	0.2
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	5.3	6.6	5.6	1.0	5.3	6.6	5.6
Bulgaria	1.0	3.1	0.6	0.8	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.5	0.6	0.5
Croatia	1.0	6.7	1.0	6.7	1.0	1.0	1.0	1.0	1.0	-0.8	-0.7	-0.7	1.0	3.8	-0.7	0.3
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	1.5	4.6	3.9	1.0	1.0	1.0	1.0	1.0	22.7	0.2	17.4	1.0	1.7	4.6	4.0
Denmark	1.0	2.3	1.7	1.8	1.0	1.0	1.0	1.0	1.0	1.0	2.4	2.4	1.0	2.3	2.0	2.0
Estonia	1.0	0.6	0.6	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.6	0.6	0.6
Finland	1.0	2.5	0.9	1.0	1.0	0.3	0.4	0.4	1.0	-0.1	0.1	0.0	1.0	0.5	0.8	0.8
France	1.0	0.8	3.7	3.7	1.0	1.0	1.0	1.0	1.0	-0.4	-0.2	-0.3	1.0	-0.1	3.7	3.7
Germany	1.0	2.8	1.3	2.1	1.0	0.2	1.0	0.2	1.0	-0.8	-0.4	-0.7	1.0	1.3	1.1	1.2
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	1.0	1.0	0.9	0.9
Hungary	1.0	4.6	4.1	4.4	1.0	1.0	1.0	1.0	1.0	2.6	-1.6	0.9	1.0	4.6	4.1	4.4
Ireland	1.0	2.4	1.0	2.4	1.0	1.0	1.0	1.0	1.0	-0.4	1.0	-0.4	1.0	-0.3	1.0	-0.3
Italy	1.0	1.0	3.9	3.9	1.0	1.0	1.0	1.0	1.0	0.3	-1.6	0.1	1.0	0.3	-0.9	0.2
Latvia	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	1.0
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.6	-0.6	1.5	1.0	2.6	-0.6	1.5
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	3.1	3.1	1.0	0.8	0.6	0.7	1.0	1.8	0.1	0.8	1.0	1.0	2.3	2.0
Poland	1.0	1.2	0.1	0.7	1.0	0.6	0.4	0.5	1.0	4.2	1.0	4.2	1.0	1.4	0.1	0.8
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	26.6	1.0	26.6	1.0	26.6	1.0	26.6
Romania	1.0	2.8	1.5	1.6	1.0	1.0	1.0	1.0	1.0	-2.1	-1.6	-1.7	1.0	1.5	1.3	1.3
Slovakia	1.0	1.7	5.2	5.1	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	1.0	1.7	5.2	5.1
Slovenia	1.0	3.3	4.8	4.7	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	2.4	4.8	4.6
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	5.6	1.2	1.0	1.1	5.6	1.2
Sweden	1.0	1.0	4.1	4.1	1.0	1.0	1.0	1.0	1.0	-2.7	-0.8	-1.1	1.0	-2.7	4.1	4.0
UK	1.0	2.6	1.0	2.6	1.0	1.0	1.0	1.0	1.0	1.6	3.2	2.0	1.0	2.3	3.2	2.4

Capital recovery index - Cournot competition case -New plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	1.4	1.9	1.6	0.8	0.8	1.3	1.0	0.8	0.7	0.2	0.4	0.8	1.1	1.2	1.2
Austria	0.3	1.0	1.0	1.0	0.1	0.2	1.0	0.2	0.2	0.4	0.0	0.1	0.2	0.2	0.0	0.1
Belgium	2.0	1.0	1.0	1.0	1.7	1.3	3.1	2.5	0.9	0.7	0.5	0.6	1.5	0.9	1.8	1.4
Bulgaria	1.0	1.2	1.8	1.4	1.0	0.8	0.7	0.7	0.6	1.2	0.2	0.9	0.6	1.2	1.5	1.3
Croatia	1.0	1.0	1.0	1.0	2.6	2.9	3.6	3.0	1.0	0.9	0.8	0.8	2.6	2.0	1.1	1.7
Cyprus	1.0	1.0	1.0	1.0	1.0	3.6	3.8	3.6	2.2	0.8	0.4	0.7	2.2	2.8	1.5	2.6
Czech	1.5	1.6	2.7	2.3	0.3	0.6	2.0	0.7	1.5	1.2	0.7	1.1	1.4	1.5	2.7	2.1
Denmark	0.4	1.0	0.6	0.6	1.0	1.0	1.0	1.0	2.1	1.0	0.5	0.5	0.7	1.0	0.5	0.5
Estonia	0.6	1.3	1.0	1.3	1.0	0.3	0.4	0.3	-0.2	0.4	0.4	0.4	0.6	1.1	0.4	1.0
Finland	1.2	0.9	1.7	1.4	0.7	1.0	1.0	1.0	0.6	2.4	-0.2	0.9	0.9	1.0	1.7	1.4
France	0.1	0.2	1.0	0.2	0.5	0.5	1.0	0.5	0.1	-1.1	0.0	0.0	0.2	0.3	0.0	0.1
Germany	1.1	1.5	1.0	1.5	0.2	0.2	0.8	0.7	0.6	0.3	-0.1	0.2	0.7	1.1	0.6	0.9
Greece	2.5	3.4	1.0	3.4	1.9	2.4	5.3	3.3	0.7	1.2	0.8	0.9	1.7	2.4	2.3	2.4
Hungary	2.3	1.0	2.1	2.1	2.1	1.7	0.7	1.4	2.5	6.2	0.6	1.1	2.3	2.2	1.5	1.7
Ireland	1.5	1.0	1.0	1.0	0.9	0.7	1.3	0.8	0.7	0.4	0.2	0.2	1.0	0.6	0.4	0.5
Italy	2.2	2.7	1.0	2.7	1.2	1.6	1.0	1.6	0.7	6.3	0.4	0.7	1.2	2.6	0.4	1.4
Latvia	2.2	1.9	1.8	1.8	1.6	1.8	1.0	1.8	1.7	0.2	0.3	0.2	1.7	0.9	0.3	0.8
Lithuania	1.0	1.0	0.9	0.9	4.3	3.5	1.0	3.5	0.8	1.2	-0.6	-0.4	3.5	3.1	0.6	0.8
Luxembourg	1.0	1.0	1.0	1.0	5.2	7.0	5.5	5.7	3.1	1.0	1.0	1.0	5.0	7.0	5.5	5.7
Malta	1.0	1.0	1.0	1.0	1.0	4.4	1.0	4.4	2.1	-0.3	1.0	-0.3	2.1	2.9	1.0	2.9
Netherlands	1.0	1.2	2.4	1.3	0.8	0.6	1.3	0.6	2.7	1.9	0.5	0.6	1.3	1.0	0.8	1.0
Poland	1.1	1.7	1.6	1.6	0.6	0.3	0.6	0.4	0.8	1.0	0.9	1.0	1.0	1.4	1.5	1.5
Portugal	1.0	1.0	1.0	1.0	0.7	0.4	1.0	0.4	0.4	0.4	1.0	0.4	0.6	0.4	1.0	0.4
Romania	1.3	1.7	1.8	1.7	0.3	0.6	-0.3	0.6	0.6	1.2	0.2	0.3	1.2	1.3	1.6	1.4
Slovakia	1.3	0.7	2.8	1.2	0.1	0.3	1.0	0.3	0.7	1.0	0.7	0.7	0.6	0.7	2.6	1.1
Slovenia	0.7	1.9	2.2	2.0	1.0	1.0	1.6	1.4	0.3	0.8	1.0	0.8	0.4	1.9	2.2	2.0
Spain	0.8	1.5	1.0	1.5	0.4	0.5	1.0	0.5	0.1	0.1	0.2	0.1	0.4	0.7	0.2	0.6
Sweden	0.9	0.2	1.3	1.3	0.8	1.0	1.0	1.0	0.6	1.7	0.0	0.2	0.7	1.6	0.5	0.6
UK	1.1	0.6	2.2	2.0	0.7	0.6	1.4	0.7	1.4	0.6	0.1	0.4	0.7	0.6	1.6	1.3

Table 64: Capacity factor for the three bidding regimes, under low XB trade conditions

Capacity factor - Marginal cost bidding case - All projected investments									
	Base-load			CCGT			Open cycle plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.6	0.7	0.7	0.3	0.4	0.3	0.3	0.1	0.2
Austria	0.5	0.4	0.4	0.2	1.0	0.2	0.8	0.4	0.6
Belgium	1.0	1.0	1.0	0.3	0.8	0.7	0.2	0.2	0.2
Bulgaria	0.3	0.6	0.4	0.1	0.1	0.1	0.2	0.1	0.2
Croatia	0.9	1.0	0.9	0.7	0.9	0.7	0.2	0.2	0.2
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.4	0.8	0.6	0.1	0.1	0.1	0.4	0.2	0.3
Denmark	0.1	0.2	0.2	1.0	1.0	1.0	1.0	0.3	0.3
Estonia	0.6	0.1	0.5	0.1	0.1	0.1	0.2	0.3	0.2
Finland	0.6	0.7	0.7	0.1	0.1	0.1	0.1	0.4	0.2
France	0.2	0.7	0.7	0.1	1.0	0.1	0.8	0.1	0.1
Germany	0.6	0.5	0.6	0.1	0.3	0.3	0.2	0.1	0.1
Greece	0.6	1.0	0.6	0.3	0.5	0.3	0.1	0.1	0.1
Hungary	1.0	0.9	0.9	0.4	0.2	0.3	0.7	0.2	0.2
Ireland	0.6	1.0	0.6	0.3	0.3	0.3	0.3	0.1	0.1
Italy	0.8	0.8	0.8	0.6	1.0	0.6	0.3	0.2	0.2
Latvia	0.5	0.6	0.6	0.3	1.0	0.3	0.2	0.6	0.4
Lithuania	1.0	0.6	0.6	0.3	1.0	0.3	0.4	0.2	0.3
Luxembourg	1.0	1.0	1.0	1.2	1.4	1.3	0.6	1.0	0.6
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.5	0.6	0.5	0.3	0.3	0.3	0.4	0.3	0.4
Poland	0.6	0.8	0.7	0.1	0.1	0.1	0.2	0.1	0.2
Portugal	1.0	1.0	1.0	0.2	1.0	0.2	0.2	1.0	0.2
Romania	0.7	0.6	0.6	0.1	0.1	0.1	0.1	0.4	0.4
Slovakia	0.5	0.8	0.7	0.1	1.0	0.1	1.0	0.4	0.4
Slovenia	0.5	0.8	0.7	0.4	0.2	0.3	0.3	0.4	0.3
Spain	0.6	1.0	0.6	0.5	1.0	0.5	0.1	0.4	0.2
Sweden	0.1	0.6	0.6	1.0	1.0	1.0	1.6	0.1	0.2
UK	0.7	0.8	0.8	0.4	0.3	0.3	0.4	0.2	0.3

Capacity factor - Supply function equilibrium case - All projected investments									
	Base-load			CCGT			Open cycle plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.6	0.7	0.7	0.2	0.4	0.3	0.3	0.2	0.2
Austria	0.6	0.4	0.4	0.2	1.0	0.2	0.8	0.4	0.6
Belgium	1.0	1.0	1.0	0.4	0.8	0.7	0.2	0.2	0.2
Bulgaria	0.3	0.6	0.4	0.1	0.1	0.1	0.2	0.1	0.2
Croatia	0.9	1.0	0.9	0.7	0.9	0.7	0.2	0.2	0.2
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.4	0.8	0.6	0.2	0.3	0.2	0.4	0.3	0.4
Denmark	0.4	0.4	0.4	1.0	1.0	1.0	1.0	0.3	0.3
Estonia	0.6	0.1	0.6	0.1	0.1	0.1	0.1	0.4	0.1
Finland	0.6	0.8	0.7	0.2	0.2	0.2	0.2	0.3	0.3
France	0.2	0.7	0.7	0.1	1.0	0.1	0.7	0.1	0.2
Germany	0.6	0.5	0.6	0.1	0.3	0.3	0.1	0.1	0.1
Greece	0.6	1.0	0.6	0.3	0.5	0.3	0.1	0.1	0.1
Hungary	1.0	0.9	0.9	0.4	0.2	0.3	0.7	0.2	0.2
Ireland	0.6	1.0	0.6	0.2	0.4	0.3	0.4	0.1	0.1
Italy	0.7	0.8	0.7	0.4	1.0	0.4	0.4	0.2	0.3
Latvia	0.7	0.8	0.7	0.2	1.0	0.2	0.3	0.5	0.4
Lithuania	1.0	0.7	0.7	0.3	1.0	0.3	0.4	0.3	0.3
Luxembourg	1.0	1.0	1.0	1.2	1.4	1.3	0.6	1.0	0.6
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.5	0.6	0.5	0.2	0.3	0.3	0.4	0.3	0.4
Poland	0.6	0.8	0.7	0.1	0.3	0.2	0.3	0.2	0.3
Portugal	1.0	1.0	1.0	0.2	1.0	0.2	0.2	1.0	0.2
Romania	0.5	0.6	0.5	0.1	0.3	0.1	0.2	0.2	0.2
Slovakia	0.5	0.8	0.7	0.1	1.0	0.1	1.0	0.3	0.3
Slovenia	0.6	0.9	0.7	0.3	0.2	0.2	0.4	0.5	0.4
Spain	0.6	1.0	0.6	0.3	1.0	0.3	0.2	0.5	0.3
Sweden	0.1	0.7	0.7	1.0	1.0	1.0	1.4	0.1	0.2
UK	0.7	0.8	0.8	0.2	0.4	0.2	0.4	0.2	0.3

Capacity factor - Cournot competition case - All projected investments

	Base-load			CCGT			Open cycle plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.6	0.7	0.7	0.2	0.4	0.3	0.3	0.2	0.2
Austria	0.6	0.4	0.4	0.2	1.0	0.2	0.9	0.4	0.6
Belgium	1.0	1.0	1.0	0.4	0.8	0.7	0.2	0.3	0.2
Bulgaria	0.3	0.6	0.4	0.1	0.1	0.1	0.2	0.1	0.2
Croatia	0.9	1.0	0.9	0.7	0.9	0.7	0.2	0.2	0.2
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.4	0.8	0.6	0.1	0.3	0.1	0.3	0.3	0.3
Denmark	0.4	0.4	0.4	1.0	1.0	1.0	1.0	0.3	0.3
Estonia	0.6	0.1	0.5	0.1	0.1	0.1	0.1	0.3	0.1
Finland	0.6	0.8	0.7	0.2	0.2	0.2	0.3	0.4	0.3
France	0.2	0.7	0.7	0.1	1.0	0.1	0.7	0.1	0.2
Germany	0.7	0.6	0.6	0.1	0.3	0.3	0.2	0.1	0.2
Greece	0.6	1.0	0.6	0.3	0.5	0.3	0.1	0.1	0.1
Hungary	1.0	0.9	0.9	0.3	0.2	0.3	0.8	0.2	0.2
Ireland	0.6	1.0	0.6	0.2	0.3	0.2	0.4	0.1	0.1
Italy	0.7	0.8	0.7	0.5	1.0	0.5	0.4	0.2	0.3
Latvia	0.6	0.6	0.6	0.3	1.0	0.3	0.3	0.5	0.4
Lithuania	1.0	0.6	0.6	0.3	1.0	0.3	0.4	0.3	0.3
Luxembourg	1.0	1.0	1.0	1.2	1.4	1.3	0.6	1.0	0.6
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.5	0.6	0.5	0.3	0.3	0.3	0.5	0.3	0.4
Poland	0.7	0.8	0.7	0.1	0.2	0.1	0.3	0.2	0.2
Portugal	1.0	1.0	1.0	0.2	1.0	0.2	0.2	1.0	0.2
Romania	0.5	0.6	0.5	0.1	0.3	0.1	0.2	0.2	0.2
Slovakia	0.5	0.8	0.7	0.1	1.0	0.1	1.0	0.3	0.3
Slovenia	0.6	0.9	0.8	0.3	0.3	0.3	0.4	0.5	0.4
Spain	0.6	1.0	0.6	0.3	1.0	0.3	0.2	0.4	0.3
Sweden	0.1	0.7	0.7	1.0	1.0	1.0	1.4	0.1	0.2
UK	0.7	0.8	0.8	0.2	0.4	0.3	0.4	0.2	0.3

Table 65: % change in capital revenues under low XB trade conditions relative to Reference scenario, for the three bidding regimes

% change of capital revenues relative to Reference - Marginal cost bidding case - All projected investments												
	Base-load			CCGT			Open cycle plants			All plants		
Commis-sioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	29	-6	2	120	143	132	61	47	57	37	-2	8
Austria	-16	-100	-98	1145	0	1145	-61	-100	-92	91	-100	-72
Belgium	0	0	0	68	158	143	10	57	20	18	133	74
Bulgaria	105	48	74	0	728	1264	1577	0	1754	131	58	92
Croatia	12	0	12	1865	0	2221	0	0	0	825	0	981
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0
Czech	-18	14	7	37	0	77	155	1219	184	-15	14	8
Denmark	119	-95	-95	0	-100	-100	0	0	0	119	-98	-98
Estonia	-1	-12	-1	-28	68	-17	113	2069	126	-1	5	-1
Finland	-2	-12	-10	0	0	0	38	0	38	-1	-12	-9
France	-33	-16	-17	-39	0	-39	0	0	0	-36	-16	-17
Germany	39	25	39	0	134	142	0	0	0	43	109	52
Greece	86	0	86	431	348	381	583	5459	1333	190	490	268
Hungary	16	55	36	163	4	110	36	119	47	24	54	39
Ireland	39	0	39	0	8344	18684	0	0	0	18632	9846	12986
Italy	10	16	10	260	0	260	1	72	9	17	70	18
Latvia	-62	-28	-40	0	0	0	-100	-100	-100	52	-96	-41
Lithuania	0	-54	-54	291	0	291	0	0	0	291	-54	-49
Luxembourg	0	0	0	292	201	219	0	0	0	292	201	219
Malta	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	8	1	5	74	77	75	9	-48	-27	14	-3	8
Poland	144	-16	4	150	-48	-10	57	-6	32	122	-16	5
Portugal	0	0	0	1176	0	1176	1	-100	-45	103	-100	15
Romania	116	54	74	448	336	444	801	46693	14768	151	64	95
Slovakia	-26	-3	-8	26	0	26	0	218	218	-25	-3	-8
Slovenia	-44	-22	-28	-81	-66	-70	0	0	0	-45	-23	-28
Spain	2	0	2	132	0	132	-56	-75	-71	10	-75	5
Sweden	-29	15	15	0	0	0	0	0	0	5205	15	18
UK	2	22	20	68	26254	116	325	0	325	43	24	26

% change of capital revenues relative to Reference - Supply function equilibrium case - All projected investments												
	Base-load			CCGT			Open cycle plants			All plants		
Commis-sioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	19	-7	-1	81	63	71	82	124	93	29	-3	6
Austria	-1	-84	-82	431	0	431	-76	-82	-80	39	-83	-61
Belgium	0	0	0	23	132	107	6	19	9	10	105	58
Bulgaria	15	-13	1	59	-11	13	236	0	254	24	-12	6
Croatia	8	0	8	486	-4	230	0	0	0	389	16	222
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0
Czech	4	36	29	132	0	176	168	0	176	10	37	30
Denmark	552	-90	-89	0	-100	-100	0	0	0	552	-82	-82
Estonia	-5	41	-5	5	422	34	172	0	186	-4	84	-2
Finland	-7	-12	-11	0	0	0	0	0	0	-7	-12	-11
France	-36	-15	-15	-5	0	-5	0	0	0	-23	-15	-15
Germany	24	3	23	60	28	29	121	0	121	26	24	25
Greece	66	0	66	299	230	256	2378	13145	4689	163	331	215
Hungary	9	29	20	63	-9	44	25	0	56	14	30	22
Ireland	47	0	47	162	0	422	0	0	0	161	0	489
Italy	28	47	28	367	0	367	37	3329	171	43	2897	62
Latvia	-54	-17	-30	263	0	263	-100	-100	-100	-9	-94	-39
Lithuania	0	-48	-48	121	0	121	0	0	0	121	-48	-42
Luxembourg	0	0	0	308	217	235	0	0	0	308	217	235
Malta	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	-4	-12	-6	91	-1	70	11	-37	-21	8	-15	0
Poland	104	-9	10	169	-30	9	69	32	55	97	-8	13
Portugal	0	0	0	125	0	125	738	-100	283	203	-100	163
Romania	-9	-84	-57	544	0	544	0	0	0	10	-84	-50
Slovakia	-15	-3	-6	-61	0	-61	0	-69	-69	-18	-4	-7
Slovenia	-15	-10	-12	-21	-11	-14	-100	0	-100	-16	-10	-12
Spain	1	0	1	5	0	5	9	34	20	2	34	3
Sweden	-50	-13	-13	0	0	0	710	0	710	576	-13	-11
UK	7	25	24	55	34238	111	328	1013	362	74	30	36

% change of capital revenues relative to reference - Cournot competition case - All projected investments												
	Base-load			CCGT			Open cycle plants			All plants		
Commis-sioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	10	-10	-4	36	39	37	81	178	108	19	-4	3
Austria	-5	-55	-52	270	0	270	-54	-78	-72	29	-72	-47
Belgium	0	0	0	33	99	84	35	103	53	35	100	71
Bulgaria	3	-19	-8	7	-28	-14	112	3070	129	8	-19	-5
Croatia	14	0	14	497	-24	205	0	0	0	516	85	297
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0
Czech	-5	21	14	47	0	87	158	0	179	0	22	16
Denmark	290	-87	-86	0	-100	-100	0	0	0	290	31	31
Estonia	-9	135	-8	-4	709	26	305	0	325	-5	248	-3
Finland	-12	-13	-13	0	-54	-39	26	-100	18	-10	-13	-13
France	-26	-15	-15	-32	0	-32	0	0	0	-30	-15	-16
Germany	11	-6	10	33	10	10	35	0	35	12	7	11
Greece	62	0	62	202	132	163	0	0	0	147	208	168
Hungary	17	27	23	110	55	96	40	6688	168	27	34	31
Ireland	28	0	28	27	17976	114	0	0	0	36	33248	196
Italy	23	31	23	105	0	105	33	876	173	34	847	56
Latvia	-42	-5	-17	29	0	29	-65	-74	-69	-9	-68	-21
Lithuania	0	-43	-43	135	0	135	1891	0	1891	191	-43	-27
Luxembourg	0	0	0	256	153	171	0	0	0	256	153	171
Malta	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	-20	-18	-20	-12	-25	-14	-1	-28	-19	-18	-20	-18
Poland	91	-13	4	268	-38	5	66	36	55	87	-12	8
Portugal	0	0	0	27	0	27	15	-100	-9	23	-100	14
Romania	15	-27	-11	491	-100	455	0	0	0	34	-27	-4
Slovakia	-17	-18	-18	-57	0	-57	0	-56	-56	-19	-19	-19
Slovenia	-16	-9	-10	-16	2	-3	-98	0	-98	-16	-8	-11
Spain	-5	0	-5	-26	0	-26	-3	-20	-12	-12	-20	-12
Sweden	-52	-22	-22	0	0	0	139	0	139	127	-22	-21
UK	5	24	23	8	13814	40	447	641	467	66	30	36

Table 66: Simulated average wholesale market marginal prices (SMP), under low XB trade conditions

Average SMP (EUR/MWh)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	44	74	86	80	89	87	97
Austria	52	79	90	80	94	80	94
Belgium	72	96	109	98	112	117	127
Bulgaria	49	84	81	95	84	107	98
Croatia	53	89	101	92	105	107	123
Cyprus	165	127	140	165	167	179	175
Czech	23	70	100	91	116	113	141
Denmark	49	83	100	92	104	109	121
Estonia	33	73	90	71	94	75	110
Finland	43	76	73	81	81	96	96
France	43	74	79	79	79	90	89
Germany	46	81	100	82	101	86	108
Greece	57	92	135	97	141	115	168
Hungary	54	85	86	87	87	101	101
Ireland	49	85	99	91	103	102	112
Italy	60	104	115	115	127	126	135
Latvia	67	81	103	89	109	111	130
Lithuania	62	102	66	106	66	149	84
Luxembourg	63	125	134	130	139	156	159
Malta	166	144	144	144	161	172	168
Netherlands	43	80	92	88	99	92	102
Poland	40	74	88	91	100	93	103
Portugal	47	86	107	97	115	106	121
Romania	57	111	175	98	57	115	121
Slovakia	27	39	72	50	90	65	107
Slovenia	30	91	94	97	112	111	123
Spain	43	82	96	89	104	91	106
Sweden	74	77	85	78	85	79	86
UK	45	85	98	93	105	95	111

Table 67: Average SMP mark-up indicators, under low XB trade conditions

Mark-up (% change over marginal cost bidding)	Supply function equilibrium		Cournot competition			Supply function equilibrium		Cournot competition	
	2020	2030	2020	2030		2020	2030	2020	2030
EU27	8.1	3.7	17.6	13.3					
Austria	1.0	3.5	1.0	4.2	Italy	10.5	10.2	21.7	17.6
Belgium	2.5	2.7	22.1	17.1	Latvia	9.7	6.5	36.8	26.7
Bulgaria	12.5	3.6	27.0	21.0	Lithuania	3.8	0.1	46.4	28.6
Croatia	2.9	4.0	19.9	21.3	Luxembourg	3.7	3.8	24.7	19.2
Cyprus	30.1	19.1	41.1	24.9	Malta	0.0	11.6	19.9	17.1
Czech	30.6	15.5	62.0	41.1	Netherlands	10.3	7.6	14.9	10.9
Denmark	10.0	3.9	30.7	21.4	Poland	22.9	13.5	25.7	17.0
Estonia	-3.2	4.3	2.1	22.8	Portugal	13.3	7.8	23.3	13.7
Finland	7.2	11.6	26.1	31.7	Romania	-11.3	-67.2	4.0	-30.8
France	7.4	0.8	21.6	13.5	Slovakia	27.4	25.2	66.0	49.0
Germany	1.3	1.7	5.3	8.3	Slovenia	6.3	18.8	21.7	30.8
Greece	5.3	4.0	25.2	24.0	Spain	8.5	8.7	12.0	10.0
Hungary	1.9	1.1	18.3	17.1	Sweden	1.1	-0.5	2.2	0.4
Ireland	6.6	3.9	19.4	13.2	UK	9.8	7.4	12.2	12.9

Table 68: Payment for electricity, under low XB trade conditions

	Payment for electricity in bn€						
	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	142.1	254.2	319.8	273.5	332.6	296.4	361.1
Austria	2.5	3.4	4.3	3.5	4.5	3.5	4.5
Belgium	6.5	8.8	10.0	9.0	10.3	10.7	11.6
Bulgaria	1.4	3.0	2.9	3.3	3.1	3.7	3.6
Croatia	0.8	1.5	1.9	1.5	2.0	1.8	2.3
Cyprus	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Czech	1.4	5.0	8.2	6.5	9.4	8.1	11.5
Denmark	1.7	2.9	3.8	3.2	3.9	3.8	4.5
Estonia	0.3	0.8	1.1	0.8	1.2	0.8	1.4
Finland	3.5	6.3	6.1	6.7	6.9	7.9	8.2
France	20.5	34.8	42.3	37.2	42.7	42.1	48.3
Germany	26.3	44.4	56.1	45.0	57.0	46.8	60.3
Greece	2.9	5.5	8.3	5.8	8.6	6.9	10.1
Hungary	2.1	3.6	4.1	3.7	4.1	4.2	4.8
Ireland	1.3	2.2	3.0	2.4	3.1	2.7	3.3
Italy	17.7	32.3	41.0	35.6	45.0	39.1	47.8
Latvia	0.2	0.4	0.6	0.4	0.6	0.5	0.7
Lithuania	0.6	1.1	0.8	1.2	0.8	1.7	1.1
Luxembourg	0.4	0.8	0.9	0.8	0.9	1.0	1.1
Malta	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Netherlands	5.0	9.9	11.0	10.9	11.8	11.4	12.2
Poland	5.6	14.0	18.0	17.2	20.5	17.6	21.0
Portugal	2.3	4.3	6.4	4.9	6.8	5.3	7.2
Romania	2.2	5.7	8.4	5.2	3.0	6.1	6.2
Slovakia	0.6	1.1	2.3	1.3	2.9	1.7	3.5
Slovenia	0.3	1.2	1.2	1.2	1.5	1.4	1.7
Spain	10.8	22.9	31.2	24.8	33.7	25.6	34.1
Sweden	9.6	9.7	12.2	9.8	12.2	10.0	12.5
UK	16.1	30.1	35.4	32.8	37.9	33.5	39.7

Cost impacts of capacity remuneration mechanisms

Table 69: Capital recovery index in the marginal cost bidding case, with the introduction of capacity payment mechanisms, in Reference scenario

Capital recovery index - Marginal cost bidding case - All projected investments - Capacity payment only to peak devices																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.6	1.0	2.4	1.8	0.1	0.2	0.3	0.2	0.6	0.5	0.4	0.4	0.3	0.7	1.7	1.2
Austria	0.3	1.0	1.3	1.2	0.0	0.0	1.0	0.0	0.5	0.3	0.4	0.4	0.1	0.1	0.5	0.3
Belgium	1.5	1.0	1.0	1.0	0.5	0.3	0.8	0.6	0.1	1.1	0.5	0.8	0.6	0.8	0.7	0.7
Bulgaria	1.0	0.5	0.8	0.6	1.0	-0.2	0.1	0.0	0.4	0.5	0.3	0.5	0.4	0.4	0.7	0.6
Croatia	1.0	4.7	1.0	4.7	0.1	0.2	-0.2	-0.1	1.0	1.0	-2.2	-2.2	0.1	0.4	-0.3	-0.1
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.2	0.9	2.3	1.7	0.0	0.1	1.0	0.1	1.0	0.6	0.1	0.5	1.1	0.8	2.3	1.6
Denmark	0.1	0.5	0.6	0.6	0.3	1.0	1.5	1.5	0.6	0.0	0.1	0.1	0.2	0.0	0.3	0.3
Estonia	0.6	0.9	0.5	0.9	1.0	0.1	0.1	0.1	0.3	0.4	0.2	0.4	0.6	0.8	0.3	0.8
Finland	0.4	0.7	1.4	1.2	0.1	1.0	-0.1	-0.1	0.9	3.8	0.0	1.7	0.4	0.7	1.4	1.2
France	0.1	0.3	4.0	3.4	0.4	0.4	1.0	0.4	-0.4	-0.3	0.0	0.0	0.1	0.3	3.5	2.7
Germany	0.6	1.0	0.6	1.0	0.0	0.0	0.2	0.2	1.3	0.4	0.5	0.4	0.4	0.7	0.3	0.6
Greece	0.9	1.3	1.0	1.3	0.1	0.2	0.8	0.4	0.8	0.6	0.5	0.6	0.5	0.6	0.7	0.6
Hungary	1.6	3.3	1.4	1.9	0.4	0.4	0.3	0.3	0.3	3.3	0.5	1.4	1.0	2.4	1.2	1.6
Ireland	0.6	1.2	1.0	1.2	0.1	-0.1	0.1	-0.1	0.4	-0.2	0.2	0.2	0.3	-0.1	0.2	0.1
Italy	1.3	1.8	2.2	1.8	0.0	0.2	1.0	0.2	0.6	2.5	0.4	0.6	0.2	1.4	0.4	0.9
Latvia	1.4	2.3	1.1	1.3	0.0	0.0	1.0	0.0	0.8	0.2	0.8	0.4	0.2	0.1	0.8	0.3
Lithuania	1.0	1.0	1.3	1.3	0.4	0.3	1.0	0.3	0.7	-0.4	-0.1	-0.2	0.5	0.0	1.1	1.0
Luxembourg	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.5	0.0	1.0	0.0	0.1	0.6	1.0	0.9
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	0.8	2.5	1.1	0.2	0.1	0.2	0.1	2.0	1.3	0.4	0.6	0.7	0.6	1.2	0.7
Poland	0.4	0.9	1.4	1.3	0.1	0.1	0.4	0.3	0.5	0.7	3.2	0.9	0.3	0.7	1.4	1.2
Portugal	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.6	0.4	1.0	0.5	0.2	0.2	1.0	0.2
Romania	0.9	1.1	2.0	1.6	-0.6	0.2	0.2	0.2	0.7	0.3	0.2	0.2	0.8	0.8	1.7	1.2
Slovakia	0.7	0.6	2.9	1.5	0.0	0.1	1.0	0.1	0.5	1.0	0.0	0.0	0.3	0.5	2.8	1.4
Slovenia	0.6	2.0	3.2	2.8	1.0	1.4	2.0	1.8	0.7	-0.1	0.0	-0.1	0.7	1.9	3.2	2.7
Spain	0.6	1.2	1.0	1.2	0.0	0.1	1.0	0.1	0.6	0.3	0.4	0.3	0.1	0.5	0.4	0.5
Sweden	0.5	0.3	2.9	2.9	0.5	1.0	1.0	1.0	0.2	-0.2	-0.6	-0.3	0.3	-0.2	2.8	2.6
UK	0.5	1.0	2.0	1.8	0.1	0.2	0.1	0.2	0.9	0.4	0.1	0.3	0.2	0.4	1.6	1.0

Capital recovery index - Marginal cost bidding case - All projected investments - Capacity payment only to peak devices and CCGT																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.6	1.0	2.4	1.8	0.7	0.7	1.0	0.8	0.6	0.5	0.4	0.4	0.7	0.8	1.8	1.3
Austria	0.3	1.0	1.3	1.2	0.6	0.6	1.0	0.6	0.5	0.3	0.4	0.4	0.6	0.5	0.5	0.5
Belgium	1.5	1.0	1.0	1.0	0.9	0.7	1.3	1.1	0.1	1.1	0.5	0.8	0.8	1.0	0.9	0.9
Bulgaria	1.0	0.5	0.8	0.6	1.0	0.6	0.7	0.7	0.4	0.5	0.3	0.5	0.4	0.5	0.8	0.6
Croatia	1.0	4.7	1.0	4.7	0.1	0.3	0.2	0.2	1.0	1.0	-2.2	-2.2	0.1	0.5	0.1	0.2
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.2	0.9	2.3	1.7	0.8	0.7	1.0	0.7	1.0	0.6	0.1	0.5	1.1	0.8	2.3	1.6
Denmark	0.1	0.5	0.6	0.6	0.8	1.0	1.9	1.9	0.6	0.0	0.1	0.1	0.3	0.0	0.4	0.4
Estonia	0.6	0.9	0.5	0.9	1.0	0.5	0.5	0.5	0.3	0.4	0.2	0.4	0.6	0.8	0.4	0.8
Finland	0.4	0.7	1.4	1.2	0.6	1.0	-0.1	-0.1	0.9	3.8	0.0	1.7	0.6	0.7	1.4	1.2
France	0.1	0.3	4.0	3.4	0.9	0.6	1.0	0.6	-0.4	-0.3	0.0	0.0	0.1	0.4	3.5	2.8
Germany	0.6	1.0	0.6	1.0	0.9	0.8	1.1	1.0	1.3	0.4	0.5	0.4	0.8	0.7	0.9	0.8
Greece	0.9	1.3	1.0	1.3	1.0	0.9	1.2	1.0	0.8	0.6	0.5	0.6	0.9	1.0	1.0	1.0
Hungary	1.6	3.3	1.4	1.9	0.6	0.5	0.5	0.5	0.3	3.3	0.5	1.4	1.0	2.4	1.3	1.7
Ireland	0.6	1.2	1.0	1.2	0.7	0.5	0.7	0.5	0.4	-0.2	0.2	0.2	0.6	0.4	0.3	0.3
Italy	1.3	1.8	2.2	1.8	0.7	0.8	1.0	0.8	0.6	2.5	0.4	0.6	0.7	1.6	0.4	1.0
Latvia	1.4	2.3	1.1	1.3	0.3	0.1	1.0	0.1	0.8	0.2	0.8	0.4	0.4	0.2	0.8	0.3
Lithuania	1.0	1.0	1.3	1.3	1.0	0.9	1.0	0.9	0.7	-0.4	-0.1	-0.2	1.0	0.4	1.1	1.0
Luxembourg	1.0	1.0	1.0	1.0	0.8	1.4	1.2	1.3	0.5	0.0	1.0	0.0	0.8	0.9	1.2	1.1
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	0.8	2.5	1.1	0.6	0.4	0.3	0.4	2.0	1.3	0.4	0.6	1.0	0.7	1.2	0.8
Poland	0.4	0.9	1.4	1.3	0.7	0.5	0.7	0.6	0.5	0.7	3.2	0.9	0.4	0.8	1.4	1.2
Portugal	1.0	1.0	1.0	1.0	0.6	0.5	1.0	0.5	0.6	0.4	1.0	0.5	0.6	0.5	1.0	0.5
Romania	0.9	1.1	2.0	1.6	0.1	0.8	0.5	0.7	0.7	0.3	0.2	0.2	0.8	1.0	1.7	1.3
Slovakia	0.7	0.6	2.9	1.5	0.3	0.2	1.0	0.2	0.5	1.0	0.0	0.0	0.5	0.5	2.8	1.4
Slovenia	0.6	2.0	3.2	2.8	1.0	1.5	2.0	1.9	0.7	-0.1	0.0	-0.1	0.7	1.9	3.2	2.7
Spain	0.6	1.2	1.0	1.2	0.7	0.7	1.0	0.7	0.6	0.3	0.4	0.3	0.7	0.7	0.4	0.7
Sweden	0.5	0.3	2.9	2.9	0.6	1.0	1.0	1.0	0.2	-0.2	-0.6	-0.3	0.3	-0.2	2.8	2.6
UK	0.5	1.0	2.0	1.8	0.7	0.7	0.1	0.7	0.9	0.4	0.1	0.3	0.8	0.6	1.6	1.1

Capital recovery index - Marginal cost bidding case - All projected investments - Capacity payment to all power plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.8	1.2	2.4	1.9	0.7	0.7	1.0	0.8	0.6	0.5	0.4	0.4	0.7	0.9	1.8	1.4
Austria	0.5	1.0	1.3	1.2	0.6	0.6	1.0	0.6	0.5	0.3	0.4	0.4	0.6	0.5	0.5	0.5
Belgium	1.5	1.0	1.0	1.0	0.9	0.7	1.3	1.1	0.1	1.1	0.5	0.8	0.8	1.0	0.9	0.9
Bulgaria	1.0	0.8	1.0	0.9	1.0	0.6	0.7	0.7	0.4	0.5	0.3	0.5	0.4	0.7	0.9	0.8
Croatia	1.0	4.7	1.0	4.7	0.1	0.3	0.2	0.2	1.0	1.0	-2.2	-2.2	0.1	0.5	0.1	0.2
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.2	1.0	2.3	1.8	0.8	0.7	1.0	0.7	1.0	0.6	0.1	0.5	1.2	1.0	2.3	1.7
Denmark	0.3	0.5	0.8	0.8	0.8	1.0	1.9	1.9	0.6	0.0	0.1	0.1	0.4	0.0	0.4	0.4
Estonia	0.8	1.1	0.5	1.1	1.0	0.5	0.5	0.5	0.3	0.4	0.2	0.4	0.8	0.9	0.4	0.9
Finland	0.6	0.8	1.5	1.2	0.6	1.0	-0.1	-0.1	0.9	3.8	0.0	1.7	0.7	0.8	1.5	1.2
France	0.2	0.3	4.0	3.4	0.9	0.6	1.0	0.6	-0.4	-0.3	0.0	0.0	0.2	0.4	3.5	2.8
Germany	1.0	1.3	0.6	1.3	0.9	0.8	1.1	1.0	1.3	0.4	0.5	0.4	1.0	0.9	0.9	0.9
Greece	1.2	1.5	1.0	1.5	1.0	0.9	1.2	1.0	0.8	0.6	0.5	0.6	1.0	1.0	1.0	1.0
Hungary	1.6	3.3	1.5	2.0	0.6	0.5	0.5	0.5	0.3	3.3	0.5	1.4	1.0	2.4	1.3	1.7
Ireland	0.9	1.2	1.0	1.2	0.7	0.5	0.7	0.5	0.4	-0.2	0.2	0.2	0.6	0.4	0.3	0.3
Italy	1.6	2.1	2.2	2.1	0.7	0.8	1.0	0.8	0.6	2.5	0.4	0.6	0.8	1.7	0.4	1.1
Latvia	1.5	2.3	1.1	1.3	0.3	0.1	1.0	0.1	0.8	0.2	0.8	0.4	0.4	0.2	0.8	0.3
Lithuania	1.0	1.0	1.4	1.4	1.0	0.9	1.0	0.9	0.7	-0.4	-0.1	-0.2	1.0	0.4	1.2	1.1
Luxembourg	1.0	1.0	1.0	1.0	0.8	1.4	1.2	1.3	0.5	0.0	1.0	0.0	0.8	0.9	1.2	1.1
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	0.9	2.5	1.2	0.6	0.4	0.3	0.4	2.0	1.3	0.4	0.6	1.0	0.7	1.2	0.8
Poland	0.6	1.1	1.4	1.4	0.7	0.5	0.7	0.6	0.5	0.7	3.2	0.9	0.6	0.8	1.4	1.2
Portugal	1.0	1.0	1.0	1.0	0.6	0.5	1.0	0.5	0.6	0.4	1.0	0.5	0.6	0.5	1.0	0.5
Romania	1.0	1.4	2.0	1.7	0.1	0.8	0.5	0.7	0.7	0.3	0.2	0.2	0.9	1.1	1.7	1.4
Slovakia	0.7	0.6	2.9	1.5	0.3	0.2	1.0	0.2	0.5	1.0	0.0	0.0	0.5	0.6	2.8	1.4
Slovenia	0.7	2.0	3.2	2.8	1.0	1.5	2.0	1.9	0.7	-0.1	0.0	-0.1	0.7	1.9	3.2	2.7
Spain	0.8	1.4	1.0	1.4	0.7	0.7	1.0	0.7	0.6	0.3	0.4	0.3	0.7	0.8	0.4	0.8
Sweden	0.5	0.3	2.9	2.9	0.6	1.0	1.0	1.0	0.2	-0.2	-0.6	-0.3	0.3	-0.2	2.8	2.6
UK	0.8	1.1	2.1	1.9	0.7	0.7	0.1	0.7	0.9	0.4	0.1	0.3	0.8	0.6	1.6	1.2

Table 70: Capital recovery index in the supply function equilibrium case, with the introduction of capacity payment mechanisms, in Reference scenario

Capital recovery index - Supply function equilibrium case - All projected investments - Capacity payment only to peak devices																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.1	2.5	1.9	0.2	0.3	0.6	0.4	0.6	0.5	0.3	0.4	0.4	0.8	1.9	1.3
Austria	0.3	1.0	1.3	1.3	0.0	0.0	1.0	0.0	0.5	0.4	0.4	0.4	0.2	0.1	0.5	0.3
Belgium	1.5	1.0	1.0	1.0	0.7	0.5	1.0	0.8	0.2	0.9	0.4	0.6	0.7	0.7	0.6	0.7
Bulgaria	1.0	1.0	1.5	1.2	1.0	0.5	0.6	0.6	0.3	0.4	0.0	0.4	0.3	0.9	1.3	1.0
Croatia	1.0	5.1	1.0	5.1	0.6	0.8	0.5	0.6	1.0	1.0	-3.7	-3.7	0.6	1.0	0.3	0.5
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.5	1.1	2.3	1.8	0.1	0.2	1.0	0.2	1.0	0.7	-0.5	0.6	1.4	1.0	2.3	1.7
Denmark	0.2	0.6	0.7	0.7	0.3	1.0	1.8	1.8	0.5	-2.8	-0.1	-0.1	0.2	-2.6	0.2	0.2
Estonia	0.7	1.0	0.3	1.0	1.0	0.1	0.1	0.1	0.4	0.5	0.1	0.5	0.7	0.9	0.2	0.8
Finland	0.6	0.9	1.6	1.3	0.1	1.0	0.0	0.0	1.0	4.8	0.0	2.2	0.5	0.9	1.6	1.3
France	0.1	0.3	4.1	3.5	0.3	0.3	1.0	0.3	0.0	-0.9	-0.1	-0.2	0.1	0.3	3.6	2.8
Germany	0.8	1.1	0.9	1.1	0.1	0.1	0.5	0.4	1.2	0.4	0.3	0.4	0.5	0.8	0.5	0.7
Greece	1.1	1.5	1.0	1.5	0.2	0.3	1.3	0.6	0.8	0.6	0.7	0.6	0.6	0.7	1.1	0.8
Hungary	1.7	3.5	1.7	2.2	0.8	0.7	0.3	0.5	0.9	3.7	0.3	1.3	1.3	2.7	1.5	1.9
Ireland	0.9	1.2	1.0	1.2	0.3	0.1	0.0	0.1	0.3	-0.2	0.2	0.1	0.4	0.1	0.2	0.1
Italy	1.4	1.8	2.2	1.8	0.1	0.2	1.0	0.2	0.6	2.1	0.4	0.5	0.3	1.4	0.4	0.9
Latvia	1.8	2.5	1.2	1.5	0.3	0.2	1.0	0.2	0.7	0.4	0.7	0.5	0.5	0.3	0.7	0.4
Lithuania	1.0	1.0	1.2	1.2	0.6	0.6	1.0	0.6	0.6	-0.3	-0.3	-0.3	0.6	0.3	1.0	0.9
Luxembourg	1.0	1.0	1.0	1.0	0.0	1.0	1.1	1.1	0.5	0.0	1.0	0.0	0.1	0.6	1.1	0.9
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.1	3.1	1.4	0.3	0.2	0.7	0.3	2.3	1.7	0.6	0.8	0.8	0.8	1.6	1.0
Poland	0.8	1.4	1.5	1.5	0.1	0.1	0.6	0.4	0.5	0.8	3.8	1.0	0.7	1.0	1.5	1.4
Portugal	1.0	1.0	1.0	1.0	0.1	0.1	1.0	0.1	0.6	0.3	0.4	0.3	0.3	0.2	0.4	0.2
Romania	0.8	1.0	1.5	1.3	0.1	0.1	-0.3	0.0	0.7	-0.4	-0.2	-0.3	0.8	0.6	1.2	0.9
Slovakia	0.8	0.6	3.6	1.8	0.2	0.5	1.0	0.5	0.9	1.0	1.3	1.3	0.5	0.6	3.5	1.7
Slovenia	0.6	1.9	3.4	2.9	1.0	0.8	1.0	0.9	0.6	0.5	0.0	0.5	0.6	1.8	3.3	2.8
Spain	0.8	1.4	1.0	1.4	0.3	0.4	1.0	0.4	0.4	0.3	0.3	0.3	0.4	0.7	0.3	0.6
Sweden	0.7	0.4	3.9	3.9	0.7	1.0	1.0	1.0	0.2	0.2	-1.2	-0.2	0.4	0.2	3.8	3.5
UK	0.7	1.2	2.1	1.9	0.3	0.3	0.1	0.3	0.9	0.3	0.1	0.3	0.3	0.4	1.6	1.1

Capital recovery index - Supply function equilibrium case - All projected investments - Capacity payment only to peak devices and CCGT

	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.1	2.5	1.9	0.8	0.8	1.2	0.9	0.6	0.5	0.3	0.4	0.7	0.9	1.9	1.4
Austria	0.3	1.0	1.3	1.3	0.6	0.6	1.0	0.6	0.5	0.4	0.4	0.4	0.5	0.5	0.5	0.5
Belgium	1.5	1.0	1.0	1.0	0.9	0.6	1.1	0.9	0.2	0.9	0.4	0.6	0.8	0.8	0.7	0.7
Bulgaria	1.0	1.0	1.5	1.2	1.0	0.9	0.9	0.9	0.3	0.4	0.0	0.4	0.3	0.9	1.3	1.1
Croatia	1.0	5.1	1.0	5.1	0.7	0.9	0.9	0.9	1.0	1.0	-3.7	-3.7	0.7	1.1	0.7	0.9
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.5	1.1	2.3	1.8	0.6	0.7	1.0	0.7	1.0	0.7	-0.5	0.6	1.4	1.0	2.3	1.7
Denmark	0.2	0.6	0.7	0.7	0.7	1.0	2.0	2.0	0.5	-2.8	-0.1	-0.1	0.3	-2.6	0.2	0.2
Estonia	0.7	1.0	0.3	1.0	1.0	0.6	0.6	0.6	0.4	0.5	0.1	0.5	0.7	0.9	0.4	0.9
Finland	0.6	0.9	1.6	1.3	0.7	1.0	0.0	0.0	1.0	4.8	0.0	2.2	0.7	0.9	1.6	1.3
France	0.1	0.3	4.1	3.5	1.1	0.8	1.0	0.8	0.0	-0.9	-0.1	-0.2	0.2	0.5	3.6	2.8
Germany	0.8	1.1	0.9	1.1	0.8	0.7	1.2	1.2	1.2	0.4	0.3	0.4	0.8	0.8	1.0	0.9
Greece	1.1	1.5	1.0	1.5	1.2	1.2	1.9	1.4	0.8	0.6	0.7	0.6	1.0	1.2	1.4	1.2
Hungary	1.7	3.5	1.7	2.2	1.0	0.8	0.7	0.8	0.9	3.7	0.3	1.3	1.3	2.7	1.5	1.9
Ireland	0.9	1.2	1.0	1.2	0.6	0.6	0.5	0.6	0.3	-0.2	0.2	0.1	0.6	0.5	0.2	0.3
Italy	1.4	1.8	2.2	1.8	0.8	0.8	1.0	0.8	0.6	2.1	0.4	0.5	0.8	1.6	0.4	1.0
Latvia	1.8	2.5	1.2	1.5	0.4	0.2	1.0	0.2	0.7	0.4	0.7	0.5	0.5	0.3	0.7	0.4
Lithuania	1.0	1.0	1.2	1.2	1.1	1.0	1.0	1.0	0.6	-0.3	-0.3	-0.3	1.0	0.6	1.0	0.9
Luxembourg	1.0	1.0	1.0	1.0	0.7	1.4	1.3	1.3	0.5	0.0	1.0	0.0	0.7	0.9	1.3	1.2
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.1	3.1	1.4	0.8	0.7	0.8	0.7	2.3	1.7	0.6	0.8	1.2	1.0	1.6	1.1
Poland	0.8	1.4	1.5	1.5	0.6	0.6	0.8	0.7	0.5	0.8	3.8	1.0	0.8	1.1	1.5	1.4
Portugal	1.0	1.0	1.0	1.0	0.7	0.6	1.0	0.6	0.6	0.3	0.4	0.3	0.7	0.4	0.4	0.4
Romania	0.8	1.0	1.5	1.3	0.9	0.7	0.2	0.7	0.7	-0.4	-0.2	-0.3	0.8	0.9	1.2	1.0
Slovakia	0.8	0.6	3.6	1.8	0.6	0.8	1.0	0.8	0.9	1.0	1.3	1.3	0.7	0.6	3.5	1.7
Slovenia	0.6	1.9	3.4	2.9	1.0	0.9	1.0	1.0	0.6	0.5	0.0	0.5	0.6	1.8	3.3	2.8
Spain	0.8	1.4	1.0	1.4	0.9	0.8	1.0	0.8	0.4	0.3	0.3	0.3	0.8	0.8	0.3	0.8
Sweden	0.7	0.4	3.9	3.9	0.7	1.0	1.0	1.0	0.2	0.2	-1.2	-0.2	0.4	0.2	3.8	3.5
UK	0.7	1.2	2.1	1.9	0.7	0.6	0.1	0.6	0.9	0.3	0.1	0.3	0.7	0.6	1.6	1.1

Capital recovery index - Supply function equilibrium case - All projected investments - Capacity payment to all power plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.9	1.3	2.6	2.0	0.8	0.8	1.2	0.9	0.6	0.5	0.3	0.4	0.8	1.0	1.9	1.5
Austria	0.5	1.0	1.3	1.3	0.6	0.6	1.0	0.6	0.5	0.4	0.4	0.4	0.6	0.5	0.5	0.5
Belgium	1.5	1.0	1.0	1.0	0.9	0.6	1.1	0.9	0.2	0.9	0.4	0.6	0.8	0.8	0.7	0.7
Bulgaria	1.0	1.1	1.6	1.3	1.0	0.9	0.9	0.9	0.3	0.4	0.0	0.4	0.3	1.0	1.4	1.2
Croatia	1.0	5.1	1.0	5.1	0.7	0.9	0.9	0.9	1.0	1.0	-3.7	-3.7	0.7	1.1	0.7	0.9
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.5	1.2	2.3	1.9	0.6	0.7	1.0	0.7	1.0	0.7	-0.5	0.6	1.4	1.1	2.3	1.8
Denmark	0.4	0.6	0.8	0.8	0.7	1.0	2.0	2.0	0.5	-2.8	-0.1	-0.1	0.5	-2.6	0.2	0.2
Estonia	1.0	1.2	0.3	1.2	1.0	0.6	0.6	0.6	0.4	0.5	0.1	0.5	1.0	1.1	0.4	1.0
Finland	0.8	1.0	1.7	1.4	0.7	1.0	0.0	0.0	1.0	4.8	0.0	2.2	0.8	1.0	1.6	1.4
France	0.3	0.4	4.1	3.5	1.1	0.8	1.0	0.8	0.0	-0.9	-0.1	-0.2	0.3	0.5	3.6	2.8
Germany	1.1	1.4	0.9	1.4	0.8	0.7	1.2	1.2	1.2	0.4	0.3	0.4	1.0	1.0	1.0	1.0
Greece	1.5	1.8	1.0	1.8	1.2	1.2	1.9	1.4	0.8	0.6	0.7	0.6	1.1	1.2	1.4	1.3
Hungary	1.7	3.5	1.8	2.3	1.0	0.8	0.7	0.8	0.9	3.7	0.3	1.3	1.3	2.7	1.6	2.0
Ireland	1.0	1.2	1.0	1.2	0.6	0.6	0.5	0.6	0.3	-0.2	0.2	0.1	0.6	0.5	0.2	0.3
Italy	1.6	2.1	2.2	2.1	0.8	0.8	1.0	0.8	0.6	2.1	0.4	0.5	0.8	1.8	0.4	1.1
Latvia	1.8	2.5	1.2	1.5	0.4	0.2	1.0	0.2	0.7	0.4	0.7	0.5	0.5	0.3	0.7	0.4
Lithuania	1.0	1.0	1.4	1.4	1.1	1.0	1.0	1.0	0.6	-0.3	-0.3	-0.3	1.0	0.6	1.1	1.1
Luxembourg	1.0	1.0	1.0	1.0	0.7	1.4	1.3	1.3	0.5	0.0	1.0	0.0	0.7	0.9	1.3	1.2
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.3	3.1	1.6	0.8	0.7	0.8	0.7	2.3	1.7	0.6	0.8	1.2	1.1	1.6	1.2
Poland	1.0	1.5	1.5	1.5	0.6	0.6	0.8	0.7	0.5	0.8	3.8	1.0	0.9	1.1	1.5	1.4
Portugal	1.0	1.0	1.0	1.0	0.7	0.6	1.0	0.6	0.6	0.3	0.4	0.3	0.7	0.4	0.4	0.4
Romania	1.0	1.3	1.5	1.4	0.9	0.7	0.2	0.7	0.7	-0.4	-0.2	-0.3	1.0	1.0	1.3	1.1
Slovakia	0.8	0.7	3.6	1.8	0.6	0.8	1.0	0.8	0.9	1.0	1.3	1.3	0.7	0.7	3.5	1.8
Slovenia	0.7	1.9	3.4	2.9	1.0	0.9	1.0	1.0	0.6	0.5	0.0	0.5	0.6	1.8	3.3	2.8
Spain	1.0	1.6	1.0	1.6	0.9	0.8	1.0	0.8	0.4	0.3	0.3	0.3	0.8	0.9	0.3	0.8
Sweden	0.7	0.4	3.9	3.9	0.7	1.0	1.0	1.0	0.2	0.2	-1.2	-0.2	0.4	0.2	3.8	3.5
UK	0.9	1.2	2.1	2.0	0.7	0.6	0.1	0.6	0.9	0.3	0.1	0.3	0.7	0.6	1.7	1.2

Table 71: Capital recovery index in the Cournot competition case, with the introduction of capacity payment mechanisms, in Reference scenario

Capital recovery index - Cournot competition case - All projected investments - Capacity payment only to peak devices																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.9	1.5	3.0	2.3	0.5	0.6	1.0	0.7	0.8	0.6	0.4	0.5	0.7	1.0	2.2	1.6
Austria	0.3	1.2	0.6	0.6	0.0	0.0	1.0	0.0	0.5	0.4	0.4	0.4	0.2	0.2	0.4	0.3
Belgium	1.9	1.0	1.0	1.0	1.5	1.0	2.0	1.6	0.7	1.2	0.5	0.9	1.3	1.1	1.2	1.2
Bulgaria	1.0	1.3	1.8	1.5	1.0	0.9	1.0	0.9	0.4	0.5	0.1	0.4	0.4	1.1	1.6	1.3
Croatia	1.0	5.9	1.0	5.9	1.0	1.3	1.0	1.1	1.0	1.0	-3.4	-3.4	1.0	1.5	0.7	1.0
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	2.1	1.7	3.1	2.6	0.2	0.4	1.0	0.4	1.3	1.0	-0.1	0.8	2.0	1.5	3.1	2.4
Denmark	0.3	1.6	1.0	1.0	0.5	1.0	2.8	2.8	0.8	-3.3	0.2	0.1	0.4	-3.0	0.5	0.5
Estonia	1.2	1.4	0.3	1.4	1.0	0.3	0.1	0.2	0.4	0.6	0.1	0.5	1.2	1.2	0.2	1.1
Finland	0.9	1.1	2.0	1.6	0.4	1.0	0.8	0.8	1.1	5.5	0.3	2.7	0.7	1.1	1.9	1.6
France	0.1	0.3	4.7	3.9	0.7	0.7	1.0	0.7	0.2	-0.7	0.0	-0.1	0.2	0.4	4.0	3.2
Germany	1.1	1.5	1.4	1.5	0.2	0.1	0.8	0.7	1.4	0.4	0.4	0.4	0.7	1.0	0.8	0.9
Greece	1.6	2.1	1.0	2.1	0.6	0.8	2.5	1.3	0.8	0.6	0.7	0.6	0.9	1.1	1.8	1.3
Hungary	2.0	4.0	2.1	2.6	1.3	0.9	0.4	0.7	1.0	4.5	0.5	1.8	1.6	3.1	1.8	2.2
Ireland	1.3	1.9	1.0	1.9	0.8	0.5	0.1	0.5	0.6	-0.1	0.2	0.1	0.9	0.4	0.2	0.3
Italy	1.7	2.2	3.0	2.2	0.5	0.8	1.0	0.8	0.7	2.5	0.4	0.6	0.6	1.8	0.4	1.1
Latvia	2.8	3.3	1.9	2.2	0.6	1.3	1.0	1.3	1.2	0.7	1.0	0.8	0.8	1.0	1.0	1.0
Lithuania	1.0	1.0	1.5	1.5	1.5	1.5	1.0	1.5	0.6	0.1	0.0	0.0	1.3	1.1	1.3	1.3
Luxembourg	1.0	1.0	1.0	1.0	0.4	1.9	2.2	2.1	0.6	0.0	1.0	0.0	0.4	1.1	2.2	1.9
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.5	3.6	1.8	0.8	0.7	1.2	0.7	2.9	2.2	0.7	0.9	1.3	1.2	1.9	1.4
Poland	0.9	1.6	1.6	1.6	0.1	0.1	0.7	0.4	0.5	0.9	4.1	1.1	0.8	1.1	1.6	1.5
Portugal	1.0	1.0	1.0	1.0	0.4	0.3	1.0	0.3	0.6	0.4	0.6	0.5	0.5	0.4	0.6	0.4
Romania	1.1	1.6	2.1	1.9	0.2	0.1	0.2	0.1	0.7	-0.3	-0.1	-0.1	1.0	1.0	1.8	1.4
Slovakia	1.1	0.9	5.0	2.5	0.3	0.7	1.0	0.7	1.1	1.0	1.5	1.5	0.6	0.8	4.9	2.4
Slovenia	0.8	2.3	3.7	3.2	1.0	1.2	1.6	1.5	0.7	0.7	0.0	0.6	0.7	2.3	3.6	3.1
Spain	0.9	1.6	1.0	1.6	0.5	0.6	1.0	0.6	0.6	0.3	0.4	0.3	0.6	0.8	0.4	0.8
Sweden	0.8	0.4	4.9	4.9	0.8	1.0	1.0	1.0	0.3	0.6	-0.6	0.3	0.4	0.6	4.7	4.5
UK	0.9	1.3	2.2	2.0	0.6	0.5	0.2	0.5	1.0	0.4	0.2	0.3	0.6	0.6	1.7	1.2

Capital recovery index - Cournot competition case - All projected investments - Capacity payment only to peak devices and CCGT																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.9	1.5	3.0	2.3	1.1	1.1	1.6	1.3	0.8	0.6	0.4	0.5	1.0	1.1	2.3	1.7
Austria	0.3	1.2	0.6	0.6	0.6	0.5	1.0	0.5	0.5	0.4	0.4	0.4	0.5	0.5	0.4	0.5
Belgium	1.9	1.0	1.0	1.0	1.7	1.2	2.2	1.8	0.7	1.2	0.5	0.9	1.4	1.2	1.3	1.3
Bulgaria	1.0	1.3	1.8	1.5	1.0	1.1	1.1	1.1	0.4	0.5	0.1	0.4	0.4	1.1	1.6	1.3
Croatia	1.0	5.9	1.0	5.9	1.0	1.4	1.4	1.4	1.0	1.0	-3.4	-3.4	1.0	1.6	1.2	1.3
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	2.1	1.7	3.1	2.6	0.9	0.8	1.0	0.8	1.3	1.0	-0.1	0.8	2.0	1.6	3.1	2.5
Denmark	0.3	1.6	1.0	1.0	1.0	1.0	3.3	3.3	0.8	-3.3	0.2	0.1	0.5	-3.0	0.6	0.6
Estonia	1.2	1.4	0.3	1.4	1.0	0.8	0.6	0.7	0.4	0.6	0.1	0.5	1.2	1.2	0.4	1.2
Finland	0.9	1.1	2.0	1.6	1.0	1.0	0.8	0.8	1.1	5.5	0.3	2.7	1.0	1.1	1.9	1.6
France	0.1	0.3	4.7	3.9	1.2	1.1	1.0	1.1	0.2	-0.7	0.0	-0.1	0.2	0.6	4.0	3.2
Germany	1.1	1.5	1.4	1.5	0.9	0.8	1.5	1.4	1.4	0.4	0.4	0.4	1.0	1.0	1.2	1.1
Greece	1.6	2.1	1.0	2.1	1.6	1.7	3.1	2.1	0.8	0.6	0.7	0.6	1.4	1.6	2.2	1.7
Hungary	2.0	4.0	2.1	2.6	1.5	1.2	1.0	1.1	1.0	4.5	0.5	1.8	1.7	3.2	1.9	2.3
Ireland	1.3	1.9	1.0	1.9	1.1	0.9	0.6	0.9	0.6	-0.1	0.2	0.1	1.0	0.7	0.2	0.5
Italy	1.7	2.2	3.0	2.2	1.1	1.4	1.0	1.4	0.7	2.5	0.4	0.6	1.1	2.0	0.4	1.2
Latvia	2.8	3.3	1.9	2.2	0.7	1.3	1.0	1.3	1.2	0.7	1.0	0.8	0.9	1.0	1.0	1.0
Lithuania	1.0	1.0	1.5	1.5	1.9	1.7	1.0	1.7	0.6	0.1	0.0	0.0	1.6	1.2	1.3	1.3
Luxembourg	1.0	1.0	1.0	1.0	0.9	2.4	2.5	2.4	0.6	0.0	1.0	0.0	0.8	1.4	2.5	2.1
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.5	3.6	1.8	1.2	1.1	1.3	1.1	2.9	2.2	0.7	0.9	1.7	1.4	1.9	1.5
Poland	0.9	1.6	1.6	1.6	0.7	0.6	0.9	0.8	0.5	0.9	4.1	1.1	0.9	1.2	1.6	1.5
Portugal	1.0	1.0	1.0	1.0	0.9	0.7	1.0	0.7	0.6	0.4	0.6	0.5	0.8	0.6	0.6	0.6
Romania	1.1	1.6	2.1	1.9	0.9	0.7	0.5	0.7	0.7	-0.3	-0.1	-0.1	1.0	1.2	1.8	1.5
Slovakia	1.1	0.9	5.0	2.5	0.5	0.9	1.0	0.9	1.1	1.0	1.5	1.5	0.8	0.9	4.9	2.4
Slovenia	0.8	2.3	3.7	3.2	1.0	1.4	1.6	1.5	0.7	0.7	0.0	0.6	0.7	2.3	3.6	3.1
Spain	0.9	1.6	1.0	1.6	1.1	1.1	1.0	1.1	0.6	0.3	0.4	0.3	1.0	1.0	0.4	0.9
Sweden	0.8	0.4	4.9	4.9	0.8	1.0	1.0	1.0	0.3	0.6	-0.6	0.3	0.4	0.6	4.7	4.5
UK	0.9	1.3	2.2	2.0	1.1	1.0	0.2	1.0	1.0	0.4	0.2	0.3	1.1	0.8	1.7	1.3

Capital recovery index - Cournot competition case - All projected investments - Capacity payment to all power plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.1	1.6	3.0	2.4	1.1	1.1	1.6	1.3	0.8	0.6	0.4	0.5	1.0	1.2	2.3	1.8
Austria	0.5	1.2	0.6	0.6	0.6	0.5	1.0	0.5	0.5	0.4	0.4	0.4	0.6	0.5	0.4	0.5
Belgium	1.9	1.0	1.0	1.0	1.7	1.2	2.2	1.8	0.7	1.2	0.5	0.9	1.4	1.2	1.3	1.3
Bulgaria	1.0	1.4	1.9	1.6	1.0	1.1	1.1	1.1	0.4	0.5	0.1	0.4	0.4	1.2	1.7	1.4
Croatia	1.0	5.9	1.0	5.9	1.0	1.4	1.4	1.4	1.0	1.0	-3.4	-3.4	1.0	1.6	1.2	1.3
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	2.1	1.8	3.2	2.6	0.9	0.8	1.0	0.8	1.3	1.0	-0.1	0.8	2.0	1.7	3.2	2.5
Denmark	0.6	1.6	1.2	1.2	1.0	1.0	3.3	3.3	0.8	-3.3	0.2	0.1	0.7	-3.0	0.6	0.6
Estonia	1.4	1.6	0.3	1.5	1.0	0.8	0.6	0.7	0.4	0.6	0.1	0.5	1.4	1.4	0.4	1.3
Finland	1.1	1.2	2.0	1.7	1.0	1.0	0.8	0.8	1.1	5.5	0.3	2.7	1.1	1.2	2.0	1.7
France	0.2	0.4	4.7	3.9	1.2	1.1	1.0	1.1	0.2	-0.7	0.0	-0.1	0.3	0.6	4.0	3.2
Germany	1.4	1.8	1.4	1.7	0.9	0.8	1.5	1.4	1.4	0.4	0.4	0.4	1.2	1.2	1.2	1.2
Greece	2.0	2.4	1.0	2.4	1.6	1.7	3.1	2.1	0.8	0.6	0.7	0.6	1.4	1.6	2.2	1.8
Hungary	2.0	4.0	2.2	2.7	1.5	1.2	1.0	1.1	1.0	4.5	0.5	1.8	1.7	3.2	2.0	2.4
Ireland	1.5	1.9	1.0	1.9	1.1	0.9	0.6	0.9	0.6	-0.1	0.2	0.1	1.1	0.7	0.2	0.5
Italy	2.0	2.5	3.0	2.5	1.1	1.4	1.0	1.4	0.7	2.5	0.4	0.6	1.1	2.2	0.4	1.3
Latvia	2.8	3.3	1.9	2.2	0.7	1.3	1.0	1.3	1.2	0.7	1.0	0.8	0.9	1.0	1.0	1.0
Lithuania	1.0	1.0	1.6	1.6	1.9	1.7	1.0	1.7	0.6	0.1	0.0	0.0	1.6	1.2	1.3	1.3
Luxembourg	1.0	1.0	1.0	1.0	0.9	2.4	2.5	2.4	0.6	0.0	1.0	0.0	0.8	1.4	2.5	2.1
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.7	3.6	2.0	1.2	1.1	1.3	1.1	2.9	2.2	0.7	0.9	1.7	1.4	1.9	1.5
Poland	1.1	1.7	1.7	1.7	0.7	0.6	0.9	0.8	0.5	0.9	4.1	1.1	1.1	1.3	1.7	1.6
Portugal	1.0	1.0	1.0	1.0	0.9	0.7	1.0	0.7	0.6	0.4	0.6	0.5	0.8	0.6	0.6	0.6
Romania	1.2	1.8	2.2	2.0	0.9	0.7	0.5	0.7	0.7	-0.3	-0.1	-0.1	1.2	1.3	1.8	1.6
Slovakia	1.1	0.9	5.0	2.5	0.5	0.9	1.0	0.9	1.1	1.0	1.5	1.5	0.8	0.9	4.9	2.4
Slovenia	0.9	2.3	3.7	3.2	1.0	1.4	1.6	1.5	0.7	0.7	0.0	0.6	0.7	2.3	3.6	3.1
Spain	1.1	1.7	1.0	1.7	1.1	1.1	1.0	1.1	0.6	0.3	0.4	0.3	1.1	1.1	0.4	1.0
Sweden	0.8	0.4	4.9	4.9	0.8	1.0	1.0	1.0	0.3	0.6	-0.6	0.3	0.4	0.6	4.7	4.5
UK	1.1	1.3	2.2	2.1	1.1	1.0	0.2	1.0	1.0	0.4	0.2	0.3	1.1	0.8	1.8	1.3

Table 72: Capacity remuneration fee per MW, for the three bidding regimes, in Reference scenario

Capacity remuneration fee (EUR/MW)	Marginal cost bidding		Supply function equilibrium		Cournot competition	
	2020	2030	2020	2030	2020	2030
EU27	51614	40613	45172	36380	46970	34484
Austria	69397	5297	68512	4607	66442	4547
Belgium	35143	53114	11524	0	9828	20998
Bulgaria	55148	49176	56019	0	37191	0
Croatia	0	0	0	0	0	0
Cyprus						
Czech	81994	0	67716	0	60926	0
Denmark	0	14833	0	22808	9351	38780
Estonia	20859	53503	34652	59724	38830	58314
Finland	68776	10528	68776	10619	68776	10619
France	0	0	70654	35583	55052	9732
Germany	66350	63664	57024	61017	54696	57958
Greece	63567	49757	74041	57500	74226	59912
Hungary	0	20362	0	0	0	25686
Ireland	47016	43232	42387	40515	36640	39625
Italy	68136	56414	67601	53278	67592	48931
Latvia	0	0	0	0	0	0
Lithuania	31036	34490	0	52498	0	0
Luxembourg	84610	18679	62717	18679	84610	18679
Malta						
Netherlands	22720	0	54811	10133	57693	4242
Poland	51422	35477	45077	18373	56069	21651
Portugal	47301	26114	49325	21181	38138	21154
Romania	76099	33746	74619	46758	77864	31717
Slovakia	0	0	28533	0	0	0
Slovenia	0	0	0	0	0	0
Spain	63781	36814	50948	27607	52687	26609
Sweden	22412	12661	0	0	0	0
UK	53689	42195	26889	28067	42487	32966

Table 73: Capacity payments, for the three bidding regimes, in Reference scenario

Payment for capacity to peak devices (M€)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	928	3045	3894	2749	3498	2818	3284
Austria	23	63	8	63	7	61	7
Belgium	0	127	313	42	0	35	124
Bulgaria	9	63	69	64	0	42	0
Croatia	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0
Czech	18	45	0	38	0	34	0
Denmark	7	0	37	0	57	4	97
Estonia	0	10	26	17	29	19	29
Finland	10	15	4	15	4	15	4
France	189	0	0	227	333	177	91
Germany	59	996	1296	856	1242	821	1180
Greece	76	116	138	136	159	136	166
Hungary	0	0	14	0	0	0	18
Ireland	27	29	37	26	35	23	34
Italy	177	379	924	376	873	376	801
Latvia	3	0	0	0	0	0	0
Lithuania	1	12	42	0	64	0	0
Luxembourg	2	5	1	3	1	5	1
Malta	0	0	0	0	0	0	0
Netherlands	29	40	0	96	36	101	15
Poland	6	251	192	220	100	274	117
Portugal	80	112	66	116	54	90	54
Romania	7	16	29	16	41	16	28
Slovakia	6	0	0	3	0	0	0
Slovenia	18	0	0	0	0	0	0
Spain	96	230	155	184	116	190	112
Sweden	5	31	20	0	0	0	0
UK	78	505	520	253	346	399	406

Payment for capacity to peak devices and CCGT (M€)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	3591	10397	10825	9129	9148	9582	8962
Austria	48	253	143	253	142	253	141
Belgium	71	291	379	152	0	107	182
Bulgaria	2	49	154	47	22	31	0
Croatia	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0
Czech	33	145	110	132	0	101	31
Denmark	48	58	14	44	11	52	39
Estonia	1	37	62	47	64	35	67
Finland	0	30	0	30	5	30	5
France	95	387	0	281	318	448	0
Germany	117	789	2356	397	2185	512	1916
Greece	77	465	350	470	395	493	443
Hungary	46	0	0	0	0	0	34
Ireland	64	185	118	115	90	63	71
Italy	968	2561	2845	2561	2731	2538	2585
Latvia	12	53	0	0	0	15	0
Lithuania	1	32	160	14	175	16	52
Luxembourg	34	35	10	21	10	17	12
Malta	0	0	0	0	0	0	0
Netherlands	115	546	140	612	189	579	75
Poland	36	149	493	243	359	243	428
Portugal	111	415	244	371	217	374	170
Romania	5	68	125	97	199	97	134
Slovakia	7	52	0	86	20	81	1
Slovenia	16	19	0	20	0	21	0
Spain	1070	2201	1545	1665	1202	2111	1342
Sweden	0	0	0	0	0	0	0
UK	616	1576	1578	1471	814	1365	1237

Payment for capacity to all power plants (M€)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	4442	12817	14164	11155	12030	11717	11457
Austria	50	258	146	258	144	258	143
Belgium	71	298	385	156	0	109	184
Bulgaria	2	117	317	113	44	74	0
Croatia	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0
Czech	189	447	524	409	0	313	146
Denmark	105	109	26	82	20	99	69
Estonia	28	59	166	76	173	56	181
Finland	5	148	0	148	43	148	43
France	296	522	0	379	581	604	0
Germany	318	1736	3507	873	3252	1127	2851
Greece	99	493	397	499	448	522	502
Hungary	46	0	0	0	0	0	65
Ireland	80	200	127	124	97	68	77
Italy	968	2874	3125	2874	3000	2849	2840
Latvia	12	53	0	0	0	15	0
Lithuania	1	32	331	14	364	16	109
Luxembourg	34	35	10	21	10	17	12
Malta	0	0	0	0	0	0	0
Netherlands	115	598	191	670	258	634	102
Poland	139	303	1028	495	749	495	893
Portugal	111	415	244	371	217	374	170
Romania	5	150	254	212	406	213	274
Slovakia	7	109	0	178	43	170	2
Slovenia	18	21	0	22	0	23	0
Spain	1126	2262	1647	1711	1282	2169	1431
Sweden	0	0	0	0	0	0	0
UK	618	1578	1740	1472	897	1366	1364

Table 74: Payment for capacity over total payment for electricity, in Reference scenario

Payment for capacity to peak devices over total payments for electricity	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	0.7	1.3	1.3	1.1	1.1	1.0	0.9
Austria	1.1	2.3	0.2	2.2	0.2	2.0	0.2
Belgium	0.0	1.5	3.3	0.5	0.0	0.4	1.1
Bulgaria	0.9	3.9	2.9	2.8	0.0	1.5	0.0
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.6	0.9	0.0	0.7	0.0	0.5	0.0
Denmark	0.5	0.0	1.1	0.0	1.6	0.1	2.5
Estonia	0.1	1.1	3.1	1.7	3.3	1.6	2.7
Finland	0.4	0.3	0.1	0.2	0.1	0.2	0.0
France	0.9	0.0	0.0	0.7	0.8	0.4	0.2
Germany	0.2	2.5	2.5	2.0	2.3	1.7	2.0
Greece	2.8	2.4	2.1	2.6	2.3	2.3	2.1
Hungary	0.0	0.0	0.4	0.0	0.0	0.0	0.5
Ireland	2.3	1.5	1.5	1.2	1.3	0.9	1.2
Italy	1.0	1.2	2.3	1.2	2.1	1.1	1.8
Latvia	2.3	0.0	0.0	0.0	0.0	0.0	0.0
Lithuania	0.2	1.4	3.3	0.0	5.2	0.0	0.0
Luxembourg	0.8	0.8	0.2	0.6	0.1	0.7	0.1
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.6	0.4	0.0	1.0	0.3	0.9	0.1
Poland	0.2	2.3	1.2	1.5	0.5	1.7	0.6
Portugal	3.8	2.8	1.1	2.8	0.9	1.8	0.8
Romania	0.8	0.5	0.5	0.5	0.9	0.5	0.5
Slovakia	1.3	0.0	0.0	0.2	0.0	0.0	0.0
Slovenia	5.9	0.0	0.0	0.0	0.0	0.0	0.0
Spain	0.9	1.0	0.5	0.7	0.4	0.7	0.3
Sweden	0.1	0.5	0.2	0.0	0.0	0.0	0.0
UK	0.5	1.7	1.5	0.8	0.9	1.2	1.1

Payment for capacity to peak devices and CCGT over total payments for electricity	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	2.7	4.4	3.6	3.6	2.8	3.4	2.5
Austria	2.2	8.8	3.0	8.5	2.9	7.9	2.9
Belgium	1.1	3.3	4.0	1.8	0.0	1.1	1.6
Bulgaria	0.2	3.1	6.3	2.1	0.6	1.1	0.0
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	1.1	2.9	1.3	2.4	0.0	1.5	0.3
Denmark	3.1	2.2	0.4	1.6	0.3	1.7	1.0
Estonia	0.2	3.9	7.0	4.7	6.9	2.9	6.1
Finland	0.0	0.6	0.0	0.5	0.1	0.4	0.1
France	0.5	1.2	0.0	0.9	0.8	1.1	0.0
Germany	0.5	2.0	4.4	0.9	3.9	1.1	3.2
Greece	2.9	9.0	5.3	8.4	5.6	7.9	5.3
Hungary	2.7	0.0	0.0	0.0	0.0	0.0	0.8
Ireland	5.3	8.6	4.6	5.2	3.2	2.5	2.5
Italy	5.4	7.9	6.8	7.7	6.4	7.0	5.7
Latvia	8.0	11.2	0.0	0.0	0.0	2.5	0.0
Lithuania	0.2	3.4	11.4	1.4	13.0	1.3	2.9
Luxembourg	9.9	5.7	1.5	3.5	1.4	2.6	1.6
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	2.3	5.5	1.4	5.8	1.6	4.7	0.6
Poland	0.9	1.4	2.9	1.6	1.8	1.5	2.0
Portugal	5.2	9.7	4.0	8.3	3.4	7.0	2.5
Romania	0.5	2.2	2.3	3.1	4.5	2.7	2.2
Slovakia	1.5	4.3	0.0	6.3	0.6	4.2	0.0
Slovenia	5.3	1.5	0.0	1.5	0.0	1.4	0.0
Spain	9.2	9.0	4.8	6.4	3.5	7.6	3.8
Sweden	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UK	3.9	5.2	4.3	4.6	2.2	4.1	3.1

Payment for capacity to all power plants over total payments for electricity	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	3.3	5.4	4.6	4.4	3.7	4.1	3.2
Austria	2.3	8.9	3.0	8.6	3.0	8.0	3.0
Belgium	1.1	3.4	4.0	1.8	0.0	1.1	1.7
Bulgaria	0.2	7.0	12.2	4.9	1.2	2.6	0.0
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	6.0	8.3	6.1	7.2	0.0	4.5	1.3
Denmark	6.6	4.0	0.7	3.0	0.6	3.1	1.8
Estonia	9.2	6.1	16.8	7.4	16.7	4.5	14.9
Finland	0.2	2.8	0.0	2.5	0.6	2.0	0.5
France	1.4	1.6	0.0	1.2	1.4	1.5	0.0
Germany	1.2	4.3	6.4	2.0	5.7	2.3	4.8
Greece	3.7	9.4	5.9	8.8	6.3	8.4	6.0
Hungary	2.7	0.0	0.0	0.0	0.0	0.0	1.6
Ireland	6.5	9.2	5.0	5.6	3.5	2.7	2.7
Italy	5.4	8.7	7.4	8.6	7.0	7.7	6.2
Latvia	8.0	11.2	0.0	0.0	0.0	2.5	0.0
Lithuania	0.2	3.4	21.1	1.4	23.7	1.3	5.8
Luxembourg	9.9	5.7	1.5	3.5	1.4	2.6	1.6
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	2.3	6.0	1.9	6.3	2.1	5.2	0.8
Poland	3.5	2.7	6.0	3.2	3.7	3.1	4.2
Portugal	5.2	9.7	4.0	8.3	3.4	7.0	2.5
Romania	0.5	4.8	4.5	6.6	8.7	5.6	4.5
Slovakia	1.5	8.6	0.0	12.2	1.3	8.4	0.1
Slovenia	5.8	1.6	0.0	1.7	0.0	1.6	0.0
Spain	9.6	9.2	5.1	6.6	3.7	7.8	4.0
Sweden	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UK	4.0	5.2	4.7	4.6	2.4	4.1	3.5

Table 75: Capital recovery index in the marginal cost bidding case, with the introduction of capacity payment mechanisms, under high RES conditions

Capital recovery index - Marginal cost bidding case - All projected investments - Capacity payment only to peak devices																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.5	0.8	2.1	1.5	0.1	0.1	0.2	0.2	0.6	0.5	0.4	0.5	0.3	0.6	1.5	1.0
Austria	0.2	0.8	0.9	0.9	0.0	0.0	1.0	0.0	0.5	0.4	0.2	0.3	0.1	0.1	0.3	0.2
Belgium	1.5	1.0	1.0	1.0	0.5	0.4	0.2	0.3	0.2	1.2	0.6	1.0	0.6	1.0	0.3	0.6
Bulgaria	1.0	0.3	1.0	0.6	1.0	-0.3	0.3	0.0	0.5	0.4	-0.3	0.3	0.5	0.3	0.9	0.5
Croatia	1.0	4.4	1.0	4.4	0.1	0.2	0.1	0.1	1.0	1.0	1.0	1.0	0.1	0.3	0.1	0.2
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.1	0.8	2.1	1.5	0.0	0.1	1.0	0.1	1.0	0.9	0.0	0.7	1.1	0.7	2.1	1.4
Denmark	0.1	1.0	0.0	0.0	0.2	1.0	1.2	1.2	0.6	1.0	0.1	0.1	0.2	1.0	0.1	0.1
Estonia	0.6	0.9	0.4	0.9	1.0	0.2	0.1	0.2	0.3	0.4	0.2	0.4	0.6	0.8	0.2	0.7
Finland	0.4	0.9	1.9	1.3	0.0	1.0	0.1	0.1	0.9	3.8	0.0	2.2	0.4	0.9	1.8	1.3
France	0.1	0.3	3.0	2.5	0.3	0.3	1.0	0.3	-0.3	0.2	0.3	0.3	0.1	0.3	2.7	2.1
Germany	0.5	0.8	0.2	0.8	0.0	0.0	0.2	0.2	1.3	0.3	0.6	0.4	0.4	0.6	0.3	0.5
Greece	0.8	0.8	1.0	0.8	0.1	0.2	0.5	0.2	0.7	0.6	0.5	0.6	0.5	0.4	0.5	0.4
Hungary	1.5	2.7	1.9	2.3	0.4	0.3	0.2	0.3	0.3	2.9	0.7	1.6	0.9	2.1	1.6	1.8
Ireland	0.5	1.0	1.0	1.0	0.1	-0.1	1.0	-0.1	0.4	-0.1	0.0	-0.1	0.2	-0.1	0.0	-0.1
Italy	1.2	1.7	1.8	1.7	0.0	0.1	1.0	0.1	0.6	2.6	0.4	0.6	0.2	1.3	0.4	0.9
Latvia	1.2	1.1	1.0	1.1	0.0	0.0	1.0	0.0	0.5	0.4	0.0	0.4	0.1	0.2	0.0	0.2
Lithuania	1.0	1.0	0.7	0.7	0.4	0.2	1.0	0.2	0.7	-0.7	-0.3	-0.5	0.5	-0.1	0.7	0.6
Luxembourg	1.0	1.0	1.0	1.0	0.0	0.3	-0.9	-0.2	0.5	0.0	1.0	0.0	0.1	0.2	-0.9	-0.1
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	0.6	2.0	0.8	0.2	0.1	0.2	0.1	2.2	1.1	0.1	0.4	0.7	0.4	1.2	0.5
Poland	0.3	0.7	1.2	1.1	0.0	0.1	0.3	0.2	0.7	0.6	3.2	0.8	0.3	0.6	1.2	1.0
Portugal	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.6	0.4	-0.2	0.4	0.2	0.2	-0.2	0.2
Romania	0.8	0.8	1.5	1.0	0.2	0.2	1.0	0.2	0.7	0.5	0.2	0.2	0.8	0.6	1.3	0.8
Slovakia	0.7	0.5	3.4	1.4	0.1	0.4	1.0	0.4	0.6	1.0	3.3	3.3	0.4	0.5	3.4	1.3
Slovenia	0.5	1.6	3.6	2.7	1.0	0.9	2.1	1.5	0.6	0.0	0.0	0.0	0.6	1.6	3.5	2.6
Spain	0.6	1.3	1.0	1.3	0.0	0.1	1.0	0.1	0.6	0.3	0.7	0.4	0.1	0.4	0.7	0.4
Sweden	0.5	0.2	3.1	2.8	0.5	1.0	1.0	1.0	0.2	0.0	0.3	0.0	0.3	0.1	3.0	2.6
UK	0.5	1.2	2.0	1.7	0.1	0.2	0.1	0.2	0.9	0.4	0.1	0.3	0.1	0.5	1.3	0.8

Capital recovery index - Marginal cost bidding case - All projected investments - Capacity payment only to peak devices and CCGT																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.5	0.8	2.1	1.5	0.7	0.7	0.9	0.8	0.6	0.5	0.4	0.5	0.6	0.7	1.6	1.1
Austria	0.2	0.8	0.9	0.9	0.6	0.6	1.0	0.6	0.5	0.4	0.2	0.3	0.6	0.5	0.3	0.4
Belgium	1.5	1.0	1.0	1.0	0.9	0.8	0.5	0.6	0.2	1.2	0.6	1.0	0.8	1.1	0.6	0.8
Bulgaria	1.0	0.3	1.0	0.6	1.0	0.3	0.8	0.6	0.5	0.4	-0.3	0.3	0.5	0.3	1.0	0.6
Croatia	1.0	4.4	1.0	4.4	0.1	0.2	0.3	0.3	1.0	1.0	1.0	1.0	0.1	0.4	0.3	0.4
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.1	0.8	2.1	1.5	0.8	0.7	1.0	0.7	1.0	0.9	0.0	0.7	1.1	0.8	2.1	1.5
Denmark	0.1	1.0	0.0	0.0	0.8	1.0	1.7	1.7	0.6	1.0	0.1	0.1	0.3	1.0	0.1	0.1
Estonia	0.6	0.9	0.4	0.9	1.0	0.5	0.4	0.5	0.3	0.4	0.2	0.4	0.6	0.8	0.4	0.8
Finland	0.4	0.9	1.9	1.3	0.6	1.0	0.1	0.1	0.9	3.8	0.0	2.2	0.6	0.9	1.8	1.3
France	0.1	0.3	3.0	2.5	1.0	0.7	1.0	0.7	-0.3	0.2	0.3	0.3	0.1	0.5	2.7	2.1
Germany	0.5	0.8	0.2	0.8	0.9	0.8	1.1	1.1	1.3	0.3	0.6	0.4	0.8	0.6	0.9	0.7
Greece	0.8	0.8	1.0	0.8	1.0	0.9	0.9	0.9	0.7	0.6	0.5	0.6	0.9	0.8	0.8	0.8
Hungary	1.5	2.7	1.9	2.3	0.6	0.5	0.5	0.5	0.3	2.9	0.7	1.6	1.0	2.1	1.6	1.9
Ireland	0.5	1.0	1.0	1.0	0.7	0.5	1.0	0.5	0.4	-0.1	0.0	-0.1	0.6	0.4	0.0	0.3
Italy	1.2	1.7	1.8	1.7	0.7	0.8	1.0	0.8	0.6	2.6	0.4	0.6	0.7	1.5	0.4	1.0
Latvia	1.2	1.1	1.0	1.1	0.5	0.3	1.0	0.3	0.5	0.4	0.0	0.4	0.5	0.4	0.0	0.4
Lithuania	1.0	1.0	0.7	0.7	1.1	1.0	1.0	1.0	0.7	-0.7	-0.3	-0.5	1.0	0.4	0.7	0.6
Luxembourg	1.0	1.0	1.0	1.0	0.8	0.8	-0.6	0.2	0.5	0.0	1.0	0.0	0.8	0.5	-0.6	0.1
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	0.6	2.0	0.8	0.7	0.5	0.3	0.5	2.2	1.1	0.1	0.4	1.1	0.6	1.2	0.7
Poland	0.3	0.7	1.2	1.1	0.7	0.6	0.6	0.6	0.7	0.6	3.2	0.8	0.3	0.7	1.2	1.0
Portugal	1.0	1.0	1.0	1.0	0.7	0.5	1.0	0.5	0.6	0.4	-0.2	0.4	0.7	0.5	-0.2	0.5
Romania	0.8	0.8	1.5	1.0	0.9	0.8	1.0	0.8	0.7	0.5	0.2	0.2	0.8	0.8	1.3	0.9
Slovakia	0.7	0.5	3.4	1.4	0.6	0.6	1.0	0.6	0.6	1.0	3.3	3.3	0.6	0.5	3.4	1.3
Slovenia	0.5	1.6	3.6	2.7	1.0	1.0	2.1	1.5	0.6	0.0	0.0	0.0	0.6	1.6	3.5	2.6
Spain	0.6	1.3	1.0	1.3	0.7	0.7	1.0	0.7	0.6	0.3	0.7	0.4	0.7	0.7	0.7	0.7
Sweden	0.5	0.2	3.1	2.8	0.5	1.0	1.0	1.0	0.2	0.0	0.3	0.0	0.3	0.1	3.0	2.6
UK	0.5	1.2	2.0	1.7	0.7	0.7	0.1	0.7	0.9	0.4	0.1	0.3	0.7	0.7	1.3	0.9

Capital recovery index - Marginal cost bidding case - All projected investments - Capacity payment to all power plants

	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.1	2.2	1.6	0.7	0.7	0.9	0.8	0.6	0.5	0.4	0.5	0.7	0.9	1.6	1.2
Austria	0.5	0.8	0.9	0.9	0.6	0.6	1.0	0.6	0.5	0.4	0.2	0.3	0.6	0.5	0.3	0.4
Belgium	1.5	1.0	1.0	1.0	0.9	0.8	0.5	0.6	0.2	1.2	0.6	1.0	0.8	1.1	0.6	0.8
Bulgaria	1.0	0.6	1.1	0.8	1.0	0.3	0.8	0.6	0.5	0.4	-0.3	0.3	0.5	0.5	1.0	0.7
Croatia	1.0	4.4	1.0	4.4	0.1	0.2	0.3	0.3	1.0	1.0	1.0	1.0	0.1	0.4	0.3	0.4
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.1	0.9	2.2	1.6	0.8	0.7	1.0	0.7	1.0	0.9	0.0	0.7	1.1	0.9	2.2	1.6
Denmark	0.4	1.0	0.0	0.0	0.8	1.0	1.7	1.7	0.6	1.0	0.1	0.1	0.5	1.0	0.1	0.1
Estonia	0.8	1.0	0.4	1.0	1.0	0.5	0.4	0.5	0.3	0.4	0.2	0.4	0.8	0.9	0.4	0.8
Finland	0.6	1.0	1.9	1.4	0.6	1.0	0.1	0.1	0.9	3.8	0.0	2.2	0.7	1.0	1.9	1.4
France	0.3	0.4	3.0	2.5	1.0	0.7	1.0	0.7	-0.3	0.2	0.3	0.3	0.3	0.5	2.7	2.1
Germany	0.9	1.2	0.2	1.1	0.9	0.8	1.1	1.1	1.3	0.3	0.6	0.4	1.0	0.9	0.9	0.9
Greece	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.7	0.6	0.5	0.6	0.9	0.8	0.8	0.8
Hungary	1.5	2.7	2.0	2.3	0.6	0.5	0.5	0.5	0.3	2.9	0.7	1.6	1.0	2.1	1.7	1.9
Ireland	0.7	1.0	1.0	1.0	0.7	0.5	1.0	0.5	0.4	-0.1	0.0	-0.1	0.6	0.4	0.0	0.3
Italy	1.5	2.0	1.8	2.0	0.7	0.8	1.0	0.8	0.6	2.6	0.4	0.6	0.8	1.7	0.4	1.1
Latvia	1.4	1.3	1.0	1.3	0.5	0.3	1.0	0.3	0.5	0.4	0.0	0.4	0.5	0.4	0.0	0.4
Lithuania	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	0.7	-0.7	-0.3	-0.5	1.0	0.4	0.9	0.8
Luxembourg	1.0	1.0	1.0	1.0	0.8	0.8	-0.6	0.2	0.5	0.0	1.0	0.0	0.8	0.5	-0.6	0.1
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	0.8	2.0	1.0	0.7	0.5	0.3	0.5	2.2	1.1	0.1	0.4	1.1	0.7	1.2	0.8
Poland	0.6	0.9	1.3	1.2	0.7	0.6	0.6	0.6	0.7	0.6	3.2	0.8	0.6	0.7	1.3	1.1
Portugal	1.0	1.0	1.0	1.0	0.7	0.5	1.0	0.5	0.6	0.4	-0.2	0.4	0.7	0.5	-0.2	0.5
Romania	0.9	1.1	1.5	1.2	0.9	0.8	1.0	0.8	0.7	0.5	0.2	0.2	0.9	1.0	1.3	1.0
Slovakia	0.7	0.6	3.4	1.4	0.6	0.6	1.0	0.6	0.6	1.0	3.3	3.3	0.6	0.6	3.4	1.4
Slovenia	0.6	1.6	3.6	2.7	1.0	1.0	2.1	1.5	0.6	0.0	0.0	0.0	0.6	1.6	3.5	2.6
Spain	0.8	1.5	1.0	1.5	0.7	0.7	1.0	0.7	0.6	0.3	0.7	0.4	0.7	0.7	0.7	0.7
Sweden	0.5	0.2	3.1	2.8	0.5	1.0	1.0	1.0	0.2	0.0	0.3	0.0	0.3	0.1	3.0	2.6
UK	0.8	1.3	2.1	1.8	0.7	0.7	0.1	0.7	0.9	0.4	0.1	0.3	0.7	0.7	1.4	0.9

Table 76: Capital recovery index in the supply function equilibrium case, with the introduction of capacity payment mechanisms, under high RES conditions

Capital recovery index - Supply function equilibrium case - All projected investments - Capacity payment only to peak devices																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.0	2.1	1.6	0.2	0.2	0.3	0.2	0.6	0.5	0.4	0.4	0.4	0.7	1.5	1.1
Austria	0.3	1.0	0.9	0.9	0.0	0.0	1.0	0.0	0.5	0.4	0.3	0.3	0.1	0.1	0.4	0.2
Belgium	1.5	1.0	1.0	1.0	0.6	0.6	0.0	0.1	0.3	0.9	0.3	0.7	0.7	0.8	0.1	0.4
Bulgaria	1.0	0.7	1.0	0.8	1.0	0.2	0.4	0.3	0.3	0.4	-0.2	0.4	0.3	0.6	0.9	0.7
Croatia	1.0	4.7	1.0	4.7	0.5	0.6	-0.3	0.1	1.0	1.0	1.0	1.0	0.5	0.7	-0.3	0.2
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.4	0.9	1.8	1.4	0.1	0.1	1.0	0.1	1.1	1.0	-0.4	0.8	1.4	0.8	1.8	1.3
Denmark	0.2	1.0	-0.1	-0.1	0.3	1.0	1.7	1.7	0.5	1.0	-0.1	-0.1	0.2	1.0	-0.1	-0.1
Estonia	0.7	0.9	0.3	0.9	1.0	0.1	0.0	0.1	0.4	0.6	0.0	0.5	0.7	0.7	0.1	0.7
Finland	0.5	1.0	2.0	1.4	0.1	1.0	0.1	0.1	1.0	4.6	0.1	2.7	0.4	1.0	1.9	1.4
France	0.1	0.3	2.9	2.4	0.3	0.2	1.0	0.2	0.1	-0.1	0.2	0.2	0.1	0.2	2.6	2.0
Germany	0.7	1.0	0.5	1.0	0.1	0.0	0.3	0.2	1.2	0.4	0.5	0.4	0.4	0.7	0.4	0.6
Greece	1.0	1.4	1.0	1.4	0.2	0.2	0.8	0.4	0.8	0.6	0.7	0.6	0.5	0.6	0.7	0.6
Hungary	1.6	3.1	2.1	2.5	0.7	0.5	0.1	0.4	0.8	3.1	0.3	1.5	1.2	2.4	1.7	2.0
Ireland	0.8	1.0	1.0	1.0	0.2	0.1	1.0	0.1	0.3	-0.4	0.0	-0.1	0.4	0.0	0.0	0.0
Italy	1.3	1.8	1.8	1.8	0.1	0.2	1.0	0.2	0.6	2.1	0.4	0.5	0.3	1.4	0.4	0.9
Latvia	1.6	1.1	1.0	1.1	0.3	0.1	1.0	0.1	0.6	0.3	0.0	0.3	0.4	0.3	0.0	0.3
Lithuania	1.0	1.0	0.8	0.8	0.6	0.4	1.0	0.4	0.6	-0.4	-0.8	-0.6	0.6	0.1	0.7	0.6
Luxembourg	1.0	1.0	1.0	1.0	-0.1	0.4	-0.9	-0.1	0.5	0.0	1.0	0.0	0.0	0.2	-0.9	-0.1
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	2.8	1.3	0.3	0.2	0.5	0.2	2.3	1.4	0.8	1.0	0.8	0.7	1.8	0.9
Poland	0.7	1.3	1.3	1.3	0.0	0.1	0.3	0.2	0.5	0.7	3.7	0.9	0.6	0.9	1.3	1.2
Portugal	1.0	1.0	1.0	1.0	0.1	0.1	1.0	0.1	0.6	0.3	0.2	0.3	0.3	0.2	0.2	0.2
Romania	0.7	0.5	0.4	0.5	0.2	0.0	1.0	0.0	0.7	-0.7	-0.1	-0.1	0.7	0.3	0.3	0.3
Slovakia	0.6	0.5	3.9	1.5	0.2	0.4	1.0	0.4	0.8	1.0	4.3	4.3	0.4	0.5	3.9	1.5
Slovenia	0.5	1.5	3.9	2.8	1.0	0.4	0.9	0.6	0.6	0.5	0.0	0.5	0.6	1.4	3.9	2.8
Spain	0.7	1.5	1.0	1.5	0.3	0.3	1.0	0.3	0.5	0.3	0.7	0.4	0.3	0.5	0.7	0.6
Sweden	0.7	0.3	3.3	3.1	0.6	1.0	1.0	1.0	0.2	0.0	-0.7	-0.1	0.3	0.1	3.3	2.8
UK	0.6	1.4	2.1	1.8	0.2	0.2	0.1	0.2	0.9	0.4	0.2	0.3	0.3	0.5	1.4	0.8

Capital recovery index - Supply function equilibrium case - All projected investments - Capacity payment only to peak devices and CCGT

	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.0	2.1	1.6	0.8	0.7	0.9	0.8	0.6	0.5	0.4	0.4	0.7	0.8	1.6	1.2
Austria	0.3	1.0	0.9	0.9	0.6	0.6	1.0	0.6	0.5	0.4	0.3	0.3	0.6	0.6	0.4	0.5
Belgium	1.5	1.0	1.0	1.0	0.9	0.7	0.1	0.3	0.3	0.9	0.3	0.7	0.8	0.8	0.2	0.5
Bulgaria	1.0	0.7	1.0	0.8	1.0	0.7	0.8	0.8	0.3	0.4	-0.2	0.4	0.3	0.6	0.9	0.8
Croatia	1.0	4.7	1.0	4.7	0.5	0.7	0.2	0.4	1.0	1.0	1.0	1.0	0.5	0.9	0.2	0.5
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.4	0.9	1.8	1.4	0.7	0.8	1.0	0.8	1.1	1.0	-0.4	0.8	1.4	0.9	1.8	1.4
Denmark	0.2	1.0	-0.1	-0.1	0.7	1.0	2.0	2.0	0.5	1.0	-0.1	-0.1	0.3	1.0	-0.1	-0.1
Estonia	0.7	0.9	0.3	0.9	1.0	0.6	0.5	0.6	0.4	0.6	0.0	0.5	0.7	0.8	0.4	0.8
Finland	0.5	1.0	2.0	1.4	0.7	1.0	0.1	0.1	1.0	4.6	0.1	2.7	0.7	1.0	1.9	1.4
France	0.1	0.3	2.9	2.4	1.1	1.0	1.0	1.0	0.1	-0.1	0.2	0.2	0.2	0.5	2.6	2.0
Germany	0.7	1.0	0.5	1.0	0.8	0.7	1.1	1.1	1.2	0.4	0.5	0.4	0.8	0.8	0.9	0.8
Greece	1.0	1.4	1.0	1.4	1.1	1.1	1.3	1.1	0.8	0.6	0.7	0.6	1.0	1.0	1.1	1.1
Hungary	1.6	3.1	2.1	2.5	1.0	0.7	0.5	0.7	0.8	3.1	0.3	1.5	1.2	2.4	1.8	2.1
Ireland	0.8	1.0	1.0	1.0	0.6	0.6	1.0	0.6	0.3	-0.4	0.0	-0.1	0.6	0.5	0.0	0.3
Italy	1.3	1.8	1.8	1.8	0.8	0.8	1.0	0.8	0.6	2.1	0.4	0.5	0.8	1.5	0.4	1.0
Latvia	1.6	1.1	1.0	1.1	0.5	0.4	1.0	0.4	0.6	0.3	0.0	0.3	0.6	0.4	0.0	0.4
Lithuania	1.0	1.0	0.8	0.8	1.2	1.0	1.0	1.0	0.6	-0.4	-0.8	-0.6	1.1	0.5	0.7	0.7
Luxembourg	1.0	1.0	1.0	1.0	0.7	0.8	-0.6	0.2	0.5	0.0	1.0	0.0	0.6	0.5	-0.6	0.2
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	2.8	1.3	0.7	0.6	0.6	0.6	2.3	1.4	0.8	1.0	1.2	0.8	1.8	1.0
Poland	0.7	1.3	1.3	1.3	0.6	0.6	0.6	0.6	0.5	0.7	3.7	0.9	0.7	0.9	1.3	1.2
Portugal	1.0	1.0	1.0	1.0	0.7	0.6	1.0	0.6	0.6	0.3	0.2	0.3	0.7	0.5	0.2	0.5
Romania	0.7	0.5	0.4	0.5	0.9	0.7	1.0	0.7	0.7	-0.7	-0.1	-0.1	0.7	0.5	0.3	0.5
Slovakia	0.6	0.5	3.9	1.5	0.7	0.8	1.0	0.8	0.8	1.0	4.3	4.3	0.7	0.6	3.9	1.5
Slovenia	0.5	1.5	3.9	2.8	1.0	0.6	0.9	0.7	0.6	0.5	0.0	0.5	0.6	1.4	3.9	2.8
Spain	0.7	1.5	1.0	1.5	0.9	0.8	1.0	0.8	0.5	0.3	0.7	0.4	0.8	0.8	0.7	0.8
Sweden	0.7	0.3	3.3	3.1	0.6	1.0	1.0	1.0	0.2	0.0	-0.7	-0.1	0.3	0.1	3.3	2.8
UK	0.6	1.4	2.1	1.8	0.7	0.6	0.1	0.6	0.9	0.4	0.2	0.3	0.7	0.7	1.4	0.9

Capital recovery index - Supply function equilibrium case - All projected investments - Capacity payment to all power plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.8	1.2	2.2	1.7	0.8	0.7	0.9	0.8	0.6	0.5	0.4	0.4	0.8	0.9	1.6	1.2
Austria	0.5	1.0	0.9	0.9	0.6	0.6	1.0	0.6	0.5	0.4	0.3	0.3	0.6	0.6	0.4	0.5
Belgium	1.5	1.0	1.0	1.0	0.9	0.7	0.1	0.3	0.3	0.9	0.3	0.7	0.8	0.8	0.2	0.5
Bulgaria	1.0	0.9	1.1	1.0	1.0	0.7	0.8	0.8	0.3	0.4	-0.2	0.4	0.3	0.8	1.1	0.9
Croatia	1.0	4.7	1.0	4.7	0.5	0.7	0.2	0.4	1.0	1.0	1.0	1.0	0.5	0.9	0.2	0.5
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.4	1.1	1.9	1.6	0.7	0.8	1.0	0.8	1.1	1.0	-0.4	0.8	1.4	1.0	1.9	1.5
Denmark	0.3	1.0	-0.1	-0.1	0.7	1.0	2.0	2.0	0.5	1.0	-0.1	-0.1	0.4	1.0	-0.1	-0.1
Estonia	1.0	1.1	0.3	1.0	1.0	0.6	0.5	0.6	0.4	0.6	0.0	0.5	1.0	0.9	0.4	0.9
Finland	0.7	1.1	2.0	1.5	0.7	1.0	0.1	0.1	1.0	4.6	0.1	2.7	0.8	1.1	2.0	1.5
France	0.3	0.4	2.9	2.4	1.1	1.0	1.0	1.0	0.1	-0.1	0.2	0.2	0.3	0.6	2.6	2.1
Germany	1.0	1.3	0.5	1.3	0.8	0.7	1.1	1.1	1.2	0.4	0.5	0.4	0.9	1.0	0.9	0.9
Greece	1.4	1.6	1.0	1.6	1.1	1.1	1.3	1.1	0.8	0.6	0.7	0.6	1.1	1.1	1.1	1.1
Hungary	1.6	3.1	2.2	2.6	1.0	0.7	0.5	0.7	0.8	3.1	0.3	1.5	1.2	2.4	1.8	2.1
Ireland	1.0	1.0	1.0	1.0	0.6	0.6	1.0	0.6	0.3	-0.4	0.0	-0.1	0.6	0.5	0.0	0.3
Italy	1.6	2.1	1.8	2.1	0.8	0.8	1.0	0.8	0.6	2.1	0.4	0.5	0.8	1.7	0.4	1.0
Latvia	1.7	1.3	1.0	1.3	0.5	0.4	1.0	0.4	0.6	0.3	0.0	0.3	0.6	0.4	0.0	0.4
Lithuania	1.0	1.0	1.0	1.0	1.2	1.0	1.0	1.0	0.6	-0.4	-0.8	-0.6	1.1	0.5	0.9	0.9
Luxembourg	1.0	1.0	1.0	1.0	0.7	0.8	-0.6	0.2	0.5	0.0	1.0	0.0	0.6	0.5	-0.6	0.2
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.1	2.8	1.4	0.7	0.6	0.6	0.6	2.3	1.4	0.8	1.0	1.2	0.9	1.8	1.1
Poland	0.9	1.4	1.4	1.4	0.6	0.6	0.6	0.6	0.5	0.7	3.7	0.9	0.9	1.0	1.4	1.2
Portugal	1.0	1.0	1.0	1.0	0.7	0.6	1.0	0.6	0.6	0.3	0.2	0.3	0.7	0.5	0.2	0.5
Romania	0.8	0.8	0.4	0.7	0.9	0.7	1.0	0.7	0.7	-0.7	-0.1	-0.1	0.8	0.7	0.3	0.6
Slovakia	0.6	0.6	3.9	1.6	0.7	0.8	1.0	0.8	0.8	1.0	4.3	4.3	0.7	0.7	3.9	1.6
Slovenia	0.6	1.5	3.9	2.8	1.0	0.6	0.9	0.7	0.6	0.5	0.0	0.5	0.6	1.4	3.9	2.8
Spain	0.9	1.6	1.0	1.6	0.9	0.8	1.0	0.8	0.5	0.3	0.7	0.4	0.8	0.8	0.7	0.8
Sweden	0.7	0.3	3.3	3.1	0.6	1.0	1.0	1.0	0.2	0.0	-0.7	-0.1	0.3	0.1	3.3	2.8
UK	0.9	1.4	2.1	1.9	0.7	0.6	0.1	0.6	0.9	0.4	0.2	0.3	0.7	0.7	1.4	0.9

Table 77: Capital recovery index in the Cournot competition case, with the introduction of capacity payment mechanisms, under high RES conditions

Capital recovery index - Cournot competition case - All projected investments - Capacity payment only to peak devices																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.9	1.3	2.7	2.0	0.5	0.5	0.6	0.5	0.8	0.6	0.5	0.5	0.6	0.9	1.9	1.4
Austria	0.3	1.1	0.6	0.6	0.0	0.0	1.0	0.0	0.5	0.5	0.3	0.3	0.2	0.2	0.3	0.2
Belgium	1.8	1.0	1.0	1.0	1.4	1.2	1.0	1.1	0.7	1.3	0.7	1.1	1.3	1.2	0.9	1.1
Bulgaria	1.0	0.9	1.7	1.2	1.0	0.6	0.7	0.6	0.4	0.5	0.0	0.5	0.4	0.9	1.6	1.1
Croatia	1.0	5.5	1.0	5.5	0.9	1.0	0.3	0.6	1.0	1.0	1.0	1.0	0.9	1.2	0.3	0.7
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	2.1	1.4	2.6	2.1	0.2	0.3	1.0	0.3	1.4	1.3	-0.2	1.1	1.9	1.3	2.6	2.0
Denmark	0.3	1.0	0.5	0.5	0.4	1.0	2.3	2.3	0.8	1.0	0.0	0.0	0.4	1.0	0.1	0.1
Estonia	1.2	1.0	0.2	1.0	1.0	0.2	0.0	0.2	0.4	0.6	0.0	0.6	1.2	0.8	0.1	0.8
Finland	0.8	1.2	2.3	1.6	0.4	1.0	0.7	0.7	1.1	5.2	0.1	3.0	0.7	1.2	2.2	1.6
France	0.1	0.3	3.7	3.0	0.5	0.4	1.0	0.4	0.3	0.1	0.4	0.3	0.2	0.3	3.3	2.5
Germany	0.9	1.2	0.9	1.2	0.1	0.1	0.6	0.5	1.4	0.4	0.6	0.4	0.6	0.9	0.6	0.8
Greece	1.5	1.8	1.0	1.8	0.5	0.5	1.4	0.7	0.8	0.6	0.7	0.6	0.8	0.9	1.2	0.9
Hungary	1.9	3.5	2.7	3.1	1.1	0.7	0.1	0.5	0.9	3.9	0.7	2.1	1.4	2.7	2.2	2.5
Ireland	1.3	1.8	1.0	1.8	0.8	0.5	1.0	0.5	0.5	-0.2	0.0	0.0	0.8	0.4	0.0	0.3
Italy	1.7	2.1	2.5	2.1	0.4	0.7	1.0	0.7	0.7	2.5	0.4	0.6	0.6	1.8	0.4	1.1
Latvia	2.7	2.2	1.0	2.2	0.6	1.2	1.0	1.2	1.2	0.5	0.0	0.5	0.8	0.8	0.0	0.8
Lithuania	1.0	1.0	1.0	1.0	1.4	1.4	1.0	1.4	0.7	0.0	-0.5	-0.3	1.3	0.9	0.9	0.9
Luxembourg	1.0	1.0	1.0	1.0	0.3	0.9	-0.2	0.5	0.4	0.0	1.0	0.0	0.3	0.5	-0.2	0.3
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.3	3.3	1.6	0.7	0.6	1.0	0.6	2.8	1.7	1.0	1.2	1.3	1.0	2.2	1.2
Poland	0.8	1.4	1.4	1.4	0.1	0.1	0.4	0.2	0.6	0.8	4.0	1.0	0.8	1.0	1.4	1.2
Portugal	1.0	1.0	1.0	1.0	0.4	0.2	1.0	0.2	0.7	0.5	0.4	0.5	0.5	0.3	0.4	0.3
Romania	0.9	1.1	1.3	1.2	0.3	0.0	1.0	0.0	0.7	-0.6	0.0	0.0	0.9	0.7	1.1	0.8
Slovakia	0.9	0.8	6.2	2.4	0.4	0.9	1.0	0.9	1.1	1.0	7.9	7.9	0.7	0.8	6.3	2.4
Slovenia	0.6	1.9	4.3	3.2	1.0	0.6	1.3	0.9	0.6	0.7	0.0	0.6	0.6	1.8	4.2	3.1
Spain	0.9	1.6	1.0	1.6	0.5	0.6	1.0	0.6	0.6	0.4	0.8	0.5	0.5	0.7	0.8	0.7
Sweden	0.8	0.3	4.8	4.4	0.8	1.0	1.0	1.0	0.3	0.4	-0.3	0.4	0.4	0.4	4.7	4.1
UK	0.9	1.5	2.2	1.9	0.6	0.5	0.1	0.5	1.0	0.4	0.2	0.4	0.6	0.7	1.5	1.0

Capital recovery index - Cournot competition case - All projected investments - Capacity payment only to peak devices and CCGT																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.9	1.3	2.7	2.0	1.1	1.0	1.3	1.1	0.8	0.6	0.5	0.5	1.0	1.1	2.0	1.5
Austria	0.3	1.1	0.6	0.6	0.6	0.6	1.0	0.6	0.5	0.5	0.3	0.3	0.6	0.6	0.3	0.4
Belgium	1.8	1.0	1.0	1.0	1.6	1.3	1.2	1.2	0.7	1.3	0.7	1.1	1.4	1.3	1.0	1.2
Bulgaria	1.0	0.9	1.7	1.2	1.0	0.9	1.0	1.0	0.4	0.5	0.0	0.5	0.4	0.9	1.6	1.1
Croatia	1.0	5.5	1.0	5.5	0.9	1.2	0.8	0.9	1.0	1.0	1.0	1.0	0.9	1.3	0.8	1.0
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	2.1	1.4	2.6	2.1	0.8	0.8	1.0	0.8	1.4	1.3	-0.2	1.1	2.0	1.4	2.6	2.0
Denmark	0.3	1.0	0.5	0.5	1.0	1.0	2.7	2.7	0.8	1.0	0.0	0.0	0.5	1.0	0.1	0.1
Estonia	1.2	1.0	0.2	1.0	1.0	0.8	0.5	0.7	0.4	0.6	0.0	0.6	1.2	0.9	0.3	0.9
Finland	0.8	1.2	2.3	1.6	0.9	1.0	0.7	0.7	1.1	5.2	0.1	3.0	0.9	1.2	2.2	1.6
France	0.1	0.3	3.7	3.0	1.3	1.2	1.0	1.2	0.3	0.1	0.4	0.3	0.2	0.6	3.3	2.6
Germany	0.9	1.2	0.9	1.2	0.9	0.8	1.3	1.2	1.4	0.4	0.6	0.4	0.9	0.9	1.1	1.0
Greece	1.5	1.8	1.0	1.8	1.4	1.3	2.0	1.5	0.8	0.6	0.7	0.6	1.2	1.3	1.6	1.4
Hungary	1.9	3.5	2.7	3.1	1.4	1.0	0.7	0.9	0.9	3.9	0.7	2.1	1.5	2.8	2.3	2.6
Ireland	1.3	1.8	1.0	1.8	1.1	0.9	1.0	0.9	0.5	-0.2	0.0	0.0	1.0	0.8	0.0	0.5
Italy	1.7	2.1	2.5	2.1	1.1	1.3	1.0	1.3	0.7	2.5	0.4	0.6	1.1	1.9	0.4	1.2
Latvia	2.7	2.2	1.0	2.2	0.8	1.4	1.0	1.4	1.2	0.5	0.0	0.5	1.0	0.9	0.0	0.9
Lithuania	1.0	1.0	1.0	1.0	1.9	1.7	1.0	1.7	0.7	0.0	-0.5	-0.3	1.6	1.1	0.9	0.9
Luxembourg	1.0	1.0	1.0	1.0	0.8	1.4	0.1	0.8	0.4	0.0	1.0	0.0	0.8	0.8	0.1	0.6
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.3	3.3	1.6	1.1	0.8	1.0	0.9	2.8	1.7	1.0	1.2	1.5	1.2	2.2	1.3
Poland	0.8	1.4	1.4	1.4	0.7	0.6	0.7	0.7	0.6	0.8	4.0	1.0	0.8	1.0	1.4	1.3
Portugal	1.0	1.0	1.0	1.0	0.9	0.6	1.0	0.6	0.7	0.5	0.4	0.5	0.8	0.6	0.4	0.6
Romania	0.9	1.1	1.3	1.2	1.0	0.7	1.0	0.7	0.7	-0.6	0.0	0.0	0.9	0.9	1.1	1.0
Slovakia	0.9	0.8	6.2	2.4	0.6	1.1	1.0	1.1	1.1	1.0	7.9	7.9	0.8	0.8	6.3	2.4
Slovenia	0.6	1.9	4.3	3.2	1.0	0.8	1.3	1.0	0.6	0.7	0.0	0.6	0.6	1.8	4.2	3.1
Spain	0.9	1.6	1.0	1.6	1.1	1.1	1.0	1.1	0.6	0.4	0.8	0.5	1.0	0.9	0.8	0.9
Sweden	0.8	0.3	4.8	4.4	0.8	1.0	1.0	1.0	0.3	0.4	-0.3	0.4	0.4	0.4	4.7	4.1
UK	0.9	1.5	2.2	1.9	1.0	0.9	0.1	0.9	1.0	0.4	0.2	0.4	1.0	0.9	1.5	1.1

Capital recovery index - Cournot competition case - All projected investments - Capacity payment to all power plants

	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.1	1.5	2.7	2.1	1.1	1.0	1.3	1.1	0.8	0.6	0.5	0.5	1.0	1.2	2.0	1.6
Austria	0.5	1.1	0.6	0.6	0.6	0.6	1.0	0.6	0.5	0.5	0.3	0.3	0.6	0.6	0.3	0.4
Belgium	1.8	1.0	1.0	1.0	1.6	1.3	1.2	1.2	0.7	1.3	0.7	1.1	1.4	1.3	1.0	1.2
Bulgaria	1.0	1.1	1.8	1.4	1.0	0.9	1.0	1.0	0.4	0.5	0.0	0.5	0.4	1.0	1.7	1.3
Croatia	1.0	5.5	1.0	5.5	0.9	1.2	0.8	0.9	1.0	1.0	1.0	1.0	0.9	1.3	0.8	1.0
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	2.1	1.6	2.7	2.2	0.8	0.8	1.0	0.8	1.4	1.3	-0.2	1.1	2.0	1.5	2.7	2.1
Denmark	0.5	1.0	0.5	0.5	1.0	1.0	2.7	2.7	0.8	1.0	0.0	0.0	0.7	1.0	0.1	0.1
Estonia	1.4	1.2	0.2	1.1	1.0	0.8	0.5	0.7	0.4	0.6	0.0	0.6	1.4	1.0	0.3	1.0
Finland	1.0	1.3	2.3	1.7	0.9	1.0	0.7	0.7	1.1	5.2	0.1	3.0	1.0	1.3	2.3	1.7
France	0.2	0.4	3.7	3.0	1.3	1.2	1.0	1.2	0.3	0.1	0.4	0.3	0.4	0.7	3.3	2.6
Germany	1.2	1.6	0.9	1.5	0.9	0.8	1.3	1.2	1.4	0.4	0.6	0.4	1.1	1.1	1.1	1.1
Greece	1.8	2.1	1.0	2.1	1.4	1.3	2.0	1.5	0.8	0.6	0.7	0.6	1.3	1.4	1.6	1.4
Hungary	1.9	3.5	2.8	3.1	1.4	1.0	0.7	0.9	0.9	3.9	0.7	2.1	1.5	2.8	2.4	2.6
Ireland	1.4	1.8	1.0	1.8	1.1	0.9	1.0	0.9	0.5	-0.2	0.0	0.0	1.1	0.8	0.0	0.5
Italy	2.0	2.4	2.5	2.4	1.1	1.3	1.0	1.3	0.7	2.5	0.4	0.6	1.1	2.1	0.4	1.2
Latvia	2.7	2.3	1.0	2.3	0.8	1.4	1.0	1.4	1.2	0.5	0.0	0.5	1.0	0.9	0.0	0.9
Lithuania	1.0	1.0	1.1	1.1	1.9	1.7	1.0	1.7	0.7	0.0	-0.5	-0.3	1.6	1.1	1.0	1.0
Luxembourg	1.0	1.0	1.0	1.0	0.8	1.4	0.1	0.8	0.4	0.0	1.0	0.0	0.8	0.8	0.1	0.6
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.4	3.3	1.7	1.1	0.8	1.0	0.9	2.8	1.7	1.0	1.2	1.5	1.2	2.3	1.4
Poland	1.0	1.6	1.5	1.5	0.7	0.6	0.7	0.7	0.6	0.8	4.0	1.0	1.0	1.1	1.5	1.3
Portugal	1.0	1.0	1.0	1.0	0.9	0.6	1.0	0.6	0.7	0.5	0.4	0.5	0.8	0.6	0.4	0.6
Romania	1.1	1.3	1.3	1.3	1.0	0.7	1.0	0.7	0.7	-0.6	0.0	0.0	1.1	1.1	1.1	1.1
Slovakia	0.9	0.8	6.2	2.4	0.6	1.1	1.0	1.1	1.1	1.0	7.9	7.9	0.8	0.9	6.3	2.4
Slovenia	0.8	1.9	4.3	3.2	1.0	0.8	1.3	1.0	0.6	0.7	0.0	0.6	0.7	1.8	4.2	3.1
Spain	1.1	1.8	1.0	1.8	1.1	1.1	1.0	1.1	0.6	0.4	0.8	0.5	1.1	1.0	0.8	1.0
Sweden	0.8	0.3	4.8	4.4	0.8	1.0	1.0	1.0	0.3	0.4	-0.3	0.4	0.4	0.4	4.7	4.1
UK	1.1	1.6	2.2	2.0	1.0	0.9	0.1	0.9	1.0	0.4	0.2	0.4	1.0	0.9	1.5	1.1

Table 78: Capacity remuneration fee per MW, for the three bidding regimes, under high RES conditions

Capacity remuneration fee (EUR/MW)	Marginal cost bidding		Supply function equilibrium		Cournot competition	
	2020	2030	2020	2030	2020	2030
EU27	53115	43482	45973	41819	47298	43347
Austria	72984	5615	71078	4960	69632	4457
Belgium	37270	39005	0	9091	4205	9045
Bulgaria	62657	53076	55818	41083	35289	34170
Croatia	0	0	0	0	0	0
Cyprus						
Czech	83743	0	69982	0	67186	0
Denmark	0	34442	0	18676	29161	36622
Estonia	9118	52932	31815	59774	43505	61364
Finland	68776	10597	68776	10619	68776	10619
France	26208	19776	71255	65434	59817	63880
Germany	63667	64852	58609	61920	54820	59323
Greece	62896	49660	72702	55796	72644	55691
Hungary	5629	0	0	5459	0	22076
Ireland	47331	47052	42032	45066	34258	40672
Italy	68057	57291	66369	56036	67422	52351
Latvia	0	33827	0	33423	0	26795
Lithuania	34001	127740	0	127687	0	48020
Luxembourg	84610	18679	71310	18679	79112	18679
Malta						
Netherlands	64152	0	35441	0	17264	0
Poland	54804	38624	52619	21938	59747	39857
Portugal	47707	31165	52285	28965	39360	29938
Romania	79885	41577	75500	45071	77943	40382
Slovakia	12485	0	41887	0	0	0
Slovenia	0	0	2063	0	331	0
Spain	65863	39590	53703	43102	57615	42262
Sweden	24668	0	0	0	0	0
UK	52181	30118	30111	18694	45130	30593

Table 79: Payment for capacity, for the three bidding regimes, under high RES conditions

Payment for capacity to peak devices (M€)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	631	1748	3396	1458	3250	1531	3299
Austria	10	37	38	37	38	37	38
Belgium	5	189	192	107	10	84	88
Bulgaria	2	42	53	37	0	24	0
Croatia	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0
Czech	15	44	38	41	20	30	23
Denmark	13	25	15	19	7	23	19
Estonia	1	22	21	30	31	23	32
Finland	0	14	2	14	2	14	2
France	60	63	66	27	363	100	361
Germany	64	256	955	135	941	174	892
Greece	39	105	101	107	117	113	125
Hungary	17	0	0	0	0	0	8
Ireland	15	34	33	24	28	18	20
Italy	91	324	860	323	824	323	771
Latvia	5	4	0	0	0	1	0
Lithuania	1	10	102	7	101	0	73
Luxembourg	3	3	1	2	1	2	1
Malta	0	0	0	0	0	0	0
Netherlands	40	81	0	99	33	87	2
Poland	2	92	268	109	213	108	313
Portugal	54	95	87	87	80	87	76
Romania	5	8	25	11	27	12	23
Slovakia	7	6	6	7	6	4	6
Slovenia	16	16	0	18	0	18	0
Spain	104	167	187	121	153	161	168
Sweden	0	0	0	0	0	0	0
UK	60	111	347	97	255	89	256

Payment for capacity to all peak devices and CCGT (M€)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	3591	10442	10418	8968	9923	9610	9883
Austria	48	253	135	253	134	253	132
Belgium	71	301	408	170	20	133	187
Bulgaria	2	54	105	47	0	30	0
Croatia	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0
Czech	33	142	113	131	60	98	68
Denmark	48	56	29	41	13	51	36
Estonia	1	35	49	48	73	37	76
Finland	0	30	5	30	5	30	5
France	95	277	149	117	817	438	813
Germany	117	882	2394	464	2360	600	2237
Greece	77	438	336	447	388	470	414
Hungary	46	0	0	0	0	0	32
Ireland	64	179	141	125	121	93	89
Italy	968	2561	2840	2551	2721	2552	2547
Latvia	12	53	0	0	0	14	0
Lithuania	1	24	174	16	173	0	125
Luxembourg	34	35	10	24	12	25	12
Malta	0	0	0	0	0	0	0
Netherlands	115	543	0	664	170	578	12
Poland	36	206	414	243	329	242	484
Portugal	111	414	253	378	231	379	219
Romania	5	77	149	114	164	116	134
Slovakia	7	71	54	95	50	47	54
Slovenia	16	18	0	20	0	21	0
Spain	1070	2198	1492	1594	1222	2121	1340
Sweden	0	0	0	0	0	0	0
UK	616	1595	1172	1394	861	1281	865

Payment for capacity to all power plants (M€)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	4442	13040	13727	11045	13202	11833	13188
Austria	50	258	137	258	136	258	135
Belgium	71	307	414	174	21	136	190
Bulgaria	2	131	216	115	0	73	0
Croatia	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0
Czech	189	440	495	405	264	302	298
Denmark	105	106	52	79	24	97	66
Estonia	28	55	125	76	185	60	194
Finland	5	148	32	148	32	148	32
France	296	375	221	159	1216	594	1210
Germany	318	1965	3590	1034	3539	1338	3354
Greece	99	464	382	474	440	499	471
Hungary	46	0	0	0	0	0	67
Ireland	80	194	152	135	130	101	96
Italy	968	2874	3118	2863	2988	2864	2797
Latvia	12	53	0	0	0	14	0
Lithuania	1	24	366	16	365	0	264
Luxembourg	34	35	10	24	12	25	12
Malta	0	0	0	0	0	0	0
Netherlands	115	595	0	728	236	633	16
Poland	139	420	832	495	662	492	974
Portugal	111	414	253	378	231	379	219
Romania	5	158	325	233	358	237	294
Slovakia	7	147	111	196	103	97	110
Slovenia	18	20	0	23	0	23	0
Spain	1126	2259	1560	1638	1278	2180	1402
Sweden	0	0	0	0	0	0	0
UK	618	1596	1337	1396	982	1283	987

Table 80: Payment for capacity over total payment for electricity, under high RES conditions

Payment for capacity to peak devices over total payments for electricity	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	0.5	0.8	1.2	0.6	1.1	0.6	1.0
Austria	0.5	1.7	0.8	1.5	0.8	1.4	0.8
Belgium	0.1	2.3	2.6	1.3	0.1	0.9	0.9
Bulgaria	0.2	3.9	2.9	2.0	0.0	0.9	0.0
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.5	1.1	0.5	0.9	0.2	0.5	0.2
Denmark	0.9	1.1	0.5	0.8	0.2	0.8	0.5
Estonia	0.2	2.4	2.9	3.2	4.4	2.1	4.8
Finland	0.0	0.3	0.0	0.3	0.0	0.2	0.0
France	0.3	0.2	0.2	0.1	1.2	0.3	1.0
Germany	0.3	0.7	2.0	0.4	1.8	0.4	1.6
Greece	1.5	2.5	1.9	2.3	1.8	2.3	1.7
Hungary	1.1	0.0	0.0	0.0	0.0	0.0	0.2
Ireland	1.3	2.0	1.8	1.3	1.3	0.8	0.8
Italy	0.5	1.1	2.2	1.1	2.1	1.0	1.8
Latvia	3.6	0.9	0.0	0.0	0.0	0.2	0.0
Lithuania	0.2	1.2	12.4	0.8	11.6	0.0	6.0
Luxembourg	0.8	0.5	0.2	0.3	0.2	0.3	0.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.8	1.0	0.0	1.1	0.3	0.8	0.0
Poland	0.0	1.0	1.7	0.8	1.1	0.7	1.6
Portugal	2.7	2.7	1.5	2.4	1.3	1.9	1.2
Romania	0.4	0.3	0.6	0.5	0.9	0.4	0.5
Slovakia	1.5	0.5	0.2	0.9	0.2	0.3	0.2
Slovenia	5.2	1.5	0.0	1.6	0.0	1.5	0.0
Spain	1.0	0.8	0.6	0.5	0.5	0.7	0.5
Sweden	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UK	0.4	0.4	1.0	0.3	0.7	0.3	0.7

Payment for capacity to peak devices and CCGT over total payments for electricity	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	2.7	4.8	3.7	3.9	3.4	3.7	3.1
Austria	2.2	10.6	2.8	9.4	2.8	8.9	2.8
Belgium	1.1	3.6	5.4	2.0	0.3	1.4	1.9
Bulgaria	0.2	4.9	5.7	2.5	0.0	1.2	0.0
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	1.1	3.5	1.5	2.9	0.7	1.6	0.7
Denmark	3.2	2.4	0.9	1.7	0.4	1.8	1.0
Estonia	0.2	3.8	6.6	5.0	9.8	3.3	10.7
Finland	0.0	0.6	0.1	0.6	0.1	0.4	0.1
France	0.5	0.9	0.5	0.4	2.8	1.1	2.2
Germany	0.5	2.5	4.9	1.2	4.4	1.5	4.0
Greece	2.8	9.8	5.9	9.1	5.7	8.9	5.3
Hungary	2.8	0.0	0.0	0.0	0.0	0.0	0.9
Ireland	5.3	9.5	7.2	6.5	5.3	3.8	3.6
Italy	5.4	8.1	6.9	7.9	6.6	7.2	5.8
Latvia	8.0	11.6	0.0	0.0	0.0	2.3	0.0
Lithuania	0.2	2.8	19.4	1.8	18.3	0.0	9.9
Luxembourg	9.9	5.9	1.4	4.1	1.7	4.0	1.6
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	2.4	6.1	0.0	6.7	1.5	5.2	0.1
Poland	1.0	2.1	2.6	1.7	1.7	1.6	2.4
Portugal	5.3	10.7	4.2	9.5	3.6	7.7	3.3
Romania	0.4	3.3	3.4	4.9	5.0	4.1	3.1
Slovakia	1.5	6.4	2.1	10.7	2.1	3.6	1.4
Slovenia	5.2	1.7	0.0	1.8	0.0	1.7	0.0
Spain	9.2	9.6	4.8	6.5	3.9	8.1	4.0
Sweden	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UK	4.0	5.5	3.3	4.6	2.4	4.1	2.3

Payment for capacity to all power plants over total payments for electricity	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	3.4	5.9	4.9	4.7	4.5	4.5	4.0
Austria	2.3	10.8	2.9	9.6	2.8	9.0	2.8
Belgium	1.1	3.6	5.5	2.1	0.3	1.4	1.9
Bulgaria	0.2	11.1	10.9	5.8	0.0	2.8	0.0
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	6.0	10.1	6.2	8.6	3.1	4.6	3.0
Denmark	6.7	4.4	1.6	3.2	0.7	3.4	1.7
Estonia	9.2	6.0	15.3	7.8	21.7	5.2	23.4
Finland	0.2	3.0	0.4	2.7	0.4	2.2	0.4
France	1.4	1.2	0.7	0.5	4.1	1.6	3.2
Germany	1.3	5.5	7.1	2.7	6.5	3.2	5.8
Greece	3.6	10.4	6.7	9.6	6.5	9.4	6.0
Hungary	2.8	0.0	0.0	0.0	0.0	0.0	1.8
Ireland	6.5	10.2	7.7	7.0	5.6	4.1	3.8
Italy	5.4	9.0	7.6	8.8	7.2	8.1	6.3
Latvia	8.0	11.6	0.0	0.0	0.0	2.3	0.0
Lithuania	0.2	2.8	33.7	1.8	32.1	0.0	18.8
Luxembourg	9.9	5.9	1.4	4.1	1.7	4.0	1.6
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	2.4	6.6	0.0	7.3	2.1	5.6	0.1
Poland	3.8	4.2	5.0	3.4	3.4	3.3	4.8
Portugal	5.3	10.7	4.2	9.5	3.6	7.7	3.3
Romania	0.4	6.5	7.2	9.5	10.3	8.0	6.6
Slovakia	1.5	12.4	4.2	19.9	4.2	7.2	2.9
Slovenia	5.7	1.9	0.0	2.0	0.0	1.8	0.0
Spain	9.7	9.9	5.0	6.7	4.0	8.3	4.2
Sweden	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UK	4.0	5.5	3.8	4.6	2.7	4.1	2.6

Table 81: Capital recovery index in the marginal cost bidding case, with the introduction of capacity payment mechanisms, under low XB trade conditions

Capital recovery index - Marginal cost bidding case - All projected investments - Capacity payment only to peak devices																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.2	2.2	1.7	0.2	0.4	0.7	0.5	0.5	0.5	0.2	0.3	0.4	0.9	1.5	1.2
Austria	0.3	0.8	-0.1	0.0	0.1	0.2	1.0	0.2	0.3	0.1	0.0	0.0	0.2	0.2	0.0	0.1
Belgium	1.6	1.0	1.0	1.0	0.7	0.5	1.6	1.3	0.2	0.8	0.3	0.6	0.7	0.7	0.9	0.8
Bulgaria	1.0	0.9	1.4	1.1	1.0	0.4	0.5	0.5	0.2	0.8	0.3	0.7	0.2	0.9	1.2	1.0
Croatia	1.0	5.3	1.0	5.3	1.1	1.4	2.0	1.5	1.0	0.0	0.0	0.0	1.1	0.8	0.2	0.6
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	0.8	0.7	2.2	1.7	0.0	0.1	0.5	0.2	0.9	0.6	0.4	0.6	0.7	0.6	2.2	1.6
Denmark	0.2	0.4	0.2	0.2	0.3	1.0	1.0	1.0	0.5	1.0	-0.2	-0.2	0.2	0.4	-0.2	-0.2
Estonia	0.5	0.9	0.4	0.9	1.0	0.1	0.1	0.1	0.3	0.3	0.2	0.3	0.5	0.8	0.3	0.7
Finland	0.6	0.7	1.2	1.0	0.2	-0.1	-0.4	-0.3	1.1	1.4	-0.4	0.4	0.6	0.7	1.2	1.0
France	0.1	0.2	3.2	2.7	0.2	0.3	1.0	0.3	-0.4	-0.3	0.3	0.3	0.1	0.2	2.4	2.0
Germany	0.8	1.3	0.8	1.3	0.1	0.1	0.5	0.4	1.1	0.5	0.3	0.4	0.5	1.0	0.5	0.8
Greece	1.4	2.4	1.0	2.4	0.6	1.1	3.3	1.8	0.8	1.0	0.5	0.7	0.8	1.4	1.4	1.4
Hungary	1.9	3.7	2.4	2.8	1.0	0.9	0.3	0.7	1.1	4.2	0.1	0.6	1.4	2.8	1.8	2.1
Ireland	0.9	1.7	1.0	1.7	0.2	0.3	0.6	0.4	0.1	0.0	0.2	0.2	0.3	0.2	0.3	0.2
Italy	1.4	1.9	2.6	2.0	0.2	0.5	1.0	0.5	0.5	2.3	0.2	0.4	0.4	1.6	0.2	0.9
Latvia	1.1	0.9	0.8	0.8	0.7	0.4	1.0	0.4	1.0	0.1	-0.7	-0.2	0.8	0.2	-0.6	0.1
Lithuania	1.0	1.0	0.6	0.6	1.0	1.0	1.0	1.0	0.5	-0.5	-0.1	-0.2	0.9	0.5	0.5	0.5
Luxembourg	1.0	1.0	1.0	1.0	2.3	3.9	2.8	3.0	1.2	0.0	1.0	0.0	2.1	2.3	2.8	2.7
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	0.9	2.5	1.1	0.3	0.2	0.4	0.2	1.9	1.2	0.2	0.3	0.7	0.6	1.1	0.7
Poland	0.7	1.2	1.3	1.3	0.3	0.2	0.3	0.2	0.4	0.7	0.6	0.7	0.7	1.0	1.2	1.1
Portugal	1.0	1.0	1.0	1.0	0.2	0.1	1.0	0.1	0.6	0.6	1.0	0.6	0.3	0.2	1.0	0.2
Romania	1.4	2.3	3.3	2.8	0.7	1.2	1.4	1.2	0.9	1.0	2.0	1.9	1.4	1.9	3.2	2.4
Slovakia	0.7	0.4	2.8	1.3	0.0	0.1	1.0	0.1	0.5	1.0	0.2	0.2	0.3	0.4	2.7	1.3
Slovenia	0.4	1.1	2.6	2.0	1.0	0.3	0.7	0.5	0.6	-0.3	0.0	-0.2	0.5	1.1	2.5	2.0
Spain	0.6	1.2	1.0	1.2	0.1	0.2	1.0	0.2	0.5	0.2	0.1	0.2	0.1	0.5	0.1	0.5
Sweden	0.8	0.2	3.0	3.0	0.8	1.0	1.0	1.0	0.5	1.3	0.0	0.2	0.6	1.2	2.0	2.0
UK	0.6	1.0	1.9	1.8	0.1	0.3	0.7	0.3	0.7	0.2	0.0	0.1	0.2	0.3	1.4	1.0

Capital recovery index - Marginal cost bidding case - All projected investments - Capacity payment only to peak devices and CCGT

	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.2	2.2	1.7	0.6	0.6	1.1	0.8	0.5	0.5	0.2	0.3	0.6	0.9	1.5	1.2
Austria	0.3	0.8	-0.1	0.0	0.5	0.5	1.0	0.5	0.3	0.1	0.0	0.0	0.4	0.4	0.0	0.2
Belgium	1.6	1.0	1.0	1.0	1.0	0.6	1.7	1.3	0.2	0.8	0.3	0.6	0.9	0.7	1.0	0.9
Bulgaria	1.0	0.9	1.4	1.1	1.0	0.5	0.7	0.6	0.2	0.8	0.3	0.7	0.2	0.9	1.2	1.0
Croatia	1.0	5.3	1.0	5.3	1.1	1.4	2.0	1.5	1.0	0.0	0.0	0.0	1.1	0.9	0.2	0.6
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	0.8	0.7	2.2	1.7	0.3	0.2	0.5	0.2	0.9	0.6	0.4	0.6	0.8	0.6	2.2	1.6
Denmark	0.2	0.4	0.2	0.2	0.5	1.0	1.0	1.0	0.5	1.0	-0.2	-0.2	0.3	0.4	-0.2	-0.2
Estonia	0.5	0.9	0.4	0.9	1.0	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.5	0.8	0.3	0.7
Finland	0.6	0.7	1.2	1.0	0.8	-0.1	-0.4	-0.3	1.1	1.4	-0.4	0.4	0.8	0.7	1.2	1.0
France	0.1	0.2	3.2	2.7	0.7	0.4	1.0	0.4	-0.4	-0.3	0.3	0.3	0.1	0.3	2.4	2.0
Germany	0.8	1.3	0.8	1.3	0.6	0.6	1.0	0.9	1.1	0.5	0.3	0.4	0.8	1.0	0.7	0.9
Greece	1.4	2.4	1.0	2.4	1.0	1.4	3.3	2.0	0.8	1.0	0.5	0.7	1.0	1.6	1.4	1.5
Hungary	1.9	3.7	2.4	2.8	1.2	0.9	0.3	0.7	1.1	4.2	0.1	0.6	1.5	2.8	1.8	2.1
Ireland	0.9	1.7	1.0	1.7	0.4	0.3	0.8	0.5	0.1	0.0	0.2	0.2	0.4	0.3	0.3	0.3
Italy	1.4	1.9	2.6	2.0	0.6	0.9	1.0	0.9	0.5	2.3	0.2	0.4	0.6	1.7	0.2	0.9
Latvia	1.1	0.9	0.8	0.8	0.8	0.5	1.0	0.5	1.0	0.1	-0.7	-0.2	0.9	0.3	-0.6	0.1
Lithuania	1.0	1.0	0.6	0.6	1.4	1.4	1.0	1.4	0.5	-0.5	-0.1	-0.2	1.2	0.8	0.5	0.5
Luxembourg	1.0	1.0	1.0	1.0	2.5	3.9	2.8	3.0	1.2	0.0	1.0	0.0	2.3	2.3	2.8	2.7
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	0.9	2.5	1.1	0.3	0.2	0.4	0.3	1.9	1.2	0.2	0.3	0.8	0.6	1.1	0.7
Poland	0.7	1.2	1.3	1.3	0.5	0.2	0.4	0.3	0.4	0.7	0.6	0.7	0.7	1.0	1.2	1.1
Portugal	1.0	1.0	1.0	1.0	0.7	0.5	1.0	0.5	0.6	0.6	1.0	0.6	0.7	0.5	1.0	0.5
Romania	1.4	2.3	3.3	2.8	0.7	1.2	1.4	1.2	0.9	1.0	2.0	1.9	1.4	1.9	3.2	2.4
Slovakia	0.7	0.4	2.8	1.3	0.2	0.3	1.0	0.3	0.5	1.0	0.2	0.2	0.4	0.4	2.7	1.3
Slovenia	0.4	1.1	2.6	2.0	1.0	0.4	0.7	0.6	0.6	-0.3	0.0	-0.2	0.5	1.1	2.5	2.0
Spain	0.6	1.2	1.0	1.2	0.7	0.7	1.0	0.7	0.5	0.2	0.1	0.2	0.6	0.7	0.1	0.6
Sweden	0.8	0.2	3.0	3.0	0.8	1.0	1.0	1.0	0.5	1.3	0.0	0.2	0.6	1.2	2.0	2.0
UK	0.6	1.0	1.9	1.8	0.4	0.4	0.7	0.5	0.7	0.2	0.0	0.1	0.4	0.4	1.4	1.0

Capital recovery index - Marginal cost bidding case - All projected investments - Capacity payment to all power plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.8	1.3	2.2	1.8	0.6	0.6	1.1	0.8	0.5	0.5	0.2	0.3	0.6	1.0	1.5	1.3
Austria	0.5	0.8	-0.1	0.0	0.5	0.5	1.0	0.5	0.3	0.1	0.0	0.0	0.4	0.4	0.0	0.2
Belgium	1.6	1.0	1.0	1.0	1.0	0.6	1.7	1.3	0.2	0.8	0.3	0.6	0.9	0.7	1.0	0.9
Bulgaria	1.0	0.9	1.5	1.1	1.0	0.5	0.7	0.6	0.2	0.8	0.3	0.7	0.2	0.9	1.3	1.0
Croatia	1.0	5.3	1.0	5.3	1.1	1.4	2.0	1.5	1.0	0.0	0.0	0.0	1.1	0.9	0.2	0.6
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	0.8	0.7	2.2	1.7	0.3	0.2	0.5	0.2	0.9	0.6	0.4	0.6	0.8	0.7	2.2	1.6
Denmark	0.2	0.4	0.2	0.2	0.5	1.0	1.0	1.0	0.5	1.0	-0.2	-0.2	0.3	0.4	-0.2	-0.2
Estonia	0.7	1.0	0.4	1.0	1.0	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.7	0.8	0.3	0.8
Finland	0.9	0.8	1.3	1.1	0.8	-0.1	-0.4	-0.3	1.1	1.4	-0.4	0.4	0.9	0.8	1.3	1.1
France	0.2	0.3	3.2	2.7	0.7	0.4	1.0	0.4	-0.4	-0.3	0.3	0.3	0.2	0.3	2.4	2.0
Germany	1.1	1.6	0.8	1.5	0.6	0.6	1.0	0.9	1.1	0.5	0.3	0.4	0.9	1.2	0.7	1.0
Greece	1.6	2.4	1.0	2.4	1.0	1.4	3.3	2.0	0.8	1.0	0.5	0.7	1.1	1.6	1.4	1.5
Hungary	1.9	3.7	2.4	2.8	1.2	0.9	0.3	0.7	1.1	4.2	0.1	0.6	1.5	2.8	1.8	2.1
Ireland	1.0	1.7	1.0	1.7	0.4	0.3	0.8	0.5	0.1	0.0	0.2	0.2	0.4	0.3	0.3	0.3
Italy	1.6	2.1	2.6	2.1	0.6	0.9	1.0	0.9	0.5	2.3	0.2	0.4	0.7	1.8	0.2	0.9
Latvia	1.2	0.9	0.8	0.9	0.8	0.5	1.0	0.5	1.0	0.1	-0.7	-0.2	0.9	0.3	-0.6	0.1
Lithuania	1.0	1.0	0.8	0.8	1.4	1.4	1.0	1.4	0.5	-0.5	-0.1	-0.2	1.2	0.8	0.6	0.6
Luxembourg	1.0	1.0	1.0	1.0	2.5	3.9	2.8	3.0	1.2	0.0	1.0	0.0	2.3	2.3	2.8	2.7
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	0.9	2.5	1.1	0.3	0.2	0.4	0.3	1.9	1.2	0.2	0.3	0.8	0.6	1.1	0.7
Poland	0.7	1.3	1.3	1.3	0.5	0.2	0.4	0.3	0.4	0.7	0.6	0.7	0.7	1.0	1.2	1.1
Portugal	1.0	1.0	1.0	1.0	0.7	0.5	1.0	0.5	0.6	0.6	1.0	0.6	0.7	0.5	1.0	0.5
Romania	1.4	2.3	3.3	2.8	0.7	1.2	1.4	1.2	0.9	1.0	2.0	1.9	1.4	1.9	3.2	2.4
Slovakia	0.7	0.5	2.8	1.4	0.2	0.3	1.0	0.3	0.5	1.0	0.2	0.2	0.4	0.4	2.7	1.3
Slovenia	0.5	1.1	2.6	2.0	1.0	0.4	0.7	0.6	0.6	-0.3	0.0	-0.2	0.6	1.1	2.5	2.0
Spain	0.9	1.3	1.0	1.3	0.7	0.7	1.0	0.7	0.5	0.2	0.1	0.2	0.7	0.7	0.1	0.7
Sweden	0.8	0.2	3.0	3.0	0.8	1.0	1.0	1.0	0.5	1.3	0.0	0.2	0.6	1.2	2.0	2.0
UK	0.7	1.0	1.9	1.8	0.4	0.4	0.7	0.5	0.7	0.2	0.0	0.1	0.4	0.4	1.4	1.0

Table 82: Capital recovery index in the supply function equilibrium case, with the introduction of capacity payment mechanisms, under low XB trade conditions

Capital recovery index - Supply function equilibrium case - All projected investments - Capacity payment only to peak devices																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.8	1.3	2.3	1.8	0.5	0.5	0.9	0.6	0.7	0.6	0.2	0.4	0.6	1.0	1.6	1.3
Austria	0.3	1.0	0.2	0.2	0.1	0.2	1.0	0.2	0.4	0.1	0.1	0.1	0.2	0.1	0.1	0.1
Belgium	1.6	1.0	1.0	1.0	0.8	0.6	1.8	1.4	0.3	0.7	0.3	0.5	0.8	0.7	1.0	0.9
Bulgaria	1.0	1.0	1.5	1.2	1.0	0.6	0.6	0.6	0.5	0.9	0.2	0.7	0.5	1.0	1.3	1.1
Croatia	1.0	5.5	1.0	5.5	1.3	1.7	2.3	1.7	1.0	0.1	0.1	0.1	1.3	1.0	0.3	0.7
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.2	1.1	2.7	2.1	0.2	0.6	1.4	0.6	1.1	1.1	0.2	1.0	1.1	1.1	2.7	2.0
Denmark	0.2	1.4	0.6	0.6	0.5	1.0	1.0	1.0	0.7	1.0	0.0	0.0	0.3	1.4	0.0	0.0
Estonia	0.4	1.0	0.5	1.0	1.0	0.1	0.2	0.1	0.3	0.4	0.2	0.4	0.4	0.8	0.3	0.8
Finland	0.9	0.8	1.4	1.2	0.4	-0.2	-0.2	-0.2	1.2	1.3	-0.2	0.5	0.8	0.8	1.4	1.1
France	0.1	0.2	3.3	2.8	0.3	0.3	1.0	0.3	0.1	-0.7	0.3	0.2	0.1	0.2	2.5	2.0
Germany	0.9	1.4	0.9	1.4	0.1	0.1	0.6	0.5	1.2	0.5	0.2	0.4	0.6	1.0	0.5	0.8
Greece	1.7	2.5	1.0	2.5	1.0	1.3	4.0	2.1	0.8	1.1	0.6	0.7	1.1	1.6	1.7	1.6
Hungary	1.9	3.8	2.4	2.8	1.1	1.0	0.4	0.7	1.2	4.2	0.1	0.5	1.5	2.9	1.8	2.2
Ireland	1.1	1.8	1.0	1.8	0.4	0.4	1.0	0.5	0.2	-0.1	0.1	0.1	0.5	0.3	0.3	0.3
Italy	1.8	2.3	3.2	2.3	0.6	0.9	1.0	0.9	0.5	2.5	0.3	0.5	0.7	2.0	0.3	1.1
Latvia	1.5	1.1	1.0	1.0	1.0	0.7	1.0	0.7	1.2	0.0	-0.3	-0.1	1.0	0.3	-0.2	0.2
Lithuania	1.0	1.0	0.6	0.6	1.2	1.2	1.0	1.2	0.6	0.0	-0.4	-0.3	1.1	0.8	0.5	0.5
Luxembourg	1.0	1.0	1.0	1.0	2.7	4.4	3.3	3.5	1.5	0.0	1.0	0.0	2.6	2.5	3.3	3.1
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.1	2.8	1.4	0.7	0.5	0.7	0.5	2.5	1.6	0.3	0.5	1.2	0.9	1.3	1.0
Poland	1.0	1.6	1.5	1.6	0.5	0.3	0.6	0.4	0.7	0.9	0.9	0.9	0.9	1.3	1.4	1.4
Portugal	1.0	1.0	1.0	1.0	0.3	0.2	1.0	0.2	0.6	0.5	1.0	0.5	0.4	0.3	1.0	0.3
Romania	0.9	0.8	0.3	0.5	0.1	0.4	-1.7	0.3	0.7	-0.2	-0.8	-0.7	0.9	0.7	0.1	0.4
Slovakia	0.9	0.5	3.5	1.7	0.1	0.2	1.0	0.2	0.6	1.0	0.4	0.4	0.4	0.5	3.3	1.6
Slovenia	0.5	1.6	3.1	2.6	1.0	0.6	0.9	0.8	0.6	-0.2	0.0	-0.1	0.6	1.5	3.0	2.5
Spain	0.7	1.4	1.0	1.4	0.3	0.4	1.0	0.4	0.4	0.1	0.2	0.1	0.3	0.6	0.2	0.6
Sweden	0.9	0.2	3.0	3.0	0.8	1.0	1.0	1.0	0.6	1.4	0.0	0.2	0.6	1.3	2.0	2.0
UK	0.9	1.2	2.1	2.0	0.5	0.4	1.1	0.5	1.2	0.5	0.1	0.3	0.5	0.6	1.6	1.2

Capital recovery index - Supply function equilibrium case - All projected investments - Capacity payment only to peak devices and CCGT																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.8	1.3	2.3	1.8	0.7	0.6	1.2	0.8	0.7	0.6	0.2	0.4	0.7	1.0	1.6	1.3
Austria	0.3	1.0	0.2	0.2	0.5	0.4	1.0	0.4	0.4	0.1	0.1	0.1	0.4	0.4	0.1	0.2
Belgium	1.6	1.0	1.0	1.0	1.1	0.8	1.8	1.5	0.3	0.7	0.3	0.5	0.9	0.7	1.0	0.9
Bulgaria	1.0	1.0	1.5	1.2	1.0	0.7	0.7	0.7	0.5	0.9	0.2	0.7	0.5	1.0	1.3	1.1
Croatia	1.0	5.5	1.0	5.5	1.3	1.7	2.3	1.7	1.0	0.1	0.1	0.1	1.3	1.0	0.3	0.7
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.2	1.1	2.7	2.1	0.3	0.6	1.4	0.6	1.1	1.1	0.2	1.0	1.1	1.1	2.7	2.0
Denmark	0.2	1.4	0.6	0.6	0.7	1.0	1.0	1.0	0.7	1.0	0.0	0.0	0.4	1.4	0.0	0.0
Estonia	0.4	1.0	0.5	1.0	1.0	0.4	0.3	0.3	0.3	0.4	0.2	0.4	0.4	0.8	0.4	0.8
Finland	0.9	0.8	1.4	1.2	1.0	-0.2	-0.2	-0.2	1.2	1.3	-0.2	0.5	1.0	0.8	1.4	1.1
France	0.1	0.2	3.3	2.8	0.7	0.5	1.0	0.5	0.1	-0.7	0.3	0.2	0.2	0.3	2.5	2.1
Germany	0.9	1.4	0.9	1.4	0.6	0.6	1.0	0.9	1.2	0.5	0.2	0.4	0.8	1.1	0.8	1.0
Greece	1.7	2.5	1.0	2.5	1.4	1.6	4.0	2.3	0.8	1.1	0.6	0.7	1.3	1.7	1.7	1.7
Hungary	1.9	3.8	2.4	2.8	1.2	1.0	0.4	0.8	1.2	4.2	0.1	0.5	1.6	2.9	1.8	2.2
Ireland	1.1	1.8	1.0	1.8	0.5	0.4	1.1	0.6	0.2	-0.1	0.1	0.1	0.5	0.3	0.3	0.3
Italy	1.8	2.3	3.2	2.3	0.7	0.9	1.0	0.9	0.5	2.5	0.3	0.5	0.8	2.0	0.3	1.1
Latvia	1.5	1.1	1.0	1.0	1.1	0.8	1.0	0.8	1.2	0.0	-0.3	-0.1	1.1	0.3	-0.2	0.2
Lithuania	1.0	1.0	0.6	0.6	1.6	1.5	1.0	1.5	0.6	0.0	-0.4	-0.3	1.4	1.0	0.5	0.5
Luxembourg	1.0	1.0	1.0	1.0	2.9	4.4	3.3	3.5	1.5	0.0	1.0	0.0	2.8	2.5	3.3	3.1
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.1	2.8	1.4	0.8	0.5	0.7	0.5	2.5	1.6	0.3	0.5	1.2	0.9	1.3	1.0
Poland	1.0	1.6	1.5	1.6	0.7	0.3	0.6	0.4	0.7	0.9	0.9	0.9	1.0	1.3	1.4	1.4
Portugal	1.0	1.0	1.0	1.0	0.6	0.5	1.0	0.5	0.6	0.5	1.0	0.5	0.6	0.5	1.0	0.5
Romania	0.9	0.8	0.3	0.5	0.2	0.5	-1.4	0.5	0.7	-0.2	-0.8	-0.7	0.9	0.7	0.1	0.5
Slovakia	0.9	0.5	3.5	1.7	0.2	0.4	1.0	0.4	0.6	1.0	0.4	0.4	0.5	0.5	3.3	1.6
Slovenia	0.5	1.6	3.1	2.6	1.0	0.7	0.9	0.8	0.6	-0.2	0.0	-0.1	0.6	1.5	3.0	2.5
Spain	0.7	1.4	1.0	1.4	0.8	0.6	1.0	0.6	0.4	0.1	0.2	0.1	0.7	0.7	0.2	0.7
Sweden	0.9	0.2	3.0	3.0	0.8	1.0	1.0	1.0	0.6	1.4	0.0	0.2	0.6	1.3	2.0	2.0
UK	0.9	1.2	2.1	2.0	0.6	0.4	1.1	0.5	1.2	0.5	0.1	0.3	0.6	0.6	1.6	1.2

Capital recovery index - Supply function equilibrium case - All projected investments - Capacity payment to all power plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.9	1.4	2.3	1.9	0.7	0.6	1.2	0.8	0.7	0.6	0.2	0.4	0.7	1.0	1.6	1.4
Austria	0.5	1.0	0.2	0.2	0.5	0.4	1.0	0.4	0.4	0.1	0.1	0.1	0.4	0.4	0.1	0.2
Belgium	1.6	1.0	1.0	1.0	1.1	0.8	1.8	1.5	0.3	0.7	0.3	0.5	0.9	0.7	1.0	0.9
Bulgaria	1.0	1.1	1.5	1.2	1.0	0.7	0.7	0.7	0.5	0.9	0.2	0.7	0.5	1.0	1.3	1.1
Croatia	1.0	5.5	1.0	5.5	1.3	1.7	2.3	1.7	1.0	0.1	0.1	0.1	1.3	1.0	0.3	0.7
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.2	1.1	2.7	2.1	0.3	0.6	1.4	0.6	1.1	1.1	0.2	1.0	1.1	1.1	2.7	2.0
Denmark	0.3	1.4	0.6	0.6	0.7	1.0	1.0	1.0	0.7	1.0	0.0	0.0	0.4	1.4	0.0	0.0
Estonia	0.6	1.1	0.5	1.0	1.0	0.4	0.3	0.3	0.3	0.4	0.2	0.4	0.6	0.9	0.4	0.9
Finland	1.1	0.9	1.5	1.2	1.0	-0.2	-0.2	-0.2	1.2	1.3	-0.2	0.5	1.1	0.9	1.4	1.2
France	0.2	0.3	3.3	2.8	0.7	0.5	1.0	0.5	0.1	-0.7	0.3	0.2	0.3	0.3	2.5	2.1
Germany	1.1	1.6	0.9	1.6	0.6	0.6	1.0	0.9	1.2	0.5	0.2	0.4	0.9	1.2	0.8	1.0
Greece	1.9	2.6	1.0	2.6	1.4	1.6	4.0	2.3	0.8	1.1	0.6	0.7	1.3	1.8	1.7	1.7
Hungary	1.9	3.8	2.4	2.8	1.2	1.0	0.4	0.8	1.2	4.2	0.1	0.5	1.6	2.9	1.8	2.2
Ireland	1.2	1.8	1.0	1.8	0.5	0.4	1.1	0.6	0.2	-0.1	0.1	0.1	0.6	0.3	0.3	0.3
Italy	1.8	2.3	3.2	2.3	0.7	0.9	1.0	0.9	0.5	2.5	0.3	0.5	0.8	2.0	0.3	1.1
Latvia	1.5	1.2	1.1	1.1	1.1	0.8	1.0	0.8	1.2	0.0	-0.3	-0.1	1.1	0.3	-0.2	0.2
Lithuania	1.0	1.0	0.8	0.8	1.6	1.5	1.0	1.5	0.6	0.0	-0.4	-0.3	1.4	1.0	0.6	0.6
Luxembourg	1.0	1.0	1.0	1.0	2.9	4.4	3.3	3.5	1.5	0.0	1.0	0.0	2.8	2.5	3.3	3.1
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.1	2.8	1.4	0.8	0.5	0.7	0.5	2.5	1.6	0.3	0.5	1.2	0.9	1.3	1.0
Poland	1.0	1.6	1.5	1.6	0.7	0.3	0.6	0.4	0.7	0.9	0.9	0.9	1.0	1.3	1.4	1.4
Portugal	1.0	1.0	1.0	1.0	0.6	0.5	1.0	0.5	0.6	0.5	1.0	0.5	0.6	0.5	1.0	0.5
Romania	0.9	0.9	0.3	0.6	0.2	0.5	-1.4	0.5	0.7	-0.2	-0.8	-0.7	0.9	0.8	0.2	0.5
Slovakia	0.9	0.6	3.5	1.7	0.2	0.4	1.0	0.4	0.6	1.0	0.4	0.4	0.5	0.5	3.3	1.6
Slovenia	0.7	1.6	3.1	2.6	1.0	0.7	0.9	0.8	0.6	-0.2	0.0	-0.1	0.6	1.5	3.0	2.5
Spain	0.9	1.5	1.0	1.5	0.8	0.6	1.0	0.6	0.4	0.1	0.2	0.1	0.7	0.8	0.2	0.7
Sweden	0.9	0.2	3.0	3.0	0.8	1.0	1.0	1.0	0.6	1.4	0.0	0.2	0.6	1.3	2.0	2.0
UK	1.0	1.2	2.1	2.0	0.6	0.4	1.1	0.5	1.2	0.5	0.1	0.3	0.6	0.6	1.6	1.2

Table 83: Capital recovery index in the Cournot competition case, with the introduction of capacity payment mechanisms, under low XB trade conditions

Capital recovery index - Cournot competition case - All projected investments - Capacity payment only to peak devices																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	1.5	2.6	2.1	0.8	0.8	1.3	1.0	0.9	0.8	0.3	0.5	0.9	1.2	1.8	1.5
Austria	0.3	1.1	0.3	0.3	0.1	0.2	1.0	0.2	0.3	0.2	0.1	0.1	0.2	0.2	0.1	0.1
Belgium	2.0	1.0	1.0	1.0	1.7	1.3	3.1	2.5	1.0	1.1	0.7	0.9	1.5	1.1	1.8	1.5
Bulgaria	1.0	1.2	1.7	1.4	1.0	0.8	0.7	0.7	0.6	1.1	0.3	0.8	0.6	1.2	1.5	1.3
Croatia	1.0	6.7	1.0	6.7	2.6	2.9	3.6	3.0	1.0	0.9	0.6	0.7	2.6	2.1	0.9	1.6
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.5	1.6	3.3	2.7	0.3	0.6	2.0	0.7	1.7	1.8	0.7	1.6	1.4	1.5	3.3	2.6
Denmark	0.4	2.3	1.3	1.3	1.0	1.0	1.0	1.0	2.2	1.0	0.5	0.5	0.8	2.3	0.5	0.5
Estonia	0.6	1.3	0.6	1.2	1.0	0.3	0.4	0.3	0.1	0.5	0.4	0.5	0.6	1.1	0.5	1.0
Finland	1.2	0.9	1.7	1.4	0.7	0.3	0.4	0.4	1.3	1.7	0.0	0.8	1.0	1.0	1.6	1.4
France	0.1	0.2	3.7	3.2	0.5	0.5	1.0	0.5	0.3	-0.6	0.3	0.2	0.2	0.3	2.8	2.3
Germany	1.1	1.6	1.3	1.6	0.2	0.2	0.8	0.7	1.2	0.5	0.1	0.3	0.7	1.2	0.6	1.0
Greece	2.5	3.4	1.0	3.4	1.9	2.4	5.3	3.3	1.0	1.4	0.8	1.0	1.8	2.4	2.3	2.4
Hungary	2.3	4.6	2.9	3.4	2.1	1.7	0.7	1.4	2.6	5.7	0.6	1.1	2.3	3.7	2.3	2.8
Ireland	1.5	2.4	1.0	2.4	0.9	0.7	1.3	0.8	0.7	0.2	0.2	0.2	1.0	0.6	0.4	0.4
Italy	2.2	2.7	3.9	2.7	1.2	1.6	1.0	1.6	0.7	3.0	0.4	0.7	1.2	2.4	0.4	1.4
Latvia	2.2	1.9	1.8	1.8	1.6	1.7	1.0	1.7	1.8	0.2	0.3	0.2	1.7	0.9	0.3	0.8
Lithuania	1.0	1.0	0.9	0.9	4.3	3.5	1.0	3.5	1.4	2.1	-0.2	0.1	3.6	3.1	0.7	0.9
Luxembourg	1.0	1.0	1.0	1.0	5.2	7.0	5.5	5.7	3.2	0.0	1.0	0.0	5.0	4.0	5.5	5.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.2	3.0	1.5	0.8	0.6	0.9	0.6	2.8	1.9	0.5	0.7	1.3	1.0	1.5	1.1
Poland	1.1	1.7	1.6	1.6	0.6	0.3	0.6	0.4	0.8	1.0	0.9	1.0	1.0	1.4	1.5	1.5
Portugal	1.0	1.0	1.0	1.0	0.7	0.4	1.0	0.4	0.7	0.6	1.0	0.6	0.7	0.5	1.0	0.5
Romania	1.3	1.7	1.7	1.7	0.3	0.6	-0.3	0.6	0.8	-0.1	-0.2	-0.2	1.2	1.3	1.5	1.4
Slovakia	1.3	0.7	4.1	2.0	0.1	0.3	1.0	0.3	0.9	1.0	0.7	0.7	0.6	0.7	4.0	1.9
Slovenia	0.7	2.0	3.4	2.9	1.0	1.0	1.6	1.4	0.7	0.0	0.0	0.0	0.7	1.9	3.4	2.8
Spain	0.8	1.5	1.0	1.5	0.4	0.5	1.0	0.5	0.5	0.2	0.2	0.2	0.4	0.7	0.2	0.7
Sweden	0.9	0.2	3.4	3.4	0.8	1.0	1.0	1.0	0.6	1.5	0.0	0.2	0.7	1.4	2.3	2.3
UK	1.1	1.4	2.2	2.1	0.7	0.6	1.4	0.7	1.5	0.7	0.1	0.4	0.7	0.8	1.6	1.3

Capital recovery index - Cournot competition case - All projected investments - Capacity payment only to peak devices and CCGT																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	1.5	2.6	2.1	1.0	0.9	1.4	1.1	0.9	0.8	0.3	0.5	1.0	1.2	1.8	1.6
Austria	0.3	1.1	0.3	0.3	0.4	0.3	1.0	0.3	0.3	0.2	0.1	0.1	0.4	0.3	0.1	0.2
Belgium	2.0	1.0	1.0	1.0	1.9	1.4	3.1	2.6	1.0	1.1	0.7	0.9	1.6	1.2	1.8	1.5
Bulgaria	1.0	1.2	1.7	1.4	1.0	0.8	0.8	0.8	0.6	1.1	0.3	0.8	0.6	1.2	1.5	1.3
Croatia	1.0	6.7	1.0	6.7	2.6	2.9	3.6	3.0	1.0	0.9	0.6	0.7	2.6	2.1	0.9	1.6
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.5	1.6	3.3	2.7	0.5	0.6	2.0	0.7	1.7	1.8	0.7	1.6	1.5	1.5	3.3	2.6
Denmark	0.4	2.3	1.3	1.3	1.2	1.0	1.0	1.0	2.2	1.0	0.5	0.5	0.8	2.3	0.5	0.5
Estonia	0.6	1.3	0.6	1.2	1.0	0.3	0.5	0.4	0.1	0.5	0.4	0.5	0.6	1.1	0.5	1.0
Finland	1.2	0.9	1.7	1.4	1.3	0.3	0.4	0.4	1.3	1.7	0.0	0.8	1.2	1.0	1.6	1.4
France	0.1	0.2	3.7	3.2	0.7	0.6	1.0	0.6	0.3	-0.6	0.3	0.2	0.2	0.3	2.8	2.3
Germany	1.1	1.6	1.3	1.6	0.6	0.5	1.0	0.9	1.2	0.5	0.1	0.3	0.9	1.2	0.7	1.0
Greece	2.5	3.4	1.0	3.4	2.2	2.5	5.3	3.4	1.0	1.4	0.8	1.0	1.9	2.5	2.3	2.4
Hungary	2.3	4.6	2.9	3.4	2.3	1.7	0.7	1.4	2.6	5.7	0.6	1.1	2.4	3.7	2.3	2.8
Ireland	1.5	2.4	1.0	2.4	0.9	0.7	1.3	0.8	0.7	0.2	0.2	0.2	1.0	0.6	0.4	0.4
Italy	2.2	2.7	3.9	2.7	1.3	1.6	1.0	1.6	0.7	3.0	0.4	0.7	1.3	2.4	0.4	1.4
Latvia	2.2	1.9	1.8	1.8	1.7	1.7	1.0	1.7	1.8	0.2	0.3	0.2	1.7	0.9	0.3	0.8
Lithuania	1.0	1.0	0.9	0.9	4.6	3.8	1.0	3.8	1.4	2.1	-0.2	0.1	3.9	3.2	0.7	0.9
Luxembourg	1.0	1.0	1.0	1.0	5.4	7.0	5.5	5.7	3.2	0.0	1.0	0.0	5.2	4.0	5.5	5.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.2	3.0	1.5	0.8	0.6	0.9	0.6	2.8	1.9	0.5	0.7	1.4	1.0	1.5	1.1
Poland	1.1	1.7	1.6	1.6	0.7	0.3	0.6	0.4	0.8	1.0	0.9	1.0	1.1	1.4	1.5	1.5
Portugal	1.0	1.0	1.0	1.0	0.9	0.6	1.0	0.6	0.7	0.6	1.0	0.6	0.8	0.6	1.0	0.6
Romania	1.3	1.7	1.7	1.7	0.4	0.7	-0.2	0.6	0.8	-0.1	-0.2	-0.2	1.2	1.3	1.5	1.4
Slovakia	1.3	0.7	4.1	2.0	0.2	0.4	1.0	0.4	0.9	1.0	0.7	0.7	0.6	0.7	4.0	1.9
Slovenia	0.7	2.0	3.4	2.9	1.0	1.1	1.6	1.4	0.7	0.0	0.0	0.0	0.7	1.9	3.4	2.8
Spain	0.8	1.5	1.0	1.5	0.9	0.8	1.0	0.8	0.5	0.2	0.2	0.2	0.9	0.8	0.2	0.8
Sweden	0.9	0.2	3.4	3.4	0.8	1.0	1.0	1.0	0.6	1.5	0.0	0.2	0.7	1.4	2.3	2.3
UK	1.1	1.4	2.2	2.1	0.8	0.6	1.4	0.7	1.5	0.7	0.1	0.4	0.8	0.8	1.6	1.3

Capital recovery index - Cournot competition case - All projected investments - Capacity payment to all power plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	1.6	2.6	2.2	1.0	0.9	1.4	1.1	0.9	0.8	0.3	0.5	1.0	1.2	1.8	1.6
Austria	0.4	1.1	0.3	0.3	0.4	0.3	1.0	0.3	0.3	0.2	0.1	0.1	0.4	0.3	0.1	0.2
Belgium	2.0	1.0	1.0	1.0	1.9	1.4	3.1	2.6	1.0	1.1	0.7	0.9	1.6	1.2	1.8	1.5
Bulgaria	1.0	1.2	1.7	1.4	1.0	0.8	0.8	0.8	0.6	1.1	0.3	0.8	0.6	1.2	1.5	1.3
Croatia	1.0	6.7	1.0	6.7	2.6	2.9	3.6	3.0	1.0	0.9	0.6	0.7	2.6	2.1	0.9	1.6
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.5	1.6	3.3	2.7	0.5	0.6	2.0	0.7	1.7	1.8	0.7	1.6	1.5	1.5	3.3	2.6
Denmark	0.5	2.3	1.3	1.3	1.2	1.0	1.0	1.0	2.2	1.0	0.5	0.5	0.8	2.3	0.5	0.5
Estonia	0.8	1.3	0.6	1.3	1.0	0.3	0.5	0.4	0.1	0.5	0.4	0.5	0.8	1.1	0.5	1.0
Finland	1.4	1.0	1.7	1.4	1.3	0.3	0.4	0.4	1.3	1.7	0.0	0.8	1.3	1.0	1.7	1.4
France	0.2	0.3	3.7	3.2	0.7	0.6	1.0	0.6	0.3	-0.6	0.3	0.2	0.3	0.4	2.8	2.3
Germany	1.3	1.7	1.3	1.7	0.6	0.5	1.0	0.9	1.2	0.5	0.1	0.3	1.0	1.3	0.7	1.1
Greece	2.6	3.4	1.0	3.4	2.2	2.5	5.3	3.4	1.0	1.4	0.8	1.0	1.9	2.5	2.3	2.4
Hungary	2.3	4.6	2.9	3.4	2.3	1.7	0.7	1.4	2.6	5.7	0.6	1.1	2.4	3.7	2.3	2.8
Ireland	1.5	2.4	1.0	2.4	0.9	0.7	1.3	0.8	0.7	0.2	0.2	0.2	1.0	0.6	0.4	0.4
Italy	2.2	2.7	3.9	2.7	1.3	1.6	1.0	1.6	0.7	3.0	0.4	0.7	1.3	2.4	0.4	1.4
Latvia	2.2	1.9	1.8	1.8	1.7	1.7	1.0	1.7	1.8	0.2	0.3	0.2	1.7	0.9	0.3	0.8
Lithuania	1.0	1.0	1.0	1.0	4.6	3.8	1.0	3.8	1.4	2.1	-0.2	0.1	3.9	3.2	0.8	1.0
Luxembourg	1.0	1.0	1.0	1.0	5.4	7.0	5.5	5.7	3.2	0.0	1.0	0.0	5.2	4.0	5.5	5.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.2	3.0	1.5	0.8	0.6	0.9	0.6	2.8	1.9	0.5	0.7	1.4	1.0	1.5	1.1
Poland	1.1	1.7	1.6	1.6	0.7	0.3	0.6	0.4	0.8	1.0	0.9	1.0	1.1	1.4	1.5	1.5
Portugal	1.0	1.0	1.0	1.0	0.9	0.6	1.0	0.6	0.7	0.6	1.0	0.6	0.8	0.6	1.0	0.6
Romania	1.3	1.7	1.7	1.7	0.4	0.7	-0.2	0.6	0.8	-0.1	-0.2	-0.2	1.2	1.3	1.5	1.4
Slovakia	1.3	0.7	4.1	2.0	0.2	0.4	1.0	0.4	0.9	1.0	0.7	0.7	0.6	0.7	4.0	2.0
Slovenia	0.8	2.0	3.4	2.9	1.0	1.1	1.6	1.4	0.7	0.0	0.0	0.0	0.8	1.9	3.4	2.8
Spain	1.0	1.5	1.0	1.5	0.9	0.8	1.0	0.8	0.5	0.2	0.2	0.2	0.9	0.9	0.2	0.8
Sweden	0.9	0.2	3.4	3.4	0.8	1.0	1.0	1.0	0.6	1.5	0.0	0.2	0.7	1.4	2.3	2.3
UK	1.2	1.4	2.2	2.1	0.8	0.6	1.4	0.7	1.5	0.7	0.1	0.4	0.8	0.8	1.6	1.3

Table 84: Capacity remuneration fee per MW, for the three bidding regimes, under low XB trade conditions

Capacity remuneration fee (EUR/MW)	Marginal cost bidding		Supply function equilibrium		Cournot competition	
	2020	2030	2020	2030	2020	2030
EU27	24997	18455	20731	13328	17737	6271
Austria	54904	0	49485	0	15009	0
Belgium	15558	898	13824	0	0	0
Bulgaria	0	12366	0	19594	0	14496
Croatia	0	0	0	0	0	0
Cyprus						
Czech	109	0	0	0	0	0
Denmark	0	0	0	0	0	0
Estonia	10814	6885	24901	0	0	0
Finland	64240	26734	64234	25684	64212	13973
France	0	28379	0	26105	0	11706
Germany	54259	41930	53029	40823	45503	15491
Greece	49142	0	47266	0	43051	0
Hungary	0	0	0	0	0	0
Ireland	2811	12510	0	3603	0	0
Italy	21373	32079	0	1107	0	0
Latvia	0	19532	0	24410	0	0
Lithuania	0	138153	0	134044	0	91804
Luxembourg	0	0	0	0	0	0
Malta						
Netherlands	0	0	0	0	0	0
Poland	0	0	0	0	0	0
Portugal	45488	2408	15289	0	17010	0
Romania	0	0	0	0	0	0
Slovakia	0	0	384	0	0	0
Slovenia	0	0	0	0	0	0
Spain	53886	16910	36032	0	46516	0
Sweden	0	0	0	5193	0	14917
UK	0	0	0	0	0	0

Table 85: Capacity payments, for the three bidding regimes, under low XB trade conditions

Payment for capacity to peak devices (M€)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	602	1573	2489	1305	1828	1101	859
Austria	6	50	0	45	0	14	0
Belgium	0	76	7	67	0	0	0
Bulgaria	2	0	16	0	25	0	18
Croatia	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0
Czech	17	0	0	0	0	0	0
Denmark	0	0	0	0	0	0	0
Estonia	0	5	3	12	0	0	0
Finland	10	44	29	44	28	44	15
France	187	0	601	0	553	0	248
Germany	31	914	1014	893	987	767	375
Greece	66	90	0	87	0	79	0
Hungary	0	0	0	0	0	0	0
Ireland	3	2	19	0	6	0	0
Italy	95	119	540	0	19	0	0
Latvia	0	0	12	0	15	0	0
Lithuania	1	0	170	0	165	0	113
Luxembourg	0	0	0	0	0	0	0
Malta	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0
Poland	0	0	0	0	0	0	0
Portugal	70	78	4	26	0	29	0
Romania	1	0	0	0	0	0	0
Slovakia	3	0	0	0	0	0	0
Slovenia	14	0	0	0	0	0	0
Spain	95	195	74	130	0	168	0
Sweden	0	0	0	0	31	0	90
UK	1	0	0	0	0	0	0

Payment for capacity to peak devices and CCGT (M€)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	3643	5013	5711	3382	3491	3214	1511
Austria	35	211	0	190	0	58	0
Belgium	0	115	12	102	0	0	0
Bulgaria	2	0	29	0	46	0	34
Croatia	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0
Czech	45	0	0	0	0	0	0
Denmark	0	0	0	0	0	0	0
Estonia	0	11	8	25	0	0	0
Finland	25	68	46	68	45	68	24
France	420	0	807	0	742	0	333
Germany	212	1525	2342	1490	2280	1279	865
Greece	200	323	0	310	0	283	0
Hungary	0	0	0	0	0	0	0
Ireland	13	8	52	0	15	0	0
Italy	958	824	1599	0	55	0	0
Latvia	0	0	35	0	44	0	0
Lithuania	5	0	238	0	231	0	158
Luxembourg	0	0	0	0	0	0	0
Malta	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0
Poland	0	0	0	0	0	0	0
Portugal	252	281	15	94	0	105	0
Romania	2	0	0	0	0	0	0
Slovakia	29	0	0	0	0	0	0
Slovenia	14	0	0	0	0	0	0
Spain	1414	1647	529	1102	0	1422	0
Sweden	0	0	0	0	34	0	97
UK	15	0	0	0	0	0	0

Payment for capacity to all power plants (M€)	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	4312	6392	8163	4623	5697	4289	2604
Austria	36	215	0	194	0	59	0
Belgium	0	117	12	104	0	0	0
Bulgaria	2	0	74	0	117	0	87
Croatia	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0
Czech	181	1	0	0	0	0	0
Denmark	0	0	0	0	0	0	0
Estonia	0	29	20	67	0	0	0
Finland	31	181	202	181	194	181	106
France	733	0	1817	0	1672	0	750
Germany	297	2508	3199	2451	3115	2103	1182
Greece	224	370	0	356	0	324	0
Hungary	0	0	0	0	0	0	0
Ireland	14	9	55	0	16	0	0
Italy	1003	924	1748	0	60	0	0
Latvia	0	0	36	0	45	0	0
Lithuania	5	0	421	0	409	0	280
Luxembourg	0	0	0	0	0	0	0
Malta	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0
Poland	0	0	0	0	0	0	0
Portugal	252	281	15	94	0	105	0
Romania	10	0	0	0	0	0	0
Slovakia	33	0	0	1	0	0	0
Slovenia	16	0	0	0	0	0	0
Spain	1458	1757	564	1175	0	1517	0
Sweden	0	0	0	0	70	0	200
UK	15	0	0	0	0	0	0

Table 86: Payment for capacity over total payment for electricity, under low XB trade conditions

Payment for capacity to peak devices over total payments for electricity	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	0.4	0.6	0.8	0.5	0.5	0.4	0.2
Austria	0.2	1.4	0.0	1.3	0.0	0.4	0.0
Belgium	0.0	0.9	0.1	0.7	0.0	0.0	0.0
Bulgaria	0.2	0.0	0.5	0.0	0.8	0.0	0.5
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Denmark	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estonia	0.0	0.7	0.3	1.5	0.0	0.0	0.0
Finland	0.3	0.7	0.5	0.7	0.4	0.6	0.2
France	0.9	0.0	1.4	0.0	1.3	0.0	0.5
Germany	0.1	2.0	1.8	1.9	1.7	1.6	0.6
Greece	2.2	1.6	0.0	1.5	0.0	1.1	0.0
Hungary	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ireland	0.2	0.1	0.6	0.0	0.2	0.0	0.0
Italy	0.5	0.4	1.3	0.0	0.0	0.0	0.0
Latvia	0.0	0.0	2.0	0.0	2.3	0.0	0.0
Lithuania	0.2	0.0	17.7	0.0	16.6	0.0	9.7
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Poland	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	3.0	1.8	0.1	0.5	0.0	0.6	0.0
Romania	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Slovakia	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Slovenia	5.0	0.0	0.0	0.0	0.0	0.0	0.0
Spain	0.9	0.8	0.2	0.5	0.0	0.7	0.0
Sweden	0.0	0.0	0.0	0.0	0.3	0.0	0.7
UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Payment for capacity to peak devices and CCGT over total payments for electricity	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	2.5	1.9	1.8	1.2	1.0	1.1	0.4
Austria	1.4	5.8	0.0	5.2	0.0	1.6	0.0
Belgium	0.0	1.3	0.1	1.1	0.0	0.0	0.0
Bulgaria	0.2	0.0	1.0	0.0	1.5	0.0	0.9
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	3.1	0.0	0.0	0.0	0.0	0.0	0.0
Denmark	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estonia	0.0	1.3	0.7	3.1	0.0	0.0	0.0
Finland	0.7	1.1	0.7	1.0	0.6	0.9	0.3
France	2.0	0.0	1.9	0.0	1.7	0.0	0.7
Germany	0.8	3.3	4.0	3.2	3.8	2.7	1.4
Greece	6.4	5.5	0.0	5.1	0.0	3.9	0.0
Hungary	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ireland	1.0	0.4	1.7	0.0	0.5	0.0	0.0
Italy	5.1	2.5	3.8	0.0	0.1	0.0	0.0
Latvia	0.0	0.0	5.8	0.0	6.7	0.0	0.0
Lithuania	0.8	0.0	23.1	0.0	21.9	0.0	13.0
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Poland	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	10.0	6.1	0.2	1.9	0.0	1.9	0.0
Romania	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Slovakia	4.7	0.0	0.0	0.0	0.0	0.0	0.0
Slovenia	5.0	0.0	0.0	0.0	0.0	0.0	0.0
Spain	11.6	6.7	1.7	4.2	0.0	5.3	0.0
Sweden	0.0	0.0	0.0	0.0	0.3	0.0	0.8
UK	0.1	0.0	0.0	0.0	0.0	0.0	0.0

Payment for capacity to all power plants over total payments for electricity	Marginal cost bidding			Supply function equilibrium		Cournot competition	
	2010	2020	2030	2020	2030	2020	2030
EU27	2.9	2.5	2.5	1.7	1.7	1.4	0.7
Austria	1.4	5.9	0.0	5.3	0.0	1.7	0.0
Belgium	0.0	1.3	0.1	1.1	0.0	0.0	0.0
Bulgaria	0.2	0.0	2.5	0.0	3.7	0.0	2.4
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	11.3	0.0	0.0	0.0	0.0	0.0	0.0
Denmark	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estonia	0.0	3.5	1.8	7.9	0.0	0.0	0.0
Finland	0.9	2.8	3.2	2.6	2.7	2.2	1.3
France	3.5	0.0	4.1	0.0	3.8	0.0	1.5
Germany	1.1	5.3	5.4	5.2	5.2	4.3	1.9
Greece	7.1	6.3	0.0	5.8	0.0	4.5	0.0
Hungary	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ireland	1.1	0.4	1.8	0.0	0.5	0.0	0.0
Italy	5.3	2.8	4.1	0.0	0.1	0.0	0.0
Latvia	0.0	0.0	5.9	0.0	6.8	0.0	0.0
Lithuania	0.8	0.0	34.7	0.0	33.1	0.0	21.0
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Poland	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	10.0	6.1	0.2	1.9	0.0	1.9	0.0
Romania	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Slovakia	5.4	0.0	0.0	0.1	0.0	0.0	0.0
Slovenia	5.6	0.0	0.0	0.0	0.0	0.0	0.0
Spain	11.9	7.1	1.8	4.5	0.0	5.6	0.0
Sweden	0.0	0.0	0.0	0.0	0.6	0.0	1.6
UK	0.1	0.0	0.0	0.0	0.0	0.0	0.0

Impacts of asymmetric capacity remuneration mechanisms

Table 87: Capacity fee per MW, if capacity mechanisms are introduced asymmetrically, under supply function equilibrium competition

Capacity fee (EUR/MW)	Capacity remuneration only in France		Capacity remuneration only in Germany	
	2020	2030	2020	2030
EU27	0	0	0	0
Austria	0	0	0	0
Belgium	0	0	0	0
Bulgaria	0	0	0	0
Croatia	0	0	0	0
Cyprus	0	0	0	0
Czech	0	0	0	0
Denmark	0	0	0	0
Estonia	0	0	0	0
Finland	0	0	0	0
France	40000	40000	0	0
Germany	0	0	40000	40000
Greece	0	0	0	0
Hungary	0	0	0	0
Ireland	0	0	0	0
Italy	0	0	0	0
Latvia	0	0	0	0
Lithuania	0	0	0	0
Luxembourg	0	0	0	0
Malta	0	0	0	0
Netherlands	0	0	0	0
Poland	0	0	0	0
Portugal	0	0	0	0
Romania	0	0	0	0
Slovakia	0	0	0	0
Slovenia	0	0	0	0
Spain	0	0	0	0
Sweden	0	0	0	0
UK	0	0	0	0

Table 88: Payment for capacity if capacity mechanisms are introduced asymmetrically, under supply function equilibrium competition

	Capacity remuneration only in France		Capacity remuneration only in Germany	
	2020	2030	2020	2030
Payment for capacity to peak devices (M€)	81	231	151	615
Payment for capacity to peak devices and CCGT (M€)	355	521	521	1543

Table 89: Change in cross border flows (sum of exports and imports), relative to Reference scenario when capacity remuneration is applied asymmetrically, under supply function equilibrium competition

Net imports in GWh	Reference		Change relative to Reference			
			Capacity payment only in France		Capacity payment only in Germany	
	2020	2030	2020	2030	2020	2030
EU27	-26204	-26038				
Austria	1299	-1676	17	43	11	70
Belgium	409	16030	3773	5155	5607	2450
Bulgaria	-12043	-13171	368	-91	38	-492
Croatia	5069	7866	82	-23	-21	-238
Cyprus	0	0	0	0	0	0
Czech	-4521	-8464	-237	-848	2	-625
Denmark	-2701	-1033	-160	-535	31	-298
Estonia	-4168	867	272	-12	14	-176
Finland	8874	-5573	256	-215	21	-423
France	-56935	-58183	-43792	-48783	43	29342
Germany	2185	22332	12468	19120	-6600	-15787
Greece	5574	7977	358	-68	43	-646
Hungary	3795	4892	219	-257	-6	-618
Ireland	-7638	-9924	-4310	-1608	-108	1433
Italy	36657	45254	5144	1678	75	-5297
Latvia	-442	-106	3	-36	-12	-64
Lithuania	4193	-7257	26	-44	-29	-203
Luxembourg	4034	4161	-39	-41	-33	-9
Malta	0	0	0	0	0	0
Netherlands	1310	-2118	328	3828	949	2093
Poland	-4837	-3825	-637	-1791	28	-1015
Portugal	2369	3799	2475	1974	-16	-314
Romania	-7297	-10211	331	-88	19	-555
Slovakia	-1053	-4619	-43	-597	-16	-440
Slovenia	-274	-3172	91	-14	4	-163
Spain	3514	-4988	15602	21171	-9	-3419
Sweden	-17731	-19549	-106	-1263	-27	-1161
UK	14154	14654	7511	3345	-8	-3445

Table 90: Capital recovery index when capacity remuneration is applied only in France, under supply function equilibrium competition

Capital recovery index - Capacity remuneration only in France - All projected investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.2	2.6	2.0	0.2	0.3	0.7	0.4	0.3	0.3	0.2	0.2	0.4	0.8	1.9	1.4
Austria	0.3	1.0	1.3	1.3	0.0	0.0	1.0	0.0	0.2	0.3	0.3	0.3	0.1	0.1	0.5	0.3
Belgium	1.5	1.0	1.0	1.0	0.6	0.3	1.2	0.8	0.1	1.4	0.6	1.1	0.6	0.9	1.0	1.0
Bulgaria	1.0	1.0	1.4	1.2	1.0	0.4	0.6	0.5	-0.1	0.2	-0.2	0.1	-0.1	0.8	1.3	1.0
Croatia	1.0	5.0	1.0	5.0	0.6	0.7	0.5	0.6	1.0	1.0	-3.7	-3.7	0.6	1.0	0.3	0.6
Cyprus	1.0	1.0	1.0	1.0	1.0	0.2	1.0	0.2	0.8	0.0	-0.3	-0.1	0.8	0.1	0.1	0.1
Czech	1.5	1.1	2.4	1.9	0.1	0.3	1.0	0.3	0.6	0.5	-0.4	0.3	1.4	1.0	2.4	1.8
Denmark	0.2	0.6	0.7	0.7	0.3	1.0	1.8	1.8	0.1	-2.8	-0.3	-0.3	0.2	-2.6	0.0	0.0
Estonia	0.7	1.0	0.3	1.0	1.0	0.1	0.0	0.1	-0.2	0.1	-0.1	0.0	0.7	0.8	0.2	0.8
Finland	0.6	0.9	1.6	1.3	0.1	1.0	0.0	0.0	0.3	4.4	-0.1	2.0	0.3	0.9	1.6	1.3
France	0.2	0.4	4.4	3.7	0.4	0.5	1.0	0.5	-0.1	0.2	0.5	0.3	0.2	0.3	3.2	2.2
Germany	0.8	1.2	1.1	1.2	0.2	0.1	0.6	0.6	0.4	0.1	-0.1	0.0	0.5	0.9	0.5	0.8
Greece	1.1	1.5	1.0	1.5	0.2	0.3	1.3	0.6	0.0	0.0	0.0	0.0	0.4	0.6	0.9	0.7
Hungary	1.8	3.6	1.8	2.3	0.8	0.7	0.3	0.5	0.7	3.5	0.0	1.1	1.2	2.7	1.5	1.9
Ireland	0.9	1.2	1.0	1.2	0.3	0.2	0.0	0.1	0.0	-0.4	-0.2	-0.2	0.3	0.1	-0.2	0.0
Italy	1.4	1.8	2.2	1.8	0.1	0.2	1.0	0.2	0.2	1.9	0.0	0.2	0.2	1.4	0.0	0.7
Latvia	1.8	2.6	1.2	1.5	0.3	0.2	1.0	0.2	0.6	0.4	0.7	0.5	0.4	0.3	0.7	0.4
Lithuania	1.0	1.0	1.3	1.3	0.7	0.6	1.0	0.6	-0.1	-0.4	-0.5	-0.5	0.5	0.3	1.0	0.9
Luxembourg	1.0	1.0	1.0	1.0	0.0	1.0	1.1	1.1	0.0	0.0	1.0	0.0	0.0	0.6	1.1	0.9
Malta	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	0.3	-0.3	1.0	-0.3	0.3	1.0	1.0	1.0
Netherlands	1.0	1.1	3.1	1.4	0.3	0.3	0.3	0.3	1.8	2.3	0.5	0.7	0.7	0.9	1.6	1.0
Poland	0.8	1.4	1.6	1.5	0.1	0.2	0.6	0.4	0.1	0.5	3.4	0.7	0.7	0.9	1.5	1.4
Portugal	1.0	1.0	1.0	1.0	0.1	0.1	1.0	0.1	0.0	-0.1	0.2	0.0	0.1	0.0	0.2	0.0
Romania	0.9	1.0	1.5	1.3	0.1	0.1	-0.2	0.1	0.0	-0.7	-0.4	-0.5	0.8	0.6	1.2	0.9
Slovakia	0.8	0.6	3.7	1.8	0.2	0.6	1.0	0.6	0.5	1.0	1.4	1.4	0.5	0.6	3.6	1.8
Slovenia	0.6	1.9	3.4	2.9	1.0	0.8	1.0	0.9	0.1	0.5	0.0	0.5	0.2	1.8	3.3	2.8
Spain	0.7	1.3	1.0	1.3	0.3	0.2	1.0	0.2	0.1	0.1	0.2	0.1	0.3	0.5	0.2	0.5
Sweden	0.7	0.5	4.3	4.3	0.6	1.0	1.0	1.0	0.2	0.0	-1.2	-0.3	0.3	0.0	4.2	3.9
UK	0.7	1.2	2.1	1.9	0.3	0.2	0.1	0.2	0.5	0.1	0.0	0.1	0.3	0.3	1.6	1.0

Capital recovery index - Capacity remuneration only in France - Retrofitting investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	2.0	4.0	3.8	1.0	0.2	0.2	0.2	1.0	0.1	0.0	0.1	1.0	1.2	3.8	3.4
Austria	1.0	1.0	1.3	1.3	1.0	1.0	1.0	1.0	1.0	0.2	4.5	0.9	1.0	0.2	1.7	1.1
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.5	4.5	3.8	1.0	3.5	4.5	3.8
Bulgaria	1.0	1.4	-0.2	0.0	1.0	1.0	1.0	1.0	1.0	0.0	-0.3	-0.1	1.0	0.4	-0.2	0.0
Croatia	1.0	5.0	1.0	5.0	1.0	1.0	1.0	1.0	1.0	1.0	-3.7	-3.7	1.0	5.0	-3.7	-0.5
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	0.7	3.3	2.8	1.0	1.0	1.0	1.0	1.0	14.2	-1.4	14.0	1.0	0.9	3.3	2.8
Denmark	1.0	0.6	0.2	0.2	1.0	1.0	1.0	1.0	1.0	-2.8	-2.9	-2.9	1.0	-2.6	-2.3	-2.3
Estonia	1.0	1.0	0.3	0.8	1.0	1.0	1.0	1.0	1.0	0.4	1.0	0.4	1.0	1.0	0.3	0.8
Finland	1.0	1.9	0.7	0.8	1.0	1.0	0.0	0.0	1.0	6.7	-0.1	0.2	1.0	2.3	0.6	0.7
France	1.0	1.1	4.4	4.3	1.0	1.0	1.0	1.0	1.0	-0.6	0.0	-0.4	1.0	-0.1	4.3	4.2
Germany	1.0	1.6	1.1	1.3	1.0	0.1	1.0	0.1	1.0	-0.5	-0.6	-0.5	1.0	0.4	1.0	0.6
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0
Hungary	1.0	3.6	2.7	3.2	1.0	1.0	1.0	1.0	1.0	0.0	-2.6	-1.2	1.0	3.5	2.7	3.1
Ireland	1.0	1.2	1.0	1.2	1.0	1.0	1.0	1.0	1.0	-0.9	1.0	-0.9	1.0	-0.8	1.0	-0.8
Italy	1.0	1.0	2.2	2.2	1.0	1.0	1.0	1.0	1.0	-0.5	-1.4	-0.6	1.0	-0.5	-1.1	-0.6
Latvia	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	1.0	1.0	0.0	0.0	1.0	0.1	0.0	0.1
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.4	-1.0	-0.6	1.0	-0.4	-1.0	-0.6
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	3.2	3.2	1.0	0.2	0.3	0.3	1.0	2.0	0.3	1.0	1.0	0.7	2.3	2.0
Poland	1.0	1.2	0.1	0.7	1.0	-0.4	0.1	-0.1	1.0	4.3	1.0	4.3	1.0	1.4	0.1	0.8
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.7	0.4	-0.7	1.0	-0.7	0.4	-0.7
Romania	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-1.1	-1.4	-1.4	1.0	0.2	0.8	0.8
Slovakia	1.0	0.8	4.7	4.6	1.0	1.0	1.0	1.0	1.0	1.0	1.4	1.4	1.0	0.8	4.7	4.6
Slovenia	1.0	3.0	4.9	4.7	1.0	1.0	1.0	1.0	1.0	0.5	0.0	0.5	1.0	2.3	4.8	4.6
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	4.7	0.9	1.0	0.8	4.7	0.9
Sweden	1.0	1.0	4.8	4.8	1.0	1.0	1.0	1.0	1.0	-3.1	-2.6	-2.7	1.0	-3.1	4.8	4.7
UK	1.0	2.3	1.0	2.3	1.0	1.0	0.1	0.1	1.0	1.2	2.1	1.4	1.0	1.9	1.7	1.9

Capital recovery index - Capacity remuneration only in France - New plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.1	1.7	1.4	0.2	0.3	0.8	0.4	0.3	0.3	0.2	0.2	0.4	0.7	1.1	0.9
Austria	0.3	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.2	0.3	0.2	0.2	0.1	0.1	0.2	0.1
Belgium	1.5	1.0	1.0	1.0	0.6	0.3	1.2	0.8	0.1	1.0	0.2	0.7	0.6	0.7	0.9	0.7
Bulgaria	1.0	1.0	1.6	1.2	1.0	0.4	0.6	0.5	-0.1	0.2	-0.2	0.1	-0.1	0.8	1.4	1.0
Croatia	1.0	1.0	1.0	1.0	0.6	0.7	0.5	0.6	1.0	1.0	1.0	1.0	0.6	0.7	0.5	0.6
Cyprus	1.0	1.0	1.0	1.0	1.0	0.2	1.0	0.2	0.8	0.0	-0.3	-0.1	0.8	0.1	0.1	0.1
Czech	1.5	1.2	1.9	1.6	0.1	0.3	1.0	0.3	0.6	0.1	-0.4	0.0	1.4	1.1	1.9	1.5
Denmark	0.2	1.0	0.7	0.7	0.3	1.0	1.8	1.8	0.1	1.0	-0.1	-0.1	0.2	1.0	0.2	0.2
Estonia	0.7	1.0	1.0	1.0	1.0	0.1	0.0	0.1	-0.2	0.0	-0.1	0.0	0.7	0.8	0.0	0.8
Finland	0.6	0.9	1.7	1.4	0.1	1.0	1.0	1.0	0.3	4.2	1.0	4.2	0.3	0.9	1.7	1.4
France	0.2	0.4	1.0	0.4	0.4	0.5	1.0	0.5	-0.1	0.2	0.5	0.4	0.2	0.3	0.5	0.4
Germany	0.8	1.2	1.0	1.2	0.2	0.1	0.6	0.6	0.4	0.2	-0.1	0.1	0.5	0.9	0.4	0.8
Greece	1.1	1.5	1.0	1.5	0.2	0.3	1.3	0.6	0.0	0.0	0.0	0.0	0.4	0.6	0.9	0.7
Hungary	1.8	1.0	1.2	1.2	0.8	0.7	0.3	0.5	0.7	4.0	0.2	1.3	1.2	1.0	1.0	1.0
Ireland	0.9	1.0	1.0	1.0	0.3	0.2	0.0	0.1	0.0	-0.3	-0.2	-0.2	0.3	0.1	-0.2	0.0
Italy	1.4	1.8	1.0	1.8	0.1	0.2	1.0	0.2	0.2	4.6	0.0	0.2	0.2	1.5	0.0	0.7
Latvia	1.8	2.6	1.2	1.5	0.3	0.2	1.0	0.2	0.6	0.4	0.7	0.5	0.4	0.4	0.7	0.4
Lithuania	1.0	1.0	1.3	1.3	0.7	0.6	1.0	0.6	-0.1	-0.4	-0.5	-0.5	0.5	0.4	1.0	1.0
Luxembourg	1.0	1.0	1.0	1.0	0.0	1.0	1.1	1.1	0.0	1.0	1.0	1.0	0.0	1.0	1.1	1.1
Malta	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	0.3	-0.3	1.0	-0.3	0.3	1.0	1.0	1.0
Netherlands	1.0	1.1	2.7	1.2	0.3	0.3	1.2	0.3	1.8	2.8	0.5	0.6	0.7	0.9	0.9	0.9
Poland	0.8	1.5	1.6	1.6	0.1	0.2	0.6	0.4	0.1	0.5	3.4	0.7	0.7	0.9	1.6	1.4
Portugal	1.0	1.0	1.0	1.0	0.1	0.1	1.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Romania	0.9	1.0	1.8	1.4	0.1	0.1	-0.2	0.1	0.0	0.0	-0.2	-0.2	0.8	0.6	1.4	0.9
Slovakia	0.8	0.6	2.6	1.1	0.2	0.6	1.0	0.6	0.5	1.0	1.4	1.4	0.5	0.6	2.5	1.0
Slovenia	0.6	1.8	2.2	2.0	1.0	0.8	1.0	0.9	0.1	0.2	1.0	0.2	0.2	1.8	2.1	1.9
Spain	0.7	1.3	1.0	1.3	0.3	0.2	1.0	0.2	0.1	0.0	0.2	0.1	0.3	0.5	0.2	0.5
Sweden	0.7	0.5	1.7	1.7	0.6	1.0	1.0	1.0	0.2	0.1	-0.4	0.0	0.3	0.2	1.5	1.1
UK	0.7	0.5	2.1	1.9	0.3	0.2	1.0	0.2	0.5	0.0	-0.1	0.0	0.3	0.2	1.6	1.0

Table 91: Capacity factor when capacity remuneration is applied only in France, under supply function equilibrium competition

Capacity factor - Capacity remuneration only in France - All projected investments									
	Base-load			CCGT			Open cycle plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.6	0.8	0.8	0.3	0.4	0.3	0.2	0.1	0.2
Austria	0.8	0.5	0.5	0.3	1.0	0.3	0.4	0.3	0.3
Belgium	1.0	1.0	1.0	0.3	0.7	0.5	0.5	0.3	0.4
Bulgaria	0.4	0.7	0.5	0.2	0.1	0.2	0.1	0.1	0.1
Croatia	1.0	1.0	1.0	0.3	0.7	0.6	1.0	0.3	0.3
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.5	0.8	0.7	0.1	1.0	0.1	0.3	0.4	0.3
Denmark	0.6	0.6	0.6	1.0	0.7	0.7	0.2	0.2	0.2
Estonia	0.6	0.1	0.6	0.0	0.0	0.0	0.0	0.1	0.0
Finland	0.7	0.8	0.8	1.0	0.3	0.3	0.6	0.3	0.4
France	0.4	0.8	0.8	0.3	1.0	0.3	0.1	0.1	0.1
Germany	0.7	0.6	0.7	0.2	0.4	0.4	0.2	0.1	0.2
Greece	0.6	1.0	0.6	0.2	0.5	0.3	0.0	0.0	0.0
Hungary	1.0	0.9	0.9	0.3	0.3	0.3	0.7	0.2	0.4
Ireland	0.5	1.0	0.5	0.1	0.2	0.1	0.2	0.1	0.1
Italy	0.7	0.8	0.7	0.4	1.0	0.4	0.4	0.1	0.1
Latvia	0.8	0.8	0.8	0.2	1.0	0.2	0.2	0.3	0.2
Lithuania	1.0	0.9	0.9	0.4	1.0	0.4	0.2	0.3	0.3
Luxembourg	1.0	1.0	1.0	1.0	1.5	1.4	0.2	1.0	0.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.6	0.7	0.7	0.3	0.3	0.3	0.4	0.2	0.3
Poland	0.7	0.8	0.8	0.2	0.4	0.3	0.2	0.5	0.2
Portugal	1.0	1.0	1.0	0.1	1.0	0.1	0.2	0.1	0.1
Romania	0.8	0.7	0.7	0.1	0.3	0.1	0.1	0.2	0.2
Slovakia	0.5	0.8	0.7	0.2	1.0	0.2	1.0	0.4	0.4
Slovenia	0.6	0.9	0.8	0.2	0.2	0.2	0.3	0.4	0.3
Spain	0.7	1.0	0.7	0.3	1.0	0.3	0.1	0.3	0.2
Sweden	0.3	0.9	0.9	1.0	1.0	1.0	1.0	0.6	0.8
UK	0.8	0.8	0.8	0.3	0.1	0.3	0.2	0.3	0.2

Table 92: Change in investment relative to Reference scenario when capacity remuneration is applied only in France, under supply function equilibrium competition

Change in investment relative to Reference when capacity remuneration is applied only in France - All projected investments in GW												
	Base-load			CCGT			Open cycle plants			All plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.0	0.0	0.0	1.6	-9.1	-7.5	-1.6	9.1	7.5	0.0	0.0	0.0
Austria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belgium	0.0	0.0	0.0	-0.06	-0.9	-0.9	-1.40	-1.3	-2.7	-1.5	-2.2	-3.6
Bulgaria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Denmark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estonia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
France	0.0	0.0	0.0	4.2	0.0	4.2	5.5	11.9	17.4	9.7	11.9	21.7
Germany	0.0	0.0	0.0	-1.4	-8.0	-9.3	-5.5	-1.1	-6.6	-6.8	-9.1	-15.9
Greece	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hungary	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ireland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Latvia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lithuania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.0	0.0	0.0	-1.3	-0.3	-1.5	-0.2	-0.5	-0.6	-1.4	-0.7	-2.1
Poland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Romania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Slovakia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Slovenia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sweden	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 93: Simulated average wholesale market marginal prices (SMP) and change relative to the Reference scenario when capacity remuneration is applied only in France, under supply function equilibrium competition

	Average SMP when capacity remuneration is applied only in France in EUR/MWh		Change relative to Reference in EUR / MWh	
	2020	2030	2020	2030
EU27	69	84	0.07	1.05
Austria	58	91	-0.59	0.01
Belgium	94	109	-0.60	-0.69
Bulgaria	62	93	0.40	-7.50
Croatia	99	91	-0.35	1.66
Cyprus	165	167	0.00	0.00
Czech	74	116	0.06	2.73
Denmark	75	92	0.34	0.60
Estonia	81	66	-0.29	-0.04
Finland	71	89	-0.08	-0.06
France	70	79	5.81	7.11
Germany	74	98	-3.03	3.29
Greece	84	102	0.33	-0.13
Hungary	82	79	0.35	1.44
Ireland	78	84	-0.84	-1.36
Italy	98	111	0.14	-0.37
Latvia	94	104	-0.07	0.07
Lithuania	86	93	0.05	0.57
Luxembourg	92	101	-0.05	1.23
Malta	144	161	0.00	0.00
Netherlands	80	93	1.09	0.36
Poland	79	97	0.63	0.84
Portugal	72	101	-9.80	-0.87
Romania	58	81	-0.02	-0.02
Slovakia	57	118	7.62	8.04
Slovenia	97	121	-0.90	0.03
Spain	85	96	-1.50	-5.12
Sweden	59	80	-6.01	0.42
UK	86	99	-0.12	-0.05

Table 94: Average SMP mark-up indicators, when capacity remuneration is applied only in France, under supply function equilibrium competition

Mark-up (% change over marginal cost bidding)	2020	2030		2020	2030
EU27	6.7	9.5			
Austria	4.5	0.4	Italy	2.0	1.2
Belgium	1.3	9.9	Latvia	8.0	3.0
Bulgaria	38.9	46.8	Lithuania	5.6	-1.2
Croatia	19.1	33.9	Luxembourg	3.9	5.7
Cyprus	30.1	19.1	Malta	0.0	11.6
Czech	7.9	15.1	Netherlands	6.5	11.0
Denmark	0.7	1.7	Poland	37.4	22.3
Estonia	2.7	2.1	Portugal	-6.8	5.8
Finland	15.2	9.3	Romania	3.2	-17.4
France	1.9	16.2	Slovakia	26.6	31.5
Germany	4.9	8.4	Slovenia	-1.9	2.1
Greece	5.8	2.8	Spain	7.5	3.3
Hungary	11.0	6.4	Sweden	20.5	39.3
Ireland	3.3	6.4	UK	4.6	4.1

Table 95: Payment for electricity and change relative to the Reference scenario when capacity remuneration is applied only in France, under supply function equilibrium competition

	Payment for electricity in bn€		Change relative to Reference in bn€	
	2020	2030	2020	2030
EU27	241.45	321.72	-0.09	4.72
Austria	2.71	4.68	-0.02	0.00
Belgium	8.58	9.91	0.07	0.28
Bulgaria	2.20	3.38	0.01	-0.29
Croatia	1.61	1.62	0.00	0.03
Cyprus	0.16	0.16	0.00	0.00
Czech	5.29	9.36	0.00	0.22
Denmark	2.67	3.48	0.00	0.01
Estonia	0.95	0.87	0.00	0.00
Finland	5.82	7.52	-0.02	0.00
France	33.66	45.11	3.23	4.59
Germany	39.84	54.94	-1.88	1.47
Greece	5.16	6.71	0.02	-0.01
Hungary	3.42	3.76	0.02	0.07
Ireland	2.05	2.61	-0.05	-0.09
Italy	30.59	39.76	0.05	-0.09
Latvia	0.45	0.61	0.00	0.00
Lithuania	0.96	1.16	0.00	-0.01
Luxembourg	0.57	0.69	0.00	0.01
Malta	0.06	0.07	0.00	0.00
Netherlands	10.11	11.86	0.16	-0.03
Poland	14.95	19.81	0.13	0.16
Portugal	3.44	6.19	-0.67	-0.05
Romania	2.98	4.28	0.00	0.00
Slovakia	1.48	3.30	0.19	-0.03
Slovenia	1.28	1.66	-0.01	0.00
Spain	23.87	31.57	-0.48	-1.54
Sweden	7.71	11.70	-0.76	0.15
UK	30.49	36.56	-0.08	-0.09

Table 96: Capital recovery index when capacity remuneration is applied only in Germany, under supply function equilibrium competition

Capital recovery index - Capacity remuneration only in Germany - All projected investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.2	2.5	1.9	0.2	0.3	0.6	0.4	0.3	0.4	0.1	0.3	0.4	0.8	1.8	1.3
Austria	0.3	1.1	1.3	1.3	0.0	0.0	1.0	0.0	0.2	0.3	0.3	0.3	0.1	0.1	0.5	0.3
Belgium	1.6	1.0	1.0	1.0	0.6	0.4	1.4	0.9	0.1	1.6	0.7	1.2	0.7	1.0	1.2	1.1
Bulgaria	1.0	1.1	1.6	1.3	1.0	0.5	0.7	0.6	-0.1	0.3	0.0	0.3	-0.1	0.9	1.4	1.1
Croatia	1.0	5.3	1.0	5.3	0.6	0.8	0.5	0.7	1.0	1.0	-3.6	-3.6	0.6	1.1	0.3	0.6
Cyprus	1.0	1.0	1.0	1.0	1.0	0.2	1.0	0.2	0.8	0.0	-0.3	-0.1	0.8	0.1	0.1	0.1
Czech	1.5	1.1	2.4	1.9	0.1	0.2	1.0	0.2	0.6	0.5	-0.4	0.3	1.4	1.0	2.4	1.8
Denmark	0.2	0.6	0.7	0.7	0.2	1.0	1.8	1.8	0.2	-2.8	-0.3	-0.3	0.2	-2.6	0.0	0.0
Estonia	0.7	1.0	0.3	1.0	1.0	0.1	0.0	0.1	-0.2	0.1	-0.2	0.0	0.7	0.8	0.2	0.8
Finland	0.6	0.9	1.6	1.3	0.1	1.0	0.0	0.0	0.3	4.4	-0.1	2.0	0.4	0.9	1.6	1.3
France	0.1	0.4	3.8	3.3	0.3	0.3	1.0	0.3	-0.5	-0.9	-0.7	-0.8	0.1	0.3	3.6	2.8
Germany	0.9	1.2	1.0	1.2	0.2	0.1	0.5	0.5	1.1	0.3	0.3	0.3	0.6	0.8	0.5	0.7
Greece	1.1	1.6	1.0	1.6	0.2	0.3	1.3	0.6	0.1	0.1	0.0	0.1	0.4	0.6	0.9	0.7
Hungary	1.8	3.7	1.8	2.3	0.8	0.7	0.4	0.6	0.9	3.7	0.1	1.2	1.3	2.8	1.5	2.0
Ireland	0.9	1.3	1.0	1.3	0.3	0.1	-0.1	0.1	0.0	-0.4	-0.2	-0.2	0.4	0.1	-0.2	0.0
Italy	1.4	1.9	2.2	1.9	0.1	0.2	1.0	0.2	0.3	1.9	0.0	0.2	0.3	1.4	0.0	0.7
Latvia	1.8	2.6	1.2	1.5	0.3	0.2	1.0	0.2	0.6	0.4	0.7	0.5	0.4	0.3	0.7	0.4
Lithuania	1.0	1.0	1.3	1.3	0.6	0.6	1.0	0.6	-0.2	-0.4	-0.5	-0.5	0.5	0.3	1.0	1.0
Luxembourg	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.6	1.0	0.9
Malta	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	0.3	-0.3	1.0	-0.3	0.3	1.0	1.0	1.0
Netherlands	1.0	1.2	3.2	1.5	0.3	0.3	0.7	0.3	1.9	2.0	0.9	1.2	0.7	0.9	2.2	1.1
Poland	0.8	1.4	1.5	1.5	0.1	0.1	0.6	0.4	0.1	0.5	3.6	0.7	0.7	0.9	1.5	1.3
Portugal	1.0	1.0	1.0	1.0	0.1	0.1	1.0	0.1	0.1	0.0	0.2	0.0	0.1	0.1	0.2	0.1
Romania	0.9	1.0	1.6	1.3	-0.2	0.1	-0.2	0.0	0.0	-0.7	-0.5	-0.5	0.8	0.6	1.3	0.9
Slovakia	0.8	0.6	3.9	1.9	0.1	0.4	1.0	0.4	0.5	1.0	1.2	1.2	0.4	0.6	3.8	1.8
Slovenia	0.6	1.9	3.4	2.9	1.0	0.7	1.0	0.9	0.1	0.5	0.0	0.5	0.2	1.8	3.3	2.8
Spain	0.8	1.4	1.0	1.4	0.3	0.4	1.0	0.4	0.1	0.0	0.2	0.1	0.3	0.6	0.2	0.6
Sweden	0.7	0.4	4.0	4.0	0.5	1.0	1.0	1.0	0.2	0.2	-1.2	-0.2	0.3	0.2	3.9	3.6
UK	0.7	1.2	2.1	2.0	0.3	0.3	0.1	0.3	0.6	0.1	0.0	0.1	0.3	0.4	1.6	1.0

Capital recovery index - Capacity remuneration only in Germany - Retrofitting investments																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	1.0	2.1	3.6	3.5	1.0	0.2	0.2	0.2	1.0	0.2	0.1	0.1	1.0	1.2	3.5	3.1
Austria	1.0	1.1	1.3	1.3	1.0	1.0	1.0	1.0	1.0	0.2	4.5	0.9	1.0	0.3	1.7	1.1
Belgium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.6	4.8	4.0	1.0	3.6	4.8	4.0
Bulgaria	1.0	1.5	0.2	0.3	1.0	1.0	1.0	1.0	1.0	0.0	0.2	0.1	1.0	0.4	0.2	0.2
Croatia	1.0	5.3	1.0	5.3	1.0	1.0	1.0	1.0	1.0	1.0	-3.6	-3.6	1.0	5.3	-3.6	-0.3
Cyprus	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Czech	1.0	0.7	3.2	2.7	1.0	1.0	1.0	1.0	1.0	13.9	-1.4	13.7	1.0	0.8	3.2	2.7
Denmark	1.0	0.6	0.1	0.1	1.0	1.0	1.0	1.0	1.0	-2.8	-2.7	-2.7	1.0	-2.6	-2.2	-2.3
Estonia	1.0	1.1	0.3	0.8	1.0	1.0	1.0	1.0	1.0	0.4	1.0	0.4	1.0	1.1	0.3	0.8
Finland	1.0	2.0	0.7	0.8	1.0	1.0	0.0	0.0	1.0	6.9	-0.1	0.2	1.0	2.4	0.6	0.7
France	1.0	1.0	3.8	3.8	1.0	1.0	1.0	1.0	1.0	-0.6	0.0	-0.4	1.0	-0.2	3.8	3.8
Germany	1.0	1.8	1.0	1.3	1.0	0.0	1.0	0.0	1.0	-0.5	-0.7	-0.5	1.0	0.5	0.9	0.7
Greece	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0
Hungary	1.0	3.7	2.8	3.3	1.0	1.0	1.0	1.0	1.0	0.6	-2.6	-0.9	1.0	3.7	2.7	3.2
Ireland	1.0	1.3	1.0	1.3	1.0	1.0	1.0	1.0	1.0	-0.8	1.0	-0.8	1.0	-0.8	1.0	-0.8
Italy	1.0	1.0	2.2	2.2	1.0	1.0	1.0	1.0	1.0	-0.5	-1.4	-0.6	1.0	-0.5	-1.1	-0.6
Latvia	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	1.0	1.0	0.0	0.0	1.0	0.1	0.0	0.1
Lithuania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.4	-0.9	-0.6	1.0	-0.4	-0.9	-0.6
Luxembourg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Malta	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Netherlands	1.0	1.0	3.3	3.3	1.0	0.3	0.3	0.3	1.0	2.1	0.2	0.9	1.0	0.8	2.4	2.0
Poland	1.0	1.2	0.0	0.6	1.0	-0.4	0.0	-0.2	1.0	4.2	1.0	4.2	1.0	1.4	0.0	0.8
Portugal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-0.3	0.6	-0.2	1.0	-0.3	0.6	-0.2
Romania	1.0	1.5	1.1	1.1	1.0	1.0	1.0	1.0	1.0	-1.1	-1.5	-1.4	1.0	0.2	0.9	0.9
Slovakia	1.0	0.8	4.9	4.7	1.0	1.0	1.0	1.0	1.0	1.0	1.6	1.6	1.0	0.8	4.9	4.7
Slovenia	1.0	3.1	4.9	4.8	1.0	1.0	1.0	1.0	1.0	0.5	0.0	0.5	1.0	2.4	4.9	4.6
Spain	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	5.1	1.0	1.0	0.9	5.1	1.0
Sweden	1.0	1.0	4.5	4.5	1.0	1.0	1.0	1.0	1.0	-2.9	-2.5	-2.6	1.0	-2.9	4.4	4.4
UK	1.0	2.3	1.0	2.3	1.0	1.0	0.1	0.1	1.0	1.3	2.3	1.5	1.0	2.0	1.8	2.0

Capital recovery index - Capacity remuneration only in Germany - New plants																
	Base-load				CCGT				Open cycle plants				All plants			
Commis-sioning date	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30	01-10	11-20	21-30	11-30
EU27	0.7	1.1	1.7	1.4	0.2	0.3	0.7	0.4	0.3	0.4	0.1	0.3	0.4	0.7	1.1	0.9
Austria	0.3	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.2	0.3	0.2	0.2	0.1	0.1	0.2	0.1
Belgium	1.6	1.0	1.0	1.0	0.6	0.4	1.4	0.9	0.1	1.1	0.2	0.8	0.7	0.7	1.0	0.9
Bulgaria	1.0	1.1	1.8	1.3	1.0	0.5	0.7	0.6	-0.1	0.3	-0.1	0.3	-0.1	1.0	1.5	1.2
Croatia	1.0	1.0	1.0	1.0	0.6	0.8	0.5	0.7	1.0	1.0	1.0	1.0	0.6	0.8	0.5	0.7
Cyprus	1.0	1.0	1.0	1.0	1.0	0.2	1.0	0.2	0.8	0.0	-0.3	-0.1	0.8	0.1	0.1	0.1
Czech	1.5	1.2	1.9	1.6	0.1	0.2	1.0	0.2	0.6	0.1	-0.4	0.0	1.4	1.0	1.9	1.4
Denmark	0.2	1.0	0.7	0.7	0.2	1.0	1.8	1.8	0.2	1.0	-0.1	-0.1	0.2	1.0	0.2	0.2
Estonia	0.7	1.0	1.0	1.0	1.0	0.1	0.0	0.1	-0.2	0.1	-0.2	0.0	0.7	0.8	0.0	0.8
Finland	0.6	0.9	1.7	1.4	0.1	1.0	1.0	1.0	0.3	4.2	1.0	4.2	0.4	0.9	1.7	1.4
France	0.1	0.3	1.0	0.3	0.3	0.3	1.0	0.3	-0.5	-1.6	-0.8	-0.9	0.1	0.3	-0.8	0.2
Germany	0.9	1.2	1.0	1.2	0.2	0.1	0.5	0.5	1.1	0.4	0.3	0.4	0.6	0.8	0.4	0.7
Greece	1.1	1.6	1.0	1.6	0.2	0.3	1.3	0.6	0.1	0.1	0.0	0.1	0.4	0.6	0.9	0.7
Hungary	1.8	1.0	1.2	1.2	0.8	0.7	0.4	0.6	0.9	4.1	0.2	1.3	1.3	1.1	1.0	1.0
Ireland	0.9	1.0	1.0	1.0	0.3	0.1	-0.1	0.1	0.0	-0.3	-0.2	-0.2	0.4	0.1	-0.2	0.0
Italy	1.4	1.9	1.0	1.9	0.1	0.2	1.0	0.2	0.3	4.7	0.0	0.2	0.3	1.5	0.0	0.7
Latvia	1.8	2.6	1.2	1.5	0.3	0.2	1.0	0.2	0.6	0.4	0.7	0.5	0.4	0.4	0.7	0.4
Lithuania	1.0	1.0	1.3	1.3	0.6	0.6	1.0	0.6	-0.2	-0.4	-0.5	-0.5	0.5	0.4	1.0	1.0
Luxembourg	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0
Malta	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	0.3	-0.3	1.0	-0.3	0.3	1.0	1.0	1.0
Netherlands	1.0	1.2	2.7	1.2	0.3	0.3	1.4	0.3	1.9	2.0	1.3	1.4	0.7	0.9	1.7	0.9
Poland	0.8	1.5	1.5	1.5	0.1	0.1	0.6	0.4	0.1	0.5	3.6	0.7	0.7	0.9	1.5	1.3
Portugal	1.0	1.0	1.0	1.0	0.1	0.1	1.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Romania	0.9	1.0	1.8	1.4	-0.2	0.1	-0.2	0.0	0.0	0.0	-0.3	-0.3	0.8	0.6	1.4	0.9
Slovakia	0.8	0.6	2.7	1.1	0.1	0.4	1.0	0.4	0.5	1.0	1.2	1.2	0.4	0.6	2.6	1.1
Slovenia	0.6	1.8	2.2	2.0	1.0	0.7	1.0	0.9	0.1	0.2	1.0	0.2	0.2	1.8	2.1	1.9
Spain	0.8	1.4	1.0	1.4	0.3	0.4	1.0	0.4	0.1	0.0	0.1	0.0	0.3	0.6	0.1	0.6
Sweden	0.7	0.4	1.6	1.5	0.5	1.0	1.0	1.0	0.2	0.4	-0.5	0.2	0.3	0.4	1.4	1.1
UK	0.7	0.5	2.1	1.9	0.3	0.3	1.0	0.3	0.6	0.1	-0.1	0.0	0.3	0.2	1.6	1.0

Table 97: Capacity factor when capacity remuneration is applied only in Germany, under supply function equilibrium competition

Capacity factor - Capacity remuneration only in Germany - All projected investments									
	Base-load			CCGT			Open cycle plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.6	0.8	0.7	0.2	0.4	0.3	0.2	0.2	0.2
Austria	0.8	0.5	0.5	0.3	1.0	0.3	0.4	0.3	0.3
Belgium	1.0	1.0	1.0	0.2	0.7	0.5	0.5	0.4	0.4
Bulgaria	0.4	0.7	0.5	0.1	0.1	0.1	0.1	0.1	0.1
Croatia	1.0	1.0	1.0	0.3	0.6	0.5	1.0	0.3	0.3
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.5	0.8	0.7	0.1	1.0	0.1	0.3	0.4	0.3
Denmark	0.6	0.6	0.6	1.0	0.7	0.7	0.2	0.2	0.2
Estonia	0.6	0.1	0.6	0.0	0.0	0.0	0.0	0.1	0.0
Finland	0.7	0.8	0.8	1.0	0.3	0.3	0.6	0.3	0.4
France	0.4	0.8	0.8	0.2	1.0	0.2	0.5	0.4	0.4
Germany	0.7	0.6	0.7	0.1	0.4	0.4	0.1	0.1	0.1
Greece	0.6	1.0	0.6	0.2	0.5	0.3	0.0	0.0	0.0
Hungary	1.0	0.9	0.9	0.3	0.3	0.3	0.7	0.3	0.4
Ireland	0.5	1.0	0.5	0.1	0.2	0.1	0.2	0.1	0.1
Italy	0.7	0.8	0.7	0.4	1.0	0.4	0.4	0.1	0.1
Latvia	0.8	0.8	0.8	0.2	1.0	0.2	0.2	0.3	0.2
Lithuania	1.0	0.9	0.9	0.4	1.0	0.4	0.2	0.3	0.3
Luxembourg	1.0	1.0	1.0	1.0	1.5	1.4	0.2	1.0	0.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.6	0.7	0.7	0.3	0.3	0.3	0.4	0.3	0.3
Poland	0.7	0.8	0.8	0.2	0.4	0.3	0.2	0.5	0.2
Portugal	1.0	1.0	1.0	0.2	1.0	0.2	0.2	0.1	0.2
Romania	0.8	0.7	0.7	0.1	0.3	0.1	0.1	0.2	0.2
Slovakia	0.5	0.8	0.7	0.2	1.0	0.2	1.0	0.4	0.4
Slovenia	0.6	0.9	0.8	0.2	0.2	0.2	0.3	0.4	0.3
Spain	0.7	1.0	0.7	0.4	1.0	0.4	0.1	0.4	0.2
Sweden	0.3	0.9	0.9	1.0	1.0	1.0	1.0	0.6	0.8
UK	0.8	0.8	0.8	0.3	0.2	0.3	0.2	0.3	0.2

Table 98: Change in investment relative to Reference scenario when capacity remuneration is applied only in Germany, under supply function equilibrium competition

Change in investment relative to Reference when capacity remuneration is applied only in Germany - All projected investments in GW												
	Base-load			CCGT			Open cycle plants			All plants		
Commissioning date	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30	11-20	21-30	11-30
EU27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Austria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belgium	0.0	0.0	0.0	0.0	-0.8	-0.8	-1.4	-1.3	-2.7	-1.4	-2.1	-3.5
Bulgaria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Denmark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estonia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
France	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4.1	-4.1	0.0	-4.1	-4.1
Germany	0.0	0.0	0.0	0.8	0.8	1.6	1.5	6.3	7.8	2.3	7.0	9.4
Greece	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hungary	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ireland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Latvia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lithuania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.0	0.0	0.0	-0.8	0.0	-0.8	-0.1	-0.9	-1.0	-0.9	-0.9	-1.8
Poland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Romania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Slovakia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Slovenia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sweden	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 99: Simulated average wholesale market marginal prices (SMP) and change relative to the Reference scenario when capacity remuneration is applied only in Germany, under supply function equilibrium competition

	Average SMP when capacity remuneration is applied only in Germany in EUR/MWh		Change relative to the Reference in EUR / MWh	
	2020	2030	2020	2030
EU27	71	84	1.75	1.05
Austria	60	92	0.91	0.11
Belgium	96	111	1.04	0.77
Bulgaria	61	109	0.19	8.39
Croatia	100	94	0.77	4.89
Cyprus	165	167	0.00	0.00
Czech	74	117	0.05	4.04
Denmark	75	91	0.20	-0.10
Estonia	82	66	0.11	0.03
Finland	72	89	1.24	0.04
France	67	69	3.43	-3.52
Germany	80	97	3.33	2.50
Greece	85	103	1.45	1.32
Hungary	86	82	4.62	4.12
Ireland	80	88	1.27	2.60
Italy	99	113	1.07	0.98
Latvia	94	104	0.02	0.15
Lithuania	88	99	2.10	6.00
Luxembourg	92	97	-0.05	-2.11
Malta	144	161	0.00	0.00
Netherlands	82	96	3.44	2.97
Poland	79	97	0.46	0.90
Portugal	82	103	0.56	0.76
Romania	58	84	0.17	3.16
Slovakia	53	112	3.80	2.40
Slovenia	98	121	0.00	0.26
Spain	87	102	0.19	0.26
Sweden	67	82	2.14	2.52
UK	87	100	0.83	0.64

Table 100: Average SMP mark-up indicators, when capacity remuneration is applied only in Germany, under supply function equilibrium competition

Mark-up (% change over marginal cost bidding)	2020	2030		2020	2030
EU27	9.2	9.5			
Austria	7.2	0.5	Italy	3.0	2.4
Belgium	3.0	11.4	Latvia	8.1	3.1
Bulgaria	38.4	71.7	Lithuania	8.1	4.5
Croatia	20.4	38.7	Luxembourg	3.9	2.2
Cyprus	30.1	19.1	Malta	0.0	11.6
Czech	7.9	16.4	Netherlands	9.7	14.1
Denmark	0.6	0.9	Poland	37.1	22.4
Estonia	3.2	2.2	Portugal	6.7	7.6
Finland	17.3	9.5	Romania	3.5	-14.1
France	-1.5	0.6	Slovakia	18.2	25.2
Germany	14.0	7.6	Slovenia	-0.9	2.3
Greece	7.2	4.3	Spain	9.7	9.1
Hungary	16.8	10.0	Sweden	37.2	43.0
Ireland	6.1	11.4	UK	5.8	4.8

Table 101: Payment for electricity and change relative to Reference scenario when capacity remuneration is applied only in Germany, under supply function equilibrium competition

	Payment for electricity in bn€		Change relative to Reference in bn€	
	2020	2030	2020	2030
EU27	241.45	321.72	6.20	2.83
Austria	2.71	4.68	0.04	0.01
Belgium	8.58	9.91	0.14	0.43
Bulgaria	2.20	3.38	0.01	0.30
Croatia	1.61	1.62	0.01	0.09
Cyprus	0.16	0.16	0.00	0.00
Czech	5.29	9.36	0.00	0.33
Denmark	2.67	3.48	0.01	-0.01
Estonia	0.95	0.87	0.00	0.00
Finland	5.82	7.52	0.10	0.00
France	33.66	45.11	1.56	-3.22
Germany	39.84	54.94	2.55	2.74
Greece	5.16	6.71	0.07	0.06
Hungary	3.42	3.76	0.18	0.19
Ireland	2.05	2.61	0.03	0.07
Italy	30.59	39.76	0.31	0.32
Latvia	0.45	0.61	0.00	0.00
Lithuania	0.96	1.16	0.02	0.07
Luxembourg	0.57	0.69	0.00	-0.02
Malta	0.06	0.07	0.00	0.00
Netherlands	10.11	11.86	0.37	0.25
Poland	14.95	19.81	0.07	0.20
Portugal	3.44	6.19	0.02	0.04
Romania	2.98	4.28	0.01	0.14
Slovakia	1.48	3.30	0.11	0.08
Slovenia	1.28	1.66	0.00	0.00
Spain	23.87	31.57	0.06	0.09
Sweden	7.71	11.70	0.27	0.51
UK	30.49	36.56	0.27	0.24

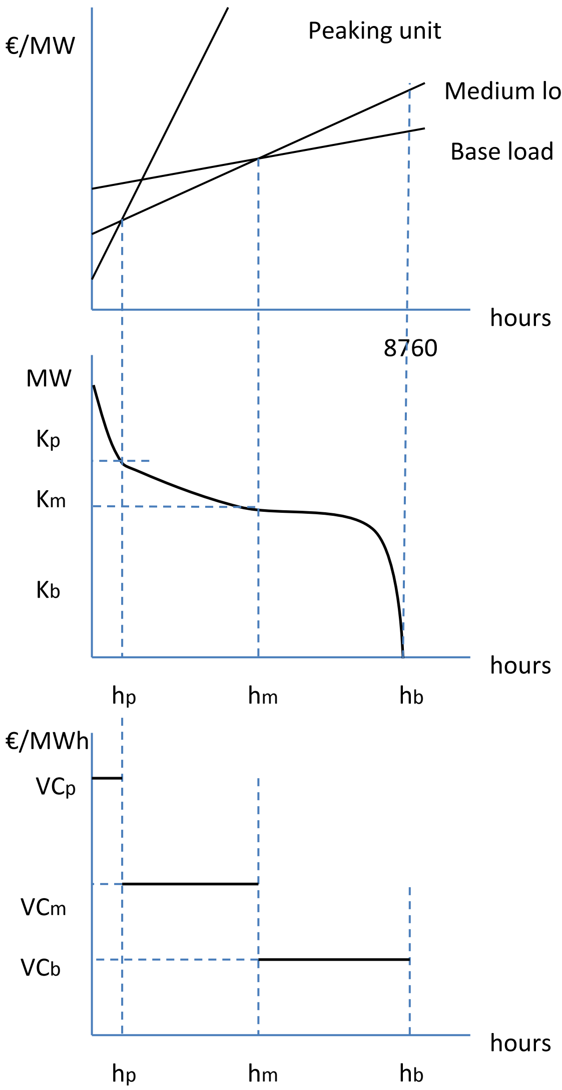
APPENDIX 4: THEORY OF CAPACITY PAYMENTS

From a theoretical perspective the concept of capacity payments has been proposed for dealing with peak load pricing in perfectly competitive markets. Under such a competition regime, all generators bid at their variable costs in a wholesale market and when selected for operation they take revenues above their variable costs as set by the most expensive plant in variable costs terms. The differences above variable costs serve to recover capital and fixed costs of the power plants. In a short term perspective, these revenues are not necessarily sufficient for recovering capital and fixed costs because they depend on the gap from the most expensive plant. In a long term perspective, capacity expansion in a perfectly competitive market would make the correct choice of plants so as to allow power plants to exactly recover their capital and fixed costs from the difference of variable costs compared to most expensive plant in operation in each unit of time. The recovery of capital costs under perfectly competitive market is true for all types of plants except the peak load plants which cover peal load and/or reserve power and which are the most expensive plants in variable cost terms. The theory of perfect competition needs load demand responses (demand reductions driven by high prices) in order to save over peak load plant investments. In the absence of such demand responses, or when power reserve requirements are administratively imposed, the peak load plants cannot recover their capital and fixed costs under perfect competition. In such a case, a capacity payment is justified to allow for this recovery.

Of course in reality an electricity market is never perfectly competitive and has never been expanding capacities in a perfectly competitive manner. Hence, when oligopolistic competition prevails it is not a priori known whether a capacity payment is justified for allowing recovery of capital and fixed costs of peaking units. An excessive capacity payment fee may lead to windfall profits for generators, or an insufficient fee may imply lack of recovery for the peaking unit but also for other plants. It is certain that in circumstances of excess power capacities a capacity payment provides revenues to plants that may not be needed from an optimality perspective. Also, in cases of lack of capacities, the absence of capacity payments would not incentivize investment in peaking units. So, assessing about the justification of a certain capacity payment fee level requires analysis about the specific circumstances prevailing in the market.

The simplest way for illustrating the impact of capacity payments is to consider a pool electricity market which supplies a fixed amount of demand for electricity by dispatching a certain number of stylized thermal power plants with given power capacities. Without significant loss of generality, we may consider that the contribution by renewables and net imports are deduced from the load curve prior to the dispatching of the thermal plants.

Each stylized thermal power plant has a total cost function which involves a fixed cost term and a variable cost term. The fixed cost term represents annuity payments (or provisions) for capital investment and annual fixed payments for operation and maintenance. The variable cost term mainly consists of fuel costs which depend on thermal efficiency and the fuel price. The variable cost do not incur when the plant do not produce electricity.



Suppose that i=p,m,b thermal plants are under consideration, p standing for a peaking unit, m denoting a combined cycle gas plant for load following and b denoting base load plants, such as lignite firing generation. The cost functions are:

$$C_i = FC_i \cdot K_i + VC_i \cdot G_i$$

where FC is the annual capital and fixed cost in Euro, VC is the variable cost per unit of production in Euro per MWh, K is the plant power capacity in MW and G is the amount of electricity produced annually, in MWh. Obviously total cost C is measured also in Euro. The plant is supposed to operate h hours per year, and thus: $G_i = h_i \cdot K_i$

The annual capital cost component can be estimated as annuity payments for overnight investment cost OI in Euro per MW for a L number of years (economic lifetime of the plant) at a WACC denoted by r. Suppose that the power plant incurs OM Euros per MW as fixed payment for annual maintenance. Thus, the fixed cost component is calculated as:

$$FC_i = \frac{r \cdot OI_i}{1 - e^{-r \cdot L}} + OM_i$$

and the variable cost component is calculated as:

$$VC_i = \frac{em_i \cdot CP + FP_i}{n_i}$$

where em is the emission factor of the fuel used (in tCO2 per MWh of fuel), CP is the carbon price (in €/tCO2), FP is the fuel purchasing price (€/MWh of fuel) and n is the thermal efficiency rate (in MWh electricity per MWh of fuel).

The economic parameters of the stylized plant types are different, so that peaking units have low fixed costs and high variable costs and base load plants have high fixed costs and low variable costs, the medium load plant type being at an intermediate position in terms of costs.

If we divide the cost equation by K_i (i.e. power capacity), we get the so-called screening curve, which is expressed in Euros per MW:

$$\frac{C_i}{K_i} = FC_i + VC_i \cdot h_i$$

In a perfectly competitive market, electricity companies bid at their variable costs. Thus, least cost unit commitment is obtained through the intersections between the screening curves and the load duration curve, as shown in the schemes below:

The last figure in the above scheme is the SMP duration curve which is based on the assumption that the participants bid at variable plant costs.

The revenues of the three stylized plant types from the wholesale market are as follows:

Base load plant: $R_b = \left(VC_b \cdot h_b + (VC_m - VC_b) \cdot h_m + \left(VC_p - VC_m\right) \cdot h_p\right) \cdot K_b$

Medium load plant: $R_m = \left(VC_m \cdot h_m + \left(VC_p - VC_m\right) \cdot h_p\right) \cdot K_m$

Peak load plant: $R_p = \left(VC_p \cdot h_p\right) \cdot K_p$

Gross profit or loss of the power plants is then calculated as follows:

Base load plant:

$$\begin{aligned} N_b &= R_b - VC_b \cdot h_b \cdot K_b - FC_b \cdot K_b \\ &= \left[(VC_m - VC_b) \cdot h_m + \left(VC_p - VC_m\right) \cdot h_p - FC_b\right] \cdot K_b \end{aligned}$$

Medium load plant:

$$\begin{aligned} N_m &= R_m - VC_m \cdot h_m \cdot K_m - FC_m \cdot K_m \\ &= \left[\left(VC_p - VC_m\right) \cdot h_p - FC_m\right] \cdot K_m \end{aligned}$$

Peak load plant:

$$N_p = R_p - VC_p \cdot h_p \cdot K_p - FC_p \cdot K_p = -FC_p \cdot K_p$$

It is obvious from the above that marginal cost bidding implies a net loss for the peaking power plant, independently of the variable cost differences or the capacity sizes of the plants. In the absence of administrative intervention (regulation) to cover the loss of the peaking plant, investment will not be sufficient to cover peak demand; hence demand must be curtailed either administratively or through retail price signals inducing demand responses to prices.

A capacity payment system is a regulation which administratively defines a certain level of capacity payment fee, which is denoted by X and measured in €/MW. In order to recover losses of the peaking plant, the fee obviously has to be equal to FC_p, that is the annuity payment for capital and fixed costs corresponding to a peaking unit. By applying X profit or losses become:

Base load plant: $N_b = \left[(VC_m - VC_b) \cdot h_m + \left(VC_p - VC_m\right) \cdot h_p + X - FC_b\right] \cdot K_b$

Medium load plant: $N_m = \left[\left(VC_p - VC_m\right) \cdot h_p + X - FC_m\right] \cdot K_m$

Base load plant: $N_p = \left[X - FC_p\right] \cdot K_p = 0$, if $X = FC_p$

Evidently, the capacity payment $X = FC_p$ ensures zero losses (and no extra profit) for the peaking unit. But it does not ensure zero losses and profits for the other units. Whether the other plants will encounter losses or extra profits depends on whether capacity expansion in the past has been optimal. The conditions for an optimal capacity expansion are derived as follows:

The capacities K_b, K_m, K_{pm} must be such that the intersection of screening curves with the load duration curve leads to dispatching hours as follows:

$$h_p = {(FC_m - FC_p)}\Big/{(VC_p - VC_m)} \quad \text{and} \quad h_m = {(FC_b - FC_m)}\Big/{(VC_m - VC_b)}$$

If the above condition does not hold true, because of non-optimal capacity expansion in the past, the base and medium load plants may incur losses or extra profits (windfall profits owing to the capacity payment). In the latter case, the level of the capacity payment is obviously penalizing consumers of electricity.

Suppose now that the wholesale market is not perfectly competitive and the market participants have some market power so as to bid above marginal costs. For simplicity, assume that the SMP is higher than variable costs only in peak load hours; it is denoted by $SMP_p > VC_p$. Then profit or losses are recalculated as follows:

Base load plant: $N_b = \left[(VC_m - VC_b) \cdot h_m + \left(SMP_p - VC_m\right) \cdot h_p + X - FC_b\right] \cdot K_b$

Medium load plant: $N_m = \left[\left(SMP_p - VC_m\right) \cdot h_p + X - FC_m\right] \cdot K_m$

Base load plant: $N_p = \left[SMP_p - VC_p + X - FC_p\right] \cdot K_p$

In order to get zero loss or profit for the peaking unit, the capacity payment fee X must now become: $X = FC_p - \left(SMP_p - VC_p\right) < FC_p$

In other words, under circumstances of market power which lead to SMP higher than variable costs, the capacity payment fee has to be lower than the annuity payment for capital and fixed cost of a peaking unit.

It is emphasized that if the regulator wants to avoid losses for all participating plants and not only for the peaking unit, the capacity payment fee differs. It remains unchanged only if capacity expansion was optimal in the past. This is rarely the case in reality and so if the regulator wants to avoid losses for all plants, then necessarily the capacity payment fee will be higher than the level required for meeting the zero loss of the peaking unit, just because the past non optimal capacity expansion lead to distorted capacity mix, hence to an extra capital cost.

The above presented theoretical foundation of capacity payment systems illustrates why regulating the capacity payment fee is extremely difficult. Since the only justifiable objective must be the recovery of capital costs of the peaking unit and since usually the market is imperfectly competitive leading to SMP higher than variable costs, the regulatory rule is to set the capacity payment fee below the capital annuity payment of a peaking unit.

APPENDIX 5: BIBLIOGRAPHY

Abel, A., 2005. Electric Reliability: Options for Electric Transmission Infrastructure Improvements. *CRS Report for Congress*.

Adib, P., Schubert, E. & Oren, S, 2008. Resource adequacy: alternate perspectives and divergent paths. *Competitive Electricity Markets: Design, Implementation, Performance*, pp.327–362.

Alonso-Ayuso, A. et al., 2010. Structuring bilateral energy contract portfolios in competitive markets. *RIESGOS-CM*, P2009/ESP-.

Alvarado, F.L. & Oren, S.S., 2000. A Tutorial on the Flowgates versus Nodal Pricing Debate. *PSERC IAB meeting*, (November).

Andrianesis, P. & Liberopoulos, G., 2012. The "hidden cost" of renewable energy sources in electricity pool markets. *2012 9th International Conference on the European Energy Market*, pp.1–8.

Antonsen, S. et al., 2010. Reliability Consequences of Liberalization in the Electricity Sector: Existing Research and Remaining Questions. *Journal of Contingencies and Crisis Management*, 18(4), pp.208–219.

Arriaga, J.P., 2005. Libro Blanco sobre la reforma del marco regulatorio de la generación eléctrica en España. *Instituto de Investigaciones Tecnológicas (IIT)*.

Assaad, D., 2012. Contributions of PXs organized markets to the pan-European integration process. *Europex presentation to European Market Coupling & Integration conference*, (24 April).

Assili, M., Javidi D.B., M.H. & Ghazi, R., 2008. An improved mechanism for capacity payment based on system dynamics modeling for investment planning in competitive electricity environment. *Energy Policy*, 36(10), pp.3703–3713.

Ausubel, L.M. & Cramton, P., 2010. Using forward markets to improve electricity market design. *Utilities Policy*, 18(4), pp.195–200.

Bajpai, P. & Singh, S., 2004. Electricity trading in competitive power market: an overview and key issues. *INTERNATIONAL CONFERENCE ON POWER SYSTEMS, ICPS2004, KATHMANDU, NEPAL*.

Baker, P.E., Mitchell, P.C. & Woodman, B., 2010. Electricity Market Design for a Low-carbon Future. *THE UK ENERGY RESEACH CENTRE*, (October), pp.0–43.

Barroso, L.A. et al., 2007. Ensuring Resource Adequacy with Auctions of Options and Forward Contracts. *2007 IEEE Power Engineering Society General Meeting*, pp.1–6.

Batlle, C. & Rodilla, P., 2010a. A critical assessment of the different approaches aimed to secure electricity generation supply. *Energy Policy*, 38(11), pp.7169–7179.

Batlle, C. & Rodilla, P., 2010b. A critical assessment of the different approaches aimed to secure electricity generation supply. *Instituto de Investigaciones Tecnológicas (IIT) IIT Working Paper IIT-10-017A*, (July).

Batlle, Carlos, Vázquez, Carlos, Rivier, Michel, et al., 2007a. Enhancing power supply adequacy in Spain: Migrating from capacity payments to reliability options. *Energy Policy*, 35(9), pp.4545–4554.

Batlle, Carlos, Vázquez, Carlos, Rivier, Michel, et al., 2007b. Enhancing power supply adequacy in Spain: Migrating from capacity payments to reliability options. *Energy Policy*, 35(9), pp.4545–4554.

Batlle, Carlos, 2012. Introduction to capacity mechanisms. *Florence School of Regulation*.

Batlle, Carlos & Barquín, J., 2005. A strategic production costing model for electricity market price analysis. *Power Systems, IEEE Transactions on*, (March 2002).

Batlle, Carlos & Pérez-Arriaga, I.J., 2007. Design criteria for implementing a capacity mechanism in deregulated electricity markets. *IIT Working Paper IIT-07-024I*, (August), pp.1–18.

Batlle, Carlos & Rodilla, Pablo, 2010. Policy and regulatory design issues on security of electricity generation supply in a market-oriented environment. Problem fundamentals and analysis of regulatory mechanisms. *Instituto de Investigaciones Tecnológicas (IIT) IIT Working Paper IIT-09-057A*, (July 2009).

Batlle, Carlos, Solé, C. & Rivier, Michel, 2008. A new security of supply mechanism for the Iberian Market. *The Electricity Journal*, (December), pp.1–14.

Batlle, Carlos & Vasquez, C., 2006. A Regulatory Instrument to Enhance the Security of Supply in the Spanish Wholesale Electricity Market. *29th IAEE International Conference*, (September 2005), pp.1–18.

Batlle, Carlos, Vázquez, Carlos & Barquín, J., 2007. The balancing market maker: a tool to enhance liquidity in the French Balancing Mechanism. *The Electricity Journal*, (September 2006), pp.1–13.

Bessembinder, H. & Lemmon, M., 2002. Equilibrium pricing and optimal hedging in electricity forward markets. *The Journal of Finance*, LVII(3).

Bidwell, M., 2005. Reliability options: a market-oriented approach to long-term adequacy. *The Electricity Journal*, 18(5), pp.1040–6190.

Blumsack, S., 2006. The Efficiency of Point-to-Point Financial Transmission Rights is Limited by the Network Topology. *Department of Engineering and Public Policy Carnegie Mellon University*, (412).

Botterud, A & Doorman, G., 2008. Generation Investment and Capacity Adequacy in Electricity Markets. *International Association for Energy Economics. Newsletter articles*.

Botterud, Audun, 2003. Long-Term Planning in Restructured Power Systems Dynamic Modelling of Investments in New Power Generation under Uncertainty. *Thesis The Norwegian University of Science and Technology (NTNU)*.

Botterud, Audun & Korpas, M., 2004. Modelling of power generation investment incentives under uncertainty in liberalised electricity markets. *Proceedings of the Sixth IAEE Conference*.

Brandstätt, C., Brunekreeft, G. & Jahnke, K., 2011. How to deal with negative power price spikes?—Flexible voluntary curtailment agreements for large-scale integration of wind. *Energy Policy*, 39(6), pp.3732–3740.

Bruegel, 2011. Will national capacity mechanisms kill the single electricity market ? *Energy and climate exchange event*, *Bruegel*, *October 25th*, pp.3–5.

Burger, A. & Ferstl, R., 2008. Generation capacity investment in oligopolistic electricity markets under uncertainty. *2008 5th International Conference on the European Electricity Market*, pp.1–10.

Burstedde, B., 2012. From Nodal to Zonal Pricing – A Bottom-Up Approach to the Second-Best. *EWI*, (July).

Bushnell, J., 1999. Transmission rights and market power. *The Electricity Journal*, 6190(October), pp.77–85.

Bustos, M., 2004. The new payment mechanism of RES-E in Spain. *introductory report*, *Spanish Renewable Energy Association*, (May).

Canchi, D. et al., 2010. Efficiency Concerns in Auctions for Financial Transmission Rights. *State Utility Forecasting Group Energy Center of Discovery Park at Purdue University*, (765).

CEER, 2006a. Survey of Capacity Support Mechanisms in the Energy Community. *SEE WG / MIF TF C06-SEE-15-06*, (June).

CEER, 2006b. Survey of Capacity Support Mechanisms in the Energy Community. *Energy Community 8th Athens Forum*.

Celebi, M. & Hanser, P., 2006. FTRs: Necessary or Burdensome? *The Brattle Group*, *IAEE Conference Postdam*.

CER, 2013. Single Electricity Market Capacity Payments Mechanism FCPP y and ECPP Y for Trading Year 2013 Consultation Paper. *SEM-12-081*, (September 2012).

CER, 2010. Single Electricity Market Capacity Payments Mechanism FCPPy and ECPPy for Trading Year 2011. *SEM-10-063*.

Chandley, J., 2008. PJM ' s Reliability Pricing Mechanism : (Why It ' s Needed and How It Works). *PJM*, (March).

Chao, H, 2006. Global electricity transformation: The critical need for integrated market design and risk management research. *Energy*, 31, pp.923–939.

Chao, H & Wilson, R, 2002. Multi-dimensional procurement auctions for power reserves: Robust incentive-compatible scoring and settlement rules. *Journal of Regulatory Economics*, 22(2), pp.161–183.

Chao, Hung-po et al., 2005. Resource Adequacy and Market Power Mitigation via Option Contracts Resource Adequacy and Market Power Mitigation via Option Contracts. *EPRI*, pp.1–43.

Chao, Hung-po, 2005. Spot Market , Forward Contracts and Capacity Investment in Electricity. *EPRI*, pp.1–15.

Clastres, C. & David, L., 2011. Capacity release, asymmetric regulation and competition in energy markets. *2011 8th International Conference on the European Energy Market (EEM)*, pp.704–709.

Commission, Electricity, 2009. Scarcity Pricing and Compulsory Contracting: options. *Electricity Commission*, (October).

Commission, European, 2012. Consultation Paper on generation adequacy, capacity mechanisms and the internal market in electricity. *Draft*.

Commission, European, 2007. DG COMPETITION REPORT ON ENERGY SECTOR INQUIRY. *DG COMP Communication*, (January).

Committee, S.E.M., 2012. Proposals for Implementation of the European Target Model for the Single Electricity Market Consultation Paper. *SEM-12-004*, (January).

Cramton, P. & Ockenfels, A., 2011. Economics and design of capacity markets for the power sector. *Zeitschrift für Energiewirtschaft*, (May), pp.1–36.

Cramton, P. & Ockenfels, A., 2012. Economics and Design of Capacity Markets for the Power Sector. *Zeitschrift für Energiewirtschaft*, 36(2), pp.113–134.

Cramton, P. & Stoft, S., 2005. A capacity market that makes sense. *The Electricity Journal*, (September), pp.43–54.

Cramton, P. & Stoft, S., 2008a. Forward reliability markets: Less risk, less market power, more efficiency. *Utilities Policy*, 16(3), pp.194–201.

Cramton, P. & Stoft, S., 2008b. Forward reliability markets: Less risk, less market power, more efficiency. *Utilities Policy*, 16(3), pp.194–201.

Creti, A. & Fabra, N., 2007. Supply security and short-run capacity markets for electricity. *Energy Economics*, 29(2), pp.259–276.

Crew, M., Fernando, C. & Kleindorfer, P., 1995. The theory of peak-load pricing: a survey. *Journal of regulatory economics*, 248(1995), pp.215–248.

Crouch, M. & Strategy, E., 2012. Electricity interconnector policy Document type. *OFGEM Consultation*, (March 2010).

Day, C. J., Hobbs, B. F., & Pang, J. S. (2002). Oligopolistic competition in power networks: a conjectured supply function approach. *Power Systems, IEEE Transactions on*, *17*(3), 597-607.

DECC, 2010. Annex A – List of respondents to December consultation. *Planning our electric future: a White Paper for secure, affordable and low-carbon electricity*, (December).

DECC, 2011a. Consumer Focus response to DECC consultation on Electricity Market Reform. *DECC Report*, (March).

DECC, 2012. Electricity Market Reform and capacity mechanisms. *DECC Report*, (August).

DECC, 2011b. Electricity Market Reform – Capacity Mechanism. Impact Assessment. *DECC Report*, pp.1–51.

DECC, 2011c. Electricity market reform : capacity market – design and implementation update. *Annex C of DECC Report*, pp.1–22.

DECC, 2011d. Planning our electric future: a White Paper for secure, affordable and low-carbon electricity. *DECC Report*, (July).

Delft & Technology, U. of, 2012. Capacity mechanisms, Policy instruments for influencing investment. *Delft University of Technology*.

Deng, S. & Oren, S, 2006. Electricity derivatives and risk management. *Energy*, 31(6-7), pp.940–953. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0360544205000496 [Accessed December 29, 2012].

Deng, S.-J., Oren, Shmuel & Meliopoulos, a. P., 2010. The inherent inefficiency of simultaneously feasible financial transmission rights auctions. *Energy Economics*, 32(4), pp.779–785.

Denton, G. & Gough, H., 2002. CAPACITY MECHANISMS THE OPTIONS. *TAVIS CONSULTING report to NECA*, (August).

DG Energy, 2012a. Quarterly Report on European Electricity Markets. *European Commission*, 5(1).

DG Energy, 2012b. Quarterly Report on European Electricity Markets. *European Commission*, 5(2).

Dr. Konstantin Petrov, 2012. Electricity Markets and Principle Market Design Models. *KEMA Consulting GmbH*, pp.1–7.

Duthaler, C. & Finger, M., 2008. Financial Transmission Rights in Europe’s Electricity Market. *CRNI paper, November*, (November), pp.1–25.

Economics, F., 2011a. Relevance of established national bidding areas for European power market integration – an approach to welfare oriented evaluation. *A Report Prepared for Bundesnetzagentur*, (October).

Economics, F., 2010. Study on flexibility in the Dutch and NW European power market in 2020. *Report to EnergieNed*, (April).

Economics, F., 2011b. Target Model for the European Natural Gas Market. *Report to GDF SUEZ*, (June).

Economics, L., 2007. Structure and performance of six European wholesale electricity markets in 2003, 2004 and 2005. *Study for the European Commission*, (February).

Eggen, S. & Grøntvedt, O.M., 2005. Analysis of the efficiency of the German Electricity Market. *Thesis Norwegian University of Science and Technology (NTNU)*.

Elberg, C., Growitsch, C., Höffle, F., et al., 2012. Investigation into a sustainable electricity market design for Germany. *EWI*, (April).

Elberg, C., Growitsch, C., Höffler, F., et al., 2012. Untersuchungen zu einem zukunftsfähigen Strommarktdesign. *EWI*.

Energy, S., 2003. An Examination of Capacity Markets In Electricity Market Design. *Strategic energy*.

Escudero, L.F. et al., 2010. Lagrangean decomposition for large-scale two-stage stochastic mixed 0-1 problems. *RIESGOS-CM*, P2009/ESP-, pp.0–23.

Eurelectric, 2011. RES Integration and Market Design : Are Capacity Remuneration Mechanisms needed to ensure generation adequacy? *TF Market Design for RES Integration*.

von der Fehr, N.-H. M. & Harbord, D., 1997. Capacity Investment and Competition in Decentralised Electricity Markets. *Department of Economics University of Oslo*, ISSN: 0801(No 27/97).

Finon, D. & Meunier, G., 2009. Option values of low carbon technologies policies: how to combine irreversibility effect and learning-by-doing in decisions? *LARSEN*, Working Pa(January).

Finon, D. & Pignon, V., 2006. Electricity and Long-Term Capacity Adequacy The Quest for Regulatory Mechanism Compatible with Electricity Market. *LARSEN*, 2006-2bis, pp.1–29.

Finon, D. & Pignon, V., 2008. Electricity and long-term capacity adequacy: The quest for regulatory mechanism compatible with electricity market. *Utilities Policy*, 16(3), pp.143–158.

Fraser, H. & Lo Passo, F., 2003. Developing a Capacity Payment Mechanism in Italy. *The Electricity Journal*, 16(9), pp.54–58.

Geiger, A., 2010. Strategic Power Plant Investment Planning under Fuel and Carbon Price Uncertainty. *KIT Scientific Publishing*.

Gollier, C., Proult, D. & Walgenwitz, G., 2004. Choice of nuclear power investments under price uncertainty : Valuing modularity. *mimeo*, (February), pp.1–22.

Green, R. & Vasilakos, N., 2011. The long-term impact of wind power on electricity prices and generating capacity. *2011 IEEE Power and Energy Society General Meeting*, pp.1–1.

Grotterud, G., 2010. Towards the integration of the electricity market in Europe : Which target model ? How will the electricity regional initiatives contribute ? *CRE*, (june).

Hagman, B. & Bjørndalen, J., 2011. FTRs in the Nordic electricity market. *Elforsk rapport 11:16*, (April).

Haikel, K.M., 2009. A game theoretic model for generation capacity adequacy in electricity markets : A comparison between investment incentive mechanisms. *GATE Groupe d'Analyse et de Théorie Économique*, W.P. 09-05(0).

Hogan, W., 2005. On an 'Energy-only Electricity Market Design for Resource Adequacy. *Center for Business and Government John F. Kennedy School of Government Harvard University Cambridge, Massachusetts 02138*, September .

Hogan, W.W., 2011. Wholesale electricity markets : nodal prices , market power and financial transmission rights. *Transmission Constraints in the Electricity Market: Nodal Prices, Market Power and Financial Transmission Rights IAEE Norge Oslo*,.

Hobbs, B. E. (2001). Linear complementarity models of Nash-Cournot competition in bilateral and POOLCO power markets. *Power Systems, IEEE Transactions on*, *16*(2), 194-202.

IWEA, 2011. IWEA Response to SEM-11-019 Capacity Payment Mechanism Mid Term Review Packages 6, 8, 9, 10. *Communication*, pp.1–6.

Jacottet, A., 2012. Cross-border electricity interconnections for a well-functioning EU Internal Electricitry Market. *The Oxford Institute for Energy Studies*, (June).

Jasper, J., 2011. The need and potential design for capacity mechanisms in the German / continental European power market. *EnBW, DIW*, pp.1–10.

Joskow, P., 2008. Capacity payments in imperfect electricity markets: Need and design. *Utilities Policy*, 16(3), pp.1–43.

Kelly, J., 2009. Public Reserve Capacity Mechanism Review Report. *IMO, Western Australia*, (May).

Kft., R.E.T., 2011. Target Model and European Market Integration in the Electricity Sector. *Study commissioned by the Hungarian Energy Office*, (September).

Kristiansen, T., 2004. Markets for financial transmission rights. *Energy Studies Review*, 13(1), pp.25–74.

Lawlor, J., 2012. The SEM Capacity Payment Mechanism and the impact on trade between Ireland and GB. *ESB*, (June).

Liaño, C.M., 2005. Analysis of firm capacity calculation methods as mechanisms to ensure long-term reliability in deregulated power markets. *Universidad Pontificia Comillas Madrid*, Thesis.

Limpaitoon, T., Chen, Y. & Oren, S.S., 2011. The impact of carbon cap and trade regulation on congested electricity market equilibrium. *Journal of Regulatory Economics*, 40(3), pp.237–260.

Lundin, M., 2011. European Power Exchanges – Challenges for market integration. *Nord Pool Spot SA*.

Mello, R.W. de, 2008. Understanding Financial Transmission Rights. *SIEMENS, Power Transmission and Distribution*, (102), pp.2–4.

Millan, J., 2002. The second generation of power exchanges: Lessons for Latin America. *Second-Generation Reforms in Infrastructure Services*.

Moreno, R. et al., 2010. Auction approaches of long-term contracts to ensure generation investment in electricity markets: Lessons from the Brazilian and Chilean experiences. *Energy Policy*, 38(10), pp.5758–5769.

Moreno, Rodrigo et al., 2009. Auctioning adequacy in south america through long-term contracts and options: From classic pay-as-bid to multi-item dynamic auctions. *2009 IEEE Power & Energy Society General Meeting*, pp.1–8.

Mount, T., Schulze, W. & Schuler, R., 2003. Markets for Reliability and Financial Options in Electricity: Theory to Support the Practice. *Presented at the 36th Annual Hawaii International Conference on Systems Sciences*, January 6-, pp.1–10.

Murto, P., 2000. Models of Capacity Investment in Deregulated Electricity Markets. *Helsinki University of Technology*, Thesis.

MYRNA M. VELASCO, 2010. New form of “ capacity payment ” emerges as incentive for liberalized power markets. *mimeo*.

Nabe, C., 2010. Capacity markets and FIS - two sides of the same coin? *ECOFYS*, (September).

NEPP, 2011. Capacity mechanisms: Revived interest in capacity mechanisms throughout Europe in the face of high volumes of intermittent generation. *NEPP Synthesis results*, (September), pp.2011–2012.

Neuhoff, K. et al., 2011. Renewable Electric Energy Integration : Quantifying the Value of Design of Markets for International Transmission Capacity Smart Power Market Project. *Climate Policy initiative*, (January).

Newbery, D., 2005. Capacity markets and capacity prices. In *The Economics of Electricity Markets*.

Newbery, D., 2011. EMR : carbon price floor , capacity mechanisms , EPS. *Meeting with Energy and Climate Change Select Committee*, (January).

Nicolosi, M., 2012a. Necessity of and Design Options for a Capacity Mechanism for Germany. *ECOFYS*.

Nicolosi, M., 2012b. Necessity of and Design Options for a Capacity Mechanism for Germany. *ECOFYS*.

No, F.S. et al., 2011. Why Have a Capacity Market ? *New England Power Generation Association*.

Oren, S.S., 2000. Capacity Payments and Supply Adequacy in Competitive Electricity Markets 1. *VII SEPOPE*, May - 21 s.

Oren, Shmuel, 2000. Capacity Payments and Supply Adequacy in a Competitive Electricity Market. In *VII SEPOPE*.

Otero-Novas, I. et al., 2000. A simulation model for a competitive generation market. *IEEE Transactions on Power Systems*, 15(1), pp.250–256.

Patiño-Echeverri, D. & Morel, B., 2006. An Options Theory Method to Value Electricity Financial Transmission Rights. *Carnegie Mellon Electricity Industry Center Working Paper CEIC-06-03*, (0325892), pp.1–31.

Paul L. Joskow, 2006. Competitive Electricity Markets and Investment in New Generating Capacity. *MIT*, (2005), pp.1–74.

Pellini, E., 2011. Discussion paper Series Measuring the impact of market coupling on the Italian electricity market using ELFO ++. *Surrey Energy Economics Centre*, (October).

Pfeifenberger, J., Spees, K. & Schumacher, A., 2009. A Comparison of PJM ' s RPM with Alternative Energy and Capacity Market Designs. *The Brattle Group*, (September).

PJM, 2008. Long Term FTR Market Training. *PJM Manual*, pp.1–52.

PJM, 2007. PJM eFTR Users Guide. *Manual*, pp.1–56.

Plug, P., 2011. European electricity market: target model, infrastructure and security of supply. *CEER EEF workshop Brussels*, (June).

Proctor, M., 2009. Primer On Financial Transmission Rights. *Missouri PSC*, (March).

PTI, S., 2009. Evaluating Financial Transmission Rights. *Network Consulting*.

Pérez-Arriaga, I. et al., 2006. Diagnosis of the White Paper for the reform of the regulatory scheme of the power generation in Spain. *Instituto de Investigación Tecnológica (IIT)*.

Pérez-arriaga, I. & Batlle, Carlos, 2007. Efficiency of reliability options and applicability in different market designs. *Instituto de Investigaciones Tecnológicas (IIT)*, LARSEN Wor(Paris, 16 March 2007).

Raineri, R. et al., 2008. From a bundled energy-capacity pricing model to an energy–capacity–ancillary services pricing model. *Energy Policy*, 36(8), pp.2878–2886.

Rodilla, Pablo et al., 2010. Regulatory intervention to ensure an efficient medium-term generating resource planning in electricity markets. *Instituto de Investigaciones Tecnológicas (IIT)*, Working Pa(September).

Rodilla, Pablo & Batlle, Carlos, 2010. Redesigning Probabilistic Production Costing models and reliability measures in the presence of market demand elasticity. *Instituto de Investigaciones Tecnológicas (IIT)*, IIT workin(June).

Rodriguez, J.M., 2012. Infrastructures : Interconnections in the Union. *3rd SOLAR THERMAL ELECTRICITY INDUSTRY FORUM*, (February).

Roques, FA, 2008. Market design for generation adequacy: Healing causes rather than symptoms. *Utilities Policy*, 33(3), pp.1–21.

Roques, Fabien, 2011. National Power Market Reforms – Barriers or Drivers of Further European Integration ? *FSR & Climate Economics Chair Workshop*, (May).

Roques, Fabien, Newbery, D.M. & Nuttall, W.J., 2004. Generation Adequacy and Investment Incentives in Britain: from the Pool to NETA. *CMI Electricity Project University of Cambridge, England*, September .

Rudkevich, A.M., Lazebnik, A.I. & Sorokin, I.S., 2012. A Nodal Capacity Market to Assure Resource Adequacy. *2012 45th Hawaii International Conference on System Sciences*, pp.1876–1887.

Schönfelder, M. et al., 2011. New Developments in Modeling Network Constraints in Techno-economic Energy System Expansion Planning Models. *Zeitschrift für Energiewirtschaft*, 36(1), pp.27–35.

Shuttleworth, G. et al., 2002. Electricity markets and capacity obligations. *NERA, London*.

Sioshansi, F.P., 2006. Electricity Market Reform: What Have We Learned? What Have We Gained? *The Electricity Journal*, 19(9), pp.70–83.

Smeers, Y., 2005. How well can one measure market power in restructured electricity systems?. *Available at SSRN 912246*.

Soledad Arellano, M. & Serra, P., 2010. Long-term contract auctions and market power in regulated power industries. *Energy Policy*, 38(4), pp.1759–1763.

Stoddard, R. & Adamson, S., 2009. Comparing Capacity Market and Payment Designs for Ensuring Supply Adequacy. *System Sciences*.

Stoft, S., 1997. How financial transmission rights curb market power. *LBNL-40568 UC-900*, (June).

Sun, J., 2005. U.S. Financial Transmission Rights: Theory and Practice. *IOWA STATE UNIVERSITY, Working Paper # 05008*, (March).

SWECO, 2012. Capacity Mechanisms – Policy Instruments for Influencing Investments. *SWECO*.

Talbot, B.D., 2012. The Great German Energy Experiment. *MIT Technology Review*, June 18.

TAN, Y., WU, Y. & ZHOU, B., 2012. Modeling Capacity Mechanisms by Dynamic Simulating the Generation Capacity Investment. *Journal of Computational Information Systems*, 12, pp.4977–4985.

TF, P., 2012. CWE Price Zone Study. *report to CWE Regulators*, May.

Trebolle, D. et al., 2010. Distribution planning with reliability options for distributed generation. *Electric Power Systems Research*, 80(2), pp.222–229.

Usaola, J., Rivier, J. & Miera, G. de, 2009. Effect of Wind Energy on Capacity Payment: The Case of Spain. *10th IAEE European Conference*, (1), pp.1–10.

Vries, L.J. De, 2004. Securing the public interest in electricity generation markets The myths of the invisible hand and the copper plate. *Thesis Technische Universiteit Delft*.

Vries, L. De, 2012. Selecting a capacity mechanism : What is the problem? *Delft University of Technology*.

Vázquez, C et al., 2006. Regulated tariff design in a liberalized power system: the case of Spain. *Instituto de Investigaciones Tecnológicas (IIT)*, IIT Working Paper.

Vázquez, C et al., 2003. Security of supply in the Dutch electricity market: the role of reliability options. *Instituto de Investigación Tecnológica (IIT)*, Report IIT.

Vázquez, C & Batlle, Carlos, 2002. Security of supply in the Dutch electricity market: the role of reliability options. *Instituto de Investigaciones Tecnológicas (IIT),*

Vázquez, Carlos et al., 2006. Electricity retail regulation in a context of vertical integration: the debate on regulated tariffs. *Instituto de Investigaciones Tecnológicas (IIT)*, IIT Working paper.

Wilson, J.F., 2008. Raising the Stakes on Capacity Incentives : PJM ' s Reliability Pricing Model (RPM). *LECG, LLC Prepared for The American Public Power Association*.

Winkler, J. & Altmann, M., 2012. Market Designs for a Completely Renewable Power Sector. *Zeitschrift für Energiewirtschaft*, 36(2), pp.77–92.

Wolak, F.A., 2009. Comments on Capacity Payment Mechanism. *CAISO*, pp.1–8.

Woodhouse, S., 2011. Capacity mechanism : an alternative option. *POYRY*, (April).

Yao, J., Oren, SS & Hobbs, BF, 2010. Hybrid Bertrand-Cournot Models of Electricity Markets with Multiple Strategic Subnetworks and Common Knowledge Constraints. *Restructured Electric Power Systems*.

Zakeri, G. & Downward, A., 2010. Financial Transmission Rights Auctions: Entry and Efficiency. *Proceedings of the 45th Annual Conference of the ORSNZ*, (January 2008), pp.400–408.