European Commission

Consultation Paper

on generation adequacy, capacity mechanisms and the internal market in electricity

A response from Wärtsilä Corporation

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Executive summary

- Deployment of subsidized variable generation has permanently changed the electricity market environment
- The need for flexibility will increase, and the costs of system inflexibility should not be socialized to consumers, but made visible for market players
- Flexibility provides significant value in systems with a high penetration of Renewable Energy Sources and enables significant savings to consumers
- The introduction of flexibility market creates market based prices for flexibility, incentivizes new investments in flexibility and enables an optimal provision of flexibility without additional administrative payment while minimizing total system costs
- Energy-only market models will not secure adequate capacity in the changed energy market environment, and therefore the introduction of capacity mechanisms are likely
- Temporary solutions to adequacy issues, like strategic reserves or procurement of out-of market capacity, will not lead to an optimal power system architecture and least cost to consumer
- Capabilities should be rewarded through competitive markets, not through capacity mechanisms
  - Models where capacity mechanism reward certain capabilities may not lead to least costs to consumer
- Our suggested approach for future market development follows following steps
  - First, establish a liquid short term electricity market and flexibility market
  - Secondly, if required, introduce a central capacity market to secure capacity adequacy and bankability of new investment
- Capacity mechanism design should treat assets equally, have minimum impact on wholesale and flexibility markets or cross border trade, and ensure bankability of new investments

Contents

1 INTRODUCTION

1.1.1 This paper has been prepared by Wärtsilä as a response to the European Commission's Consultation Paper on generation adequacy, capacity mechanisms and the internal market in electricity. It should be read in conjunction with our responses to each of the specific consultation questions posed by the Commission, which are contained at Section 4.

2 WÄRTSILÄ CORPORATION

2.1.1 Wärtsilä is a global leader in complete lifecycle power solutions for the marine and energy markets. By emphasising technological innovation and total efficiency, Wärtsilä maximises the environmental and economic performance of the vessels and power plants of its customers. In 2012, Wärtsilä's net sales totalled EUR 4.7 billion with approximately 18,800 employees. The company has operations in 170 locations in 70 countries around the world. Wärtsilä is listed on the NASDAQ OMX Helsinki, Finland.

Ship Power

2.1.2 Wärtsilä enhances the business of its customers by providing solutions for the marine industry that are environmentally sustainable, efficient, flexible, and economically sound. Our solutions are based on our customers' needs and include products, systems and services. Being a technology leader in this field and through the experience, know-how and dedication of our personnel, we are able to customise optimised solutions for the benefit of our clients around the world.

Power Plants

2.1.3 Wärtsilä is a leading supplier of modern, environmentally advanced, highly efficient, and dynamic power plants that allow amongst others the maximum integration of intermittent renewable power generation. We offer multi-fuel solutions for power generation markets, from base load generation to peaking and load following, as well as dynamic system balancing and ultra-fast grid reserve for current and future capacity markets. Our fast track deliveries of complete power plants, together with long-term operation and maintenance agreements, offer our customers flexible capacity in both urban areas and the most demanding remote environments.

Services

2.1.4 Wärtsilä supports its customers throughout the lifecycle of their installations by optimising efficiency and performance. We provide the most comprehensive portfolio of services and the broadest service network in the industry, for both the energy and marine markets. We are committed to providing high quality, expert support, and the availability of services wherever our customers are – and in the most environmentally sound way possible.

3 THE NEED FOR INVESTMENTS IN FLEXIBILITY

3.1 The challenge of integrating renewable generation

3.1.1 The EU decarbonisation and renewables agenda will radically change the generation mix, leading in particular to a much greater level of intermittent generation on the system (i.e. wind and solar). Increasing amount of intermittent renewable generation brings a new aspect to system operations, in that it causes unpredictable fluctuations in the generation fleet output. These fluctuations have to be balanced – or 'mirrored' – with other generation units or with some other source of flexibility (e.g. storage, demand side response) to maintain system balance.

3.1.2 The uncertainty of wind and solar generation forecasting increases rapidly when the lead time is prolonged. For example the forecast error for wind production 24 hours ahead can be up to 25-30%. The combined wind and solar forecast error could correspond to around 100GW in the EU power system in 2020. The magnitude of this potential 'error' is something totally different to that faced by the system today.

3.1.3 Wind forecasts get more accurate the closer to real-time, however some forecasting error will remain even in very short lead times (minutes). This needs to be taken into consideration when estimating adequate fast reserve levels for system balancing. It is unlikely that today's short term balancing markets are able to provide the necessary response to decreases in wind production, as such fast capacity does not exist in the quantity necessary on the system (as it has not been needed). Ways must be found to procure sufficient balancing capacity which is available fast enough to react to unpredictable changes in wind generation.

3.1.4 The need for this kind of flexible balancing capacity depends on wind characteristics. In a recent study by Wärtsilä the maximum changes in wind generation output in EU in 2020 were estimated. A large amount of wind data was analyzed, both in North Sea and on-shore, with a total wind generation output estimated at 285GW (of which 40% is estimated to be off-shore). Table 1 presents our estimate of the magnitude of changes in wind output over a 10 minute and 1 hour period.

Table 1 Maximum EU 2020 wind generation changes over 10 minute and 1 hour period

	10 min	1 h
Max wind production **negative** change rate GW	-17	-40
Max wind production **negative** change rate %	-6%	-14%
Max wind production **positive** change rate GW	37	63
Max wind production **positive** change rate %	13%	22%

Source: Wärtsilä, "How to boost investment in the flexible balancing capacity? 2030 dynamic modelling study on roadmap scenarios"

3.1.5 As balancing reserves need to ramp in the opposite direction to the wind generation, the numbers in Table 1 represent the necessary quantity of fast reserves of wind balancing. So, for example, we estimate that there could be a drop in wind generation of up to 40GW in the final hour before real-time.

3.1.6 In addition, the amount of solar power in the EU power system will approach 100GW by 2020. Adding the changes in solar output during sunrise and sunset to the wind changes we have presented above expands the dynamic reserve need close to 100GW in total. In other words, the capability to start and stop 100GW of flexible capacity within an hour must be available in the EU power system by 2020. This capacity may be required to start and stop several times per day, without any clear or predictable pattern between days, months or years.

3.2 Characteristics of flexible generation

3.2.1 Sufficient flexible resources must be scheduled continuously to meet the flexibility requirements. The most efficient operational resources are those that maximise flexibility while minimising cost, emissions and wind curtailment. This balancing capacity will therefore need to have true dynamic characteristics to maintain system frequency levels and to support EU decarbonisation and renewable goals. Such characteristics are:

- Fast starting and stopping, without impacting on product reliability and operating costs,
- Fast loading: ramp up / down from standstill (matching the speed of change of wind power output),
- Capability for continuous cyclic operation,
- Wide load range (preferably as close as possible to 0-100%), while maintaining high efficiency,
- Low carbon and other emissions,
- Optimal plant size and location from the total power system point of view, and
- Flexibility in fuel supplies (e.g. natural gas and biofuels).

3.2.2 Various solutions are available to meet the challenges of balancing the system as intermittent generation increases. Some of these solutions are already proven and available (e.g hydro power, thermal generation), whereas others are as yet untested (e.g. batteries). Different balancing solutions have different characteristics with regard to the time they can be utilized and the amount available.

3.3 Value of flexibility in a system with high RES penetration

3.3.1 Flexible gas generation offers high operational flexibility and high generation efficiency. This combination enables the high integration of renewable sources into the power systems at least cost, thus contributing to the transition to a sustainable, reliable and affordable power system. It is the missing piece of the low carbon power system puzzle.

3.3.2 The need for flexibility will increase in low carbon system. In other words, flexibility has value in future low carbon power system. Currently, the increasing need for flexibility has been recognised among TSOs and market players, but the value of flexibility has not been quantified. Wärtsilä has commissioned several studies on the value of flexibility, following the approach is presented in figure 1.

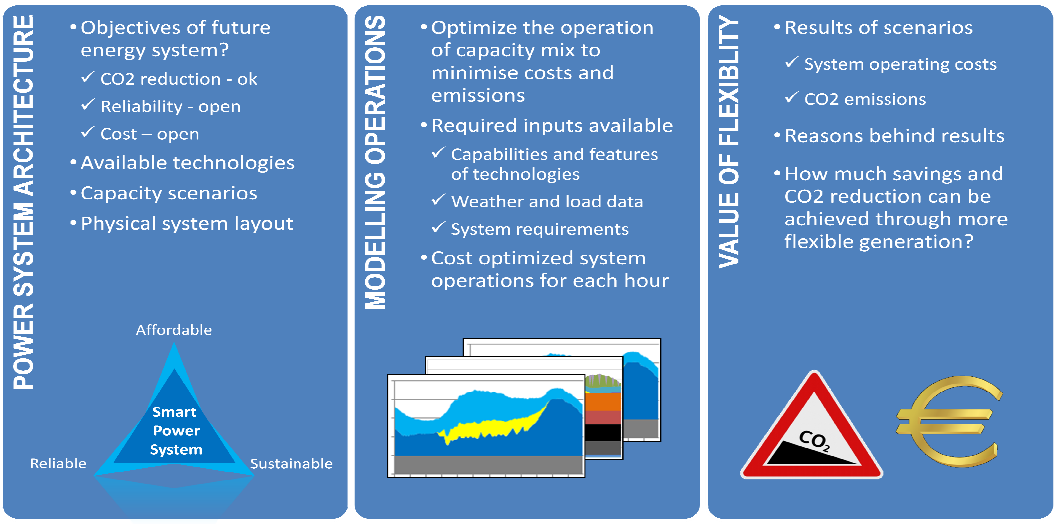

Figure 1 Approach to define the value of flexibility

3.3.3 The first step in the process is to define the future power system architecture and its objectives. The objectives for any smart power system are quite similar: Sustainable, Affordable, and Reliable. To test the feasibility of these objectives, several capacity scenarios are built with different mixes of available technologies, as for example was done in the European roadmap 2050. In addition, the power system architecture defines the physical system layout, including the location of renewable resources, required interconnectors and balancing capacity.

3.3.4 The power system architecture provides input to the second phase of the process, which is the modelling of power system operations. Dynamic power system modelling tools are used to optimize the operations of the defined capacity mixes for 1 hour or 30 minutes period across the year. The user defines the modelling inputs (capacity mix, capabilities of technologies, weather and load data, system requirements, and market operations), and the modelling tool optimizes the generating costs of the power system for each 1 hour or 30 minutes period.

3.3.5 The third and final step in the process is to define the value of flexibility by comparing the results of different scenarios. Power system modelling provides the system operating costs and CO2 emissions as an output for each scenario, allowing the comparison between scenarios. The approach provides understanding of the potential cost savings and additional CO2 savings that flexibility can provide in the low carbon power systems.

Value of flexibility in the Spanish system in 2030

3.3.6 We have undertaken some quantitative analysis to examine the value of flexibility in the Spanish system in 2030, using Plexos dispatch modelling software. The software freely dispatches all the plants based on a least cost optimisation, allowing them to operate when their overall cost (including starting and stopping etc.) is lowest from the point of view of total system costs.

3.3.7 The EU 2030 study for Spain is used as a basis for the power system modelling, but the capacity mixes are adjusted according to the EU level capacity mix scenarios shown in the EU2050 roadmap study (different share of renewables in scenarios). The model is run with and without flexible gas generation.

3.3.8 The results clearly show that flexible power generation, indicated as Smart Power Generation (SPG) in the results, can play a critical role in a future system with significant volumes of intermittent renewable generation. The optimum quantity (in GW) of flexible power generation varies depending on the capacity mix in question. To reach the optimum cost and system efficiency, CCGT plants are also needed in parallel with SPG. This is illustrated in Figure 2, which presents our modelling results.

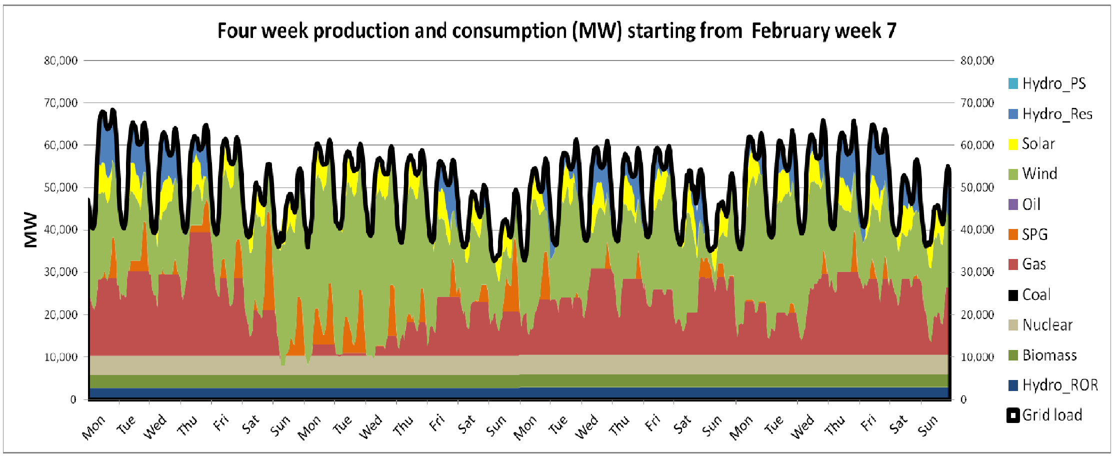

Figure 2 Modelling results for Spanish power system, February 2030

Source: Wärtsilä

3.3.9 Depending on the scenario modelled, relative to the baseline scenario (without SPG), dispatch of SPG:

- Reduces average system level variable generation costs by between 1% and 5.5%, and;
- Provides additional reduction in CO_2 emissions by between 1% and 12%.

3.3.10 This latter result is quite remarkable taking into account that the Spanish energy has a high penetration of highly efficient CCGTs in the current generation mix.

Value of flexibility in the UK

3.3.11 Given the UK's ambition with respect to decarbonisation and renewables in the power system, the need for flexibility is beginning to rise up the policy agenda. An analysis by UK's DECC (Department of Energy and Climate Change), published in August 2012, estimates that flexibility from a range of sources – including from flexible generation, demand side response, interconnection and electricity storage – can generate significant savings to UK consumers, particularly in a scenario with a high wind penetration.

3.3.12 Following this report, Wärtsilä engaged Redpoint Energy and Imperial College London to undertake further analysis of the potential value of system flexibility through detailed modelling of the UK power market and balancing costs. The focus has been on supply-side flexibility e.g. flexible plant such as 'Smart Power Generation' (SPG). The results however are more generally applicable to all sources of flexibility (DSR, storage and interconnection).

3.3.13 The modelled scenarios are based on DECC's and National Grid's (UK's TSO) projections on the demand and capacity mix development by 2020 and 2030. Two separate capacity mixes were investigated under different wind scenarios (high wind and base wind). In the "NO SPG" Capacity mix, gas generation capacity is represented by efficient CCGTs with a small fraction of OCGT. In the "SPG" Capacity mix, 4.8 GW of the most efficient CCGT capacity is replaced by 4.8 GW of Smart Power Generation (SPG). This amount approximates the volume of new-build CCGT to 2020 under the base wind scenario. National Grid estimate that in 2020 flexibility requirements will vary between 4.8 GW and 13 GW across the year, and so 4.8 GW of SPG can provide some but not all of this requirement. SPG has a slightly lower net electrical efficiency but superior operational flexibility compared to CCGT. The modelled capacity mixes and wind scenarios for different years are shown in figure 3.

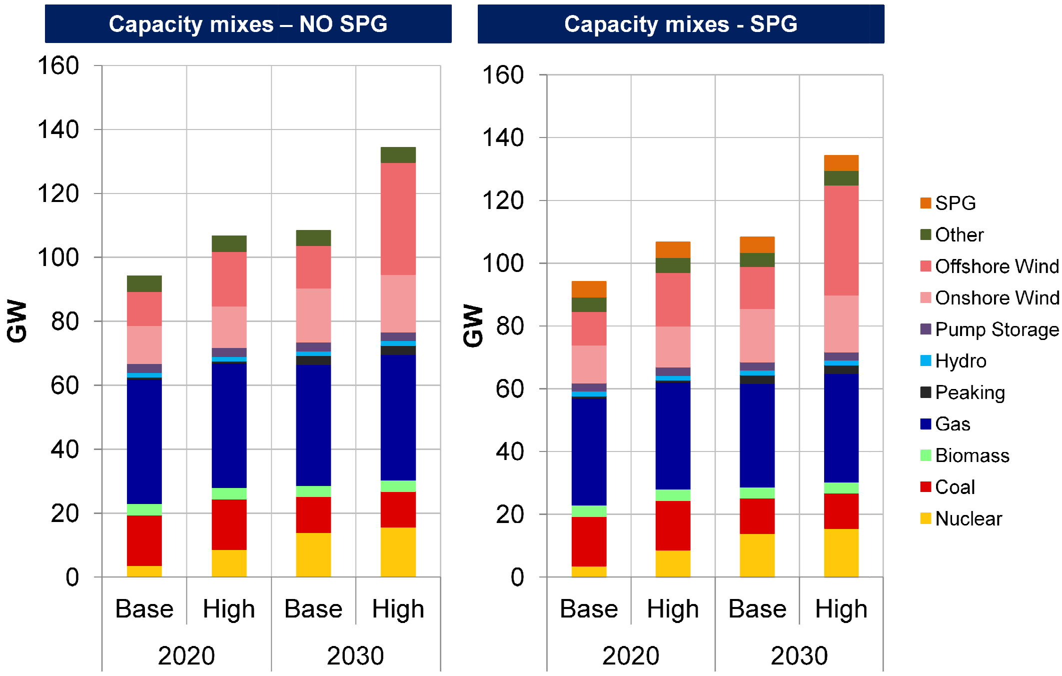

Figure 3 Capacity mixes for power system modelling in the UK case

3.3.14 The UK interconnected system was modelled in 30 minutes granularity and included all power plants and interconnectors. The modelling outcome was based on a two-step approach. Where the first step modelled the dispatch of generation capacity based on lowest system operation costs and acted as input to the second step where the model simulated system balancing actions (re-dispatch of the generating fleet) taken by the TSO to meet the flexibility requirements for each half hour resulting in a part-loading of thermal units.

3.3.15 Figure 4 demonstrates the impact of SPG to system flexibility provision. Depending on the case, SPG is the least cost option to provide flexibility 35-40 % of the time. With SPG providing system flexibility in an optimal way, more room is available for efficient CCGTs and coal generation to run at full load, providing cheap electricity to consumers.

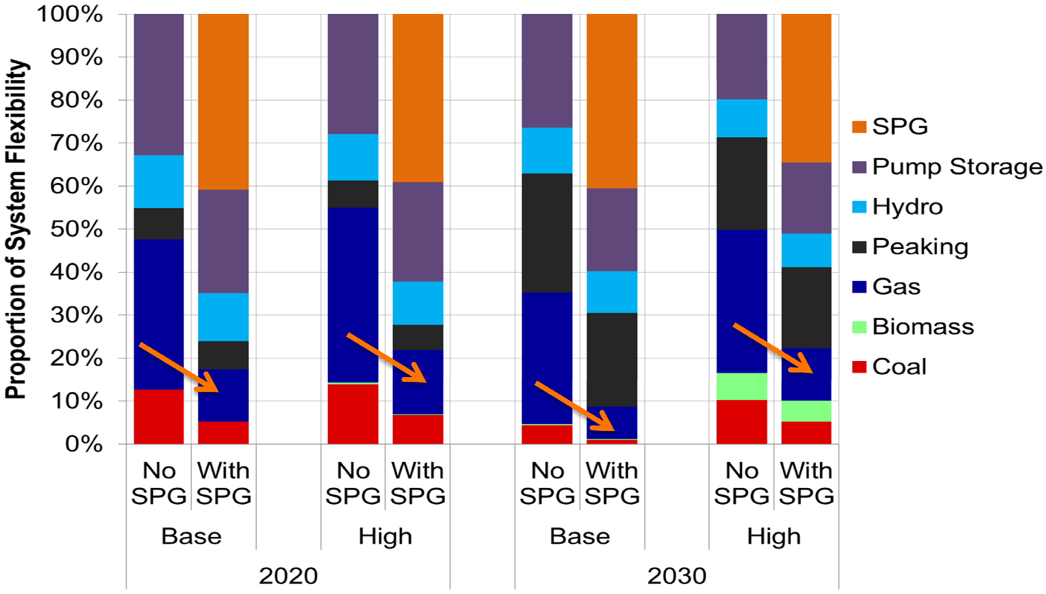

Figure 4 Provision of flexibility across the year

3.3.16 The analysis demonstrated that, depending on the wind scenario, flexible gas generation (as a reliable source of flexibility) could save the UK consumer between £380m to £550m per year by 2020 through reduced balancing costs incurred by National Grid. Modelled savings are estimated to be significantly higher in 2030 (£580m to £ 1,540m) as the volume of wind of the system is anticipated to increase further. Figure 5 shows the overall system balancing costs (total cost of flexibility), and costs savings due to SPG.

Potential cost savings due to Smart Power Generation

Balancing costs – flexibility provision (£ mn per annun, real 2011)	2020		2030	
	Base Wind	High Wind	Base Wind	High Wind
Costs - No SPG	692	1008	834	2781
Costs - With 4.8 GW SPG	311	464	256	1244
Cost Saving due to SPG	**381**	**545**	**578**	**1537**

Figure 5 Modelling results for UK Balancing costs

Source: Study Redpoint Energy and Imperial College London.

Base Wind: DECC Updated Emissions Projections, central (Oct 2011).

http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/en_emis_projs/en_emis_projs.aspx .

High Wind: National Grid Future Energy Scenarios, Gone Green (Oct 2012).

http://www.nationalgrid.com/uk/Gas/OperationalInfo/TBE/Future+Energy+Scenarios/.

The 4.8 GW of SPG approximates the volume of new-build CCGT to 2020 under the base wind scenario. We have assumed no new SPG post-2020

3.3.17 To give some scale to the potential savings in balancing costs, these are compared to the UK system-wide generation costs. Due to increasing amount of low-cost renewable generation the total generation costs will reduce when the output of renewable generation increases. However, the need for balancing actions will increase accordingly, and these costs will have a significant role by 2030. The saving potential of SPG is as high as 5 % in 2020 increasing to 19 % of total generating costs in 2030. Figure 6 shows the savings compared to total system generation costs in SPG scenarios.

Scale of potential system savings (£ mn per annum, real 2011)	2020		2030	
	Base Wind	High Wind	Base Wind	High Wind
Total generation costs (£ mn)	13164	11682	10176	8282
Saving in balancing costs (£ mn)	381	545	578	1537
% saving	**3%**	**5%**	**6%**	**19%**

Figure 6 Value of flexibility in UK system in 2020 and 2030
Source: Study Redpoint Energy and Imperial College London.

Value of flexibility in California in 2020

3.3.18 The state of California in the USA has ambitious target to increase the generation from renewable sources up to 33 % by 2020. California's Renewable Portfolio Standard (RPS) program aims to alter the in-state generation and import mix by requiring jurisdictional utilities to obtain a progressively larger proportion of their electricity delivered to end users from renewable energy. This development has started the debate on the required flexible assets to secure reliable operations of the power system. The Californian system operator CAISO has already started a stakeholder process with a target to introduce new market products explicitly for flexibility (called FlexRamp).

3.3.19 The Californian system will face another issue in near future, when 12 GW power plants with once-through cooling are at risk to retire due to new environmental regulation. CAISO and the local regulator have analysed this risk and came up with the conclusion that 5.5GW of new CCGT and OCGT (50-50 split) is required by 2020 to secure the power system reliability.

3.3.20 Wärtsilä engaged KEMA DNV to analyse the Californian system in 2020 by using dynamic system modelling. The base case for the power system modelling was the Californian system in 2020 with 33 % renewables penetration (wind and solar but excluding hydro) and 5.5 GW of new gas turbine plants. The alternative modelling scenario had the same basic assumptions, but 5.5. GW of gas turbines was replaced with 5.5 GW of flexible Smart Power Generation. This scenario is called Flexible Case. The complete Western Interconnected system (WECC) was modelled in 1 hour granularity and the results were isolated for the Californian system. The WECC system covers majority of the states in the west cost of the USA and includes thousands of power plant units and established demand response program.

3.3.21 Figure 7 shows the flexibility provision by technology in different scenarios for two main ramping products: Load following up and Regulation up. SPG is the cost optimal solution to provide load following over 60 % of modelled hours, and around 80 % of required regulation service. It can be seen clearly that SPG provides the majority of ramping services, when more efficient gas generation does not need to offer system services, but can run at full load providing cheap electricity.

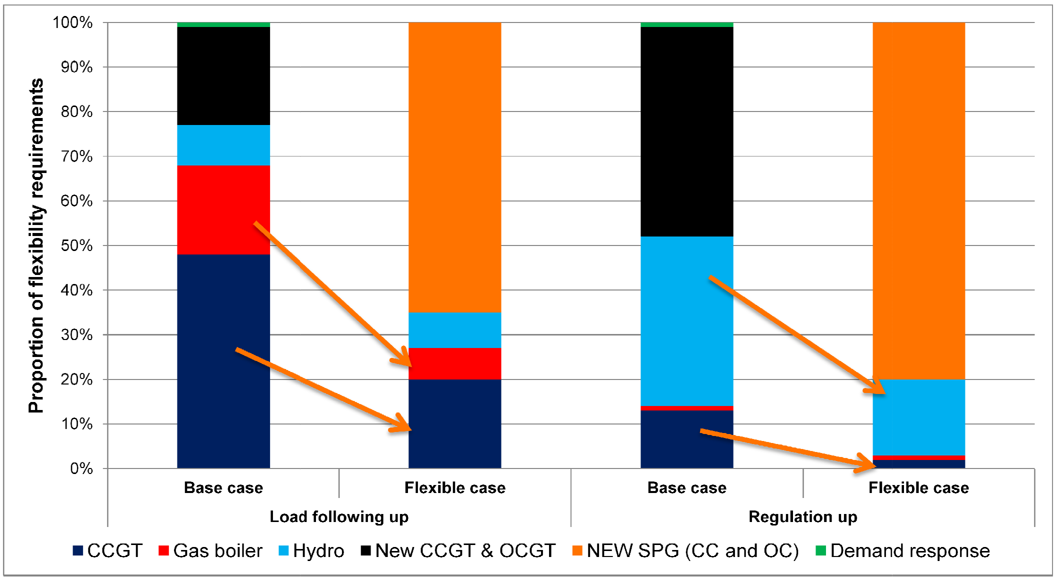

Figure 7 Flexibility provision in California in 2020

3.3.22 Introduction of flexible SPG provides significant system level savings for California in 2020. By introducing 5.5 GW of SPG instead of 5.5 GW of gas turbines, the Californian consumers save around 900 MUSD per year representing around 11 % savings in system level operating costs. The cost breakdown of total system operating costs for the modelled scenarios is shown in the figure 8.

Cost category	Base case Million $	Flexible case Million $	Cost savings in Flexible case
Variable generation cost	4 963	4764	199
Start and stop cost	179	96	83
Emission cost	1 463	1 401	62
Import cost	327	379	-52
Ancillary service cost	1 201	603	598
TOTAL system operating costs	8 133	7 243	890

Flexibility reduces system generating costs by letting the cheaper generation to provide more energy, and avoiding the usage of inefficient generation

Flexibility provides additional CO2 savings

Import cost increase, due to slightly lower efficiency of SPG

Over 50 % savings in system service's costs

Value of flexibility around 900 MUSD/a (11 % system level cost savings)

Figure 8 Value of flexibility in California in 2020

Value of flexibility – conclusions

3.3.23 Based on the modelling studies performed by KEMA DNV, Redpoint Energy and London Imperial College, it is evident that flexible generation reduces total system operating costs in high RES systems. Existing generation is able to fulfil system flexibility requirements by running plants at part load, but such actions significantly increase cost to consumers as shown in the California and UK studies. The value of flexibility in 60 GW (UK and California) peak load system with high RES penetration is analysed to be >> 500 MEUR per year. Translating this to a European size system, the value of flexibility is approximated to be >> 5 bn EUR per year, already in 2020.

3.3.24 Increasing amounts of flexibility is required in high RES systems. The value of flexibility, or costs of inflexibility, is significant in these future power systems. Flexibility becomes one of the key parameters of future power systems and energy market designs. Based on our analysis we highlight four key points on the value of flexibility:

1. In high RES power systems, flexibility is no longer an invisible and low cost side product of power generation, taken care by system operator, but a key factor in power system design and optimization.

2. While continuously ensuring capacity adequacy, adding flexibility to the system can significantly reduce generation costs and CO2 emissions.

3. The value of flexibility cannot be materialized by modifying existing inelastic generating assets or by demand response – New flexible power generation is needed.

4. Future electricity markets need to recognize the value of flexibility to boost investments in flexible power generation – This requires a new approach to electricity market design.

3.4 Electricity market challenge

3.4.1 Decarbonising the energy sector is one of the main objectives of the EU. To meet this objective, significant amounts of variable renewable capacity have been deployed already and a lot more will be deployed by 2020 and beyond. Today, variable renewable generation is not feasible without support mechanisms. Wind and solar capacity receives subsidies to boost investments in these low operating cost and carbon free generation. This development impacts power system operations and electricity markets.

3.4.2 Reliable system operation requires more balancing capabilities in high RES systems, since the output of variable generation contains always unpredictability (forecast errors) and variability (from hour to hour and day to day). In addition, RES production has typically priority to dispatch and therefore the rest of the system needs to adjust its output to balance the variable RES output. To cope with these variations in RES generation output, system operators need to have capacity available that can respond fast to these changes. As a result, thermal capacity needs to be flexible enough to respond to system operator requests, and at the same time needs to 'make room' for low-carbon generation when it comes available.

3.4.3 The impact on electricity market is severe. Variable RES generates electricity at very low costs and pushes thermal capacity higher up or out of the merit order. This means reduced operating hours and less revenue for thermal capacity. In addition, subsidized RES output depresses electricity prices, which make the feasibility of thermal plants even more challenging. Thermal capacity is still needed in a system with high penetration of Renewable Energy Sources to balance the system, but the profitability of these assets is jeopardized.

3.4.4 Several EU member states have identified a concern that the market may bring forward insufficient capacity under current market arrangements. There is a potential market failure associated with a perceived political risk to allowing prices to reach high levels at peak times. Such high prices would be required to remunerate plant running at lower load factors, such that they are able to recover fixed costs whilst operating for only a small number of hours per year, and at a higher rate of return than baseload plant, reflecting a higher price and load factor uncertainty. This issue has been termed the "missing money" problem.

3.4.5 However, we believe that there is another issue that must be addressed. It is not simply "capacity" that is required. Consideration must be given to delivering the "right types" of capacity, and in particular, that a sufficiently flexible mix is available. Without appropriate price signals, there is an equally important concern around "missing flexibility". We think this has not received adequate attention during the current debate but is essential in meeting the overall decarbonisation objectives. Therefore, in addition to resource adequacy and operational security, "market flexibility" should be considered as a direct objective for any new arrangements.

3.4.6 There are three core requirements of economic, efficient and co-ordinated power systems:

- Resource adequacy: ensure there is sufficient reliable capacity on the system to meet peak demand
- Operational security: responsiveness to manage very short term and unpredictable variations in load and generation output
- Market flexibility: ability to vary output / demand in response to 'predictable' changes in load and generation output

3.4.7 Table 2 sets out the potential market mechanisms to deliver each of the three core requirements described above.

Table 2 Possible market mechanisms to deliver the core system requirements

System need	Met by:
Resource adequacy	Forward / spot markets ***OR*** Capacity mechanism
Operational security	Reserves and balancing markets
Market flexibility	Reserves and balancing markets **AND** Spot / intra-day markets ***OR*** Capacity mechanism

Resource adequacy

3.4.8 We recognise that resource adequacy is clearly high on the agenda in some member states. For example, the UK Government has decided to implement a 'market-wide' capacity mechanism in Great Britain (GB), which will be in the form of a forward capacity auction with availability incentives and penalties. The rationale for intervention is to deal with the so-called 'missing money' problem brought about by increasingly uncertain market-based revenues for thermal plant. Our understanding is that the capacity mechanism will be technology-neutral (subject to meeting technical availability requirements), focused on ensuring overall capacity adequacy rather than on securing certain types of capacity. In our view, while this form of capacity mechanism may increase capacity margin, it is unlikely to deliver the required market flexibility at least cost to consumers.

3.4.9 On a European level, the "Scenario Outlook & Adequacy Forecast" produced by ENTSO-E analyses resource adequacy of the ENTSO-E interconnected transmission system, based on different scenarios. Though the report provides welcome insight on available capacity, peak load and resulting margin, it does not address market flexibility. Dynamic fluctuations in the generation fleet caused by intermittent renewable generation are not considered, even though all scenarios predict increasing amounts of wind and solar generation. Such fluctuations have to be balanced with other generation units. The report however also does not analyse the dynamic characteristics of the power generation fleet (e.g. start-up times, ramp rates, etc.). Such analyses would provide good insight in the level of flexible power generation available for system balancing.

3.4.10 Securing capacity adequacy in a system with high penetration of RES becomes more and more challenging with the energy-only market model when the amount of subsidized RES generation increases. The market theory claims that higher and more frequent price spikes will compensate the reduced operating hours and depressed peak prices to thermal plants. The reality is different. Severe price spikes are politically very unpopular and this increases the risk of price caps or other interventions to limit the price levels in times of scarcity. This can potentially lead to investment hiatus and early closures of existing plants, causing the risk of capacity shortfall. Some forms of capacity mechanisms are needed in near future to secure capacity adequacy in Europe.

Operational Security and Market Flexibility

3.4.11 Traditionally, there have been three main causes for imbalances between electricity supply and demand that require actions from TSOs:

1) Predictable variations in load patterns throughout the day (which requires active 'load following' by the TSO);
2) Unpredictable but constant small fluctuations in most loads; and

3) Generator and transmission & distribution line outages.

3.4.12 For the latter two categories, TSOs contract reserve capacity and response capability in day-ahead and longer-term markets so as to provide flexibility that can be called upon at short notice to balance the system. Balancing and reserve has been necessary for relatively small volumes (load or thermal generation prediction errors) or fault events of small probabilities (power station failures). This has meant that total requirements have been small relative to the size of the total system peak load (typically 1% to 3%). Further, load forecasting is quite predictable day-ahead, so TSOs are able to estimate system balancing requirements well in advance to meet the demand uncertainty and volatility. This has allowed TSOs to start power plants well before the period in which they are needed. However, this situation has changed. The increasing amount of intermittent renewable generation causes unpredictable fluctuations in the generation fleet output that have to be balanced. While traditionally TSOs have focused on ensuring operational security, the requirement for market flexibility is expected to increase dramatically in line with the increased wind (in particular) and solar penetration.

3.4.13 Table 2 highlights the critical role for the balancing arrangements (not limiting to balancing markets only). The balancing arrangements should:

- Provide the right price signals to facilitate the emergence of an efficient mix of flexible technologies, recognising the different technical characteristics provided by different flexibility products.
- Enable wide scale integration of renewable capacity, and to ensure maximum utilisation of this capacity in line with the RES Directive (e.g. by encouraging fast ramp times, high efficiency, avoidance of unnecessary operation).

3.4.14 In broad terms, in order to integrate significant volumes of renewable generation onto the system, electricity market arrangements must appropriately reward flexibility in balancing resources such that the future value of this flexibility can be realistically and confidently predicted by potential investors.

3.4.15 We note that under current market arrangements the value of flexibility is not appropriately rewarded and the value is not visible to market players. Barriers to this may differ per member state. Below we aim to provide a general overview of such barriers:

- **Price calculation of imbalance price**: a price calculation based on the weighted average cost of actions rather than the marginal cost, and that does not accurately allocate reserve costs, which means that the price does not reflect the marginal value of energy.

- **Pricing method of imbalance price:** (pay-as bid instead of pay-as-cleared): pay-as-bid pricing can make it difficult for smaller balancing resources to participate, given that analysis to anticipate the market clearing price is required. Such parties may adopt an over cautious pricing strategy as a result, which can dampen imbalance prices and therefore signals to invest.
- **Out-of-market capacity**: capacity contracted by the TSO can act as a potential price-cap during scarcity events which can dampen prices and therefore signals to invest.
- **Mixing different products:** mixing different products procured through different means and over different timeframes. This generates imbalance prices which are not reflective of the true costs of procuring the individual products used at that point, and as such can cause the misallocation of costs to market participants over the long run.
- **Non-costed actions**: the use of non-costed actions means that no price signal is available at these times for market participants to respond to.
- **Unpredictability** caused by the complex calculation and use of different services,
- **A lack of transparency** of service procurement, utilization of resources and pricing
- **An artificial spread** in the value placed on energy caused by the dual price system as used in some member states, which causes an asymmetric risk for parties with an imbalance

3.4.16 Flexibility should be at the heart of any reform of a power system, as it helps to deliver secure and affordable energy whilst optimising the use of low carbon renewable energy on the system. Despite market wide acknowledgment that flexibility is vital, insufficient focus has been given on putting the appropriate provisions in place to deliver flexible generation. This could ultimately leave a system reliant on less flexible technology to meet the intermittency challenge, resulting in higher costs to the consumer.

3.5 Electricity market vision for high RES system

3.5.1 Deployment of variable renewable generation will have major impact to power system operations and electricity markets as has been shown in the previous chapters. Future power system operations require a lot more flexibility from the generation fleet, and new flexible power generation capacity could provide significant savings to consumers. As mentioned, in a system with high penetration of RES flexibility is no longer an invisible and low cost side product of power generation, but a key factor in the power system design and optimization.

3.5.2 However, the current market arrangements do not reflect the value of flexibility or incentivize investments in flexibility. There are several issues in current market setups that "hide" the cost of inflexibility into consumer bills and prevent the investments in new flexible capacity. Simultaneously, energy-only market setups are struggling to keep capacity adequacy on healthy levels in this new market situation.

3.5.3 Wärtsilä has studied several electricity market models for systems with high penetration of RES to incentivize flexibility and ensure capacity adequacy. Based on this study, we have developed an electricity market design that secures capacity adequacy, incentivizes the right type of capacity, and leads to the least cost to consumer. Wärtsilä supports a market based design where wholesale electricity markets (day-ahead, intra-day and balancing market) together with a flexibility market establishes a competitive market environment to compete on equal basis for all market players. Competitive capacity market would be introduced if it is needed to secure capacity adequacy. The overall setup of the market design is shown in the figure 9.

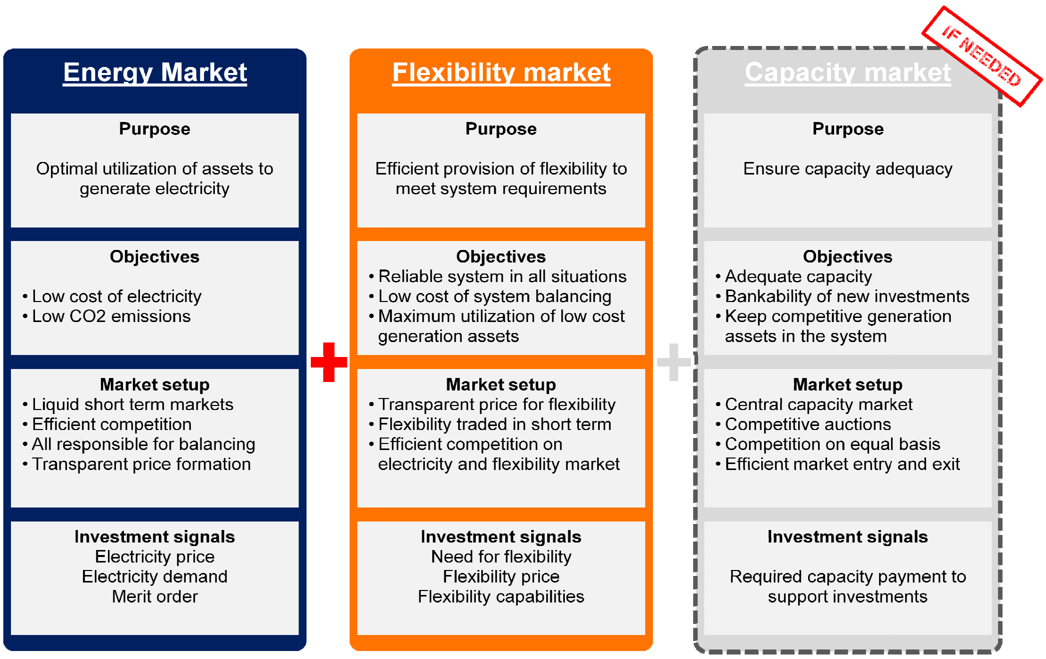

Figure 9 Market design for a system with high penetration of RES power generation

3.5.4 A competitive **Energy Market** forms the basis of the market model. The objectives of energy markets are to provide low cost electricity and low CO2 emission in all situations through competitive short term markets. Cost reflective imbalance prices will increase the imbalance exposure of all players (all players responsible for balancing), which increases willingness to be in balance at gate closure. This development enhances the liquidity in intra-day markets, and on the other hand, provides additional income for flexible assets through transparent balancing and intra-day markets. The main competitive factor is still electrical efficiency. Investor need to assess the revenues and margin from the energy market based on the future electricity price and demand, and the asset’s position in the merit order (running hours).

3.5.5 A competitive **Flexibility market** is a day-ahead option market for flexibility to increase/decrease energy the following day. The flexibility market would replace existing procurement strategies of TSOs and would make the procurement of system services more transparent to market players. TSOs would procure required flexibility (reserves) to satisfy the system needs for the following day from the flexibility market, when the volumes are not locked away under long-term contracts. Flexibility market would also be open for market participants to procure flexibility to hedge against intra-day prices and imbalance exposure. When flexibility is procured close to real time, generators can choose their provisions between flexibility and energy markets, when the overall system operation costs are reduced. Key features of the flexibility market are the following:

- **Buyer of flexibility:** Voluntary procurement of market participants. The TSO would procure always flexibility to the system needs, but the procurement of market participants could reduce the amount procured by the TSO. Reduced imbalance exposure provides incentive for market participants to buy flexibility. The TSO is a key player in the market, but its role is limited so as to maintain incentives on market participants.

- **Volume:** Market participants determine their own volume requirements and the TSO provides the backstop in the DAH auctions to ensure that the system has the flexibility needed. Thus there is only a ‘quasi’ central determination of volume requirements. Share of market vs. TSO procurement can change dynamically from day to day.

- **Products:** Multiple products defined by the TSO in consultation with industry, to ensure the needs of the system are met. All products require an option to deliver and increase or decrease in physical energy in a future settlement period. Products have various technical capabilities (e.g. start times, ramp times, spinning / standing), but aim to minimise complexity to maximise liquidity. Typical products could be:
    - Response in 5 seconds, achieve the contract point in 30 seconds

- Response in 30 seconds, achieve the contract point in 5 minutes
  - Response in 1 minute, achieve the contract point in 10 minutes
  - Response in 5 minutes, achieve the contract point in 30 minutes
  - Response in 30 minutes, achieve the contract point in 1 hour
  - Response in 1 hour, achieve the contract point in 4 hours

- **Timeframes:** DAH timeframe aligns (or allows co-optimisation) with the energy market, and provides a daily reference price for different flexibility products. A secondary within-day market for market participants and the TSO to trade their options as more information emerges. Liquid within-day energy market is important to enable efficient exercise of options that are 'in the money'. After gate closure, the TSO may exercise any unused options in the balancing market or options holders must sell the option in the balancing market.

- **Delivery:** Option holder (market participant or the TSO) may exercise the option by calling for energy to be delivered prior to gate closure. Self-provided flexibility must provide information to the TSO within-day on whether it will be exercised. After gate closure any unused options would be exercisable by the TSO in the balancing market.

- **Cash flows:** Flexibility cleared through the DAH auctions (other than self-provided reserve) is paid the market clearing availability fee (per MW) for the contract period (next 24 hours or hourly products). Utilisation fee (per MWh) is paid upon exercise. Unused flexibility must be offered into the balancing market at the fixed utilisation fee, for dispatch and payment by the TSO.

- **Cost recovery:** Option holder pays the availability fee to the flexibility providers. Availability fees incurred by the TSO could be recovered via an information imbalance charge levied on out of balance market participants. Availability fees incurred by the TSO could be allocated to specific periods based on ex ante expected usage, or based on a flat allocation over the day.

- **Monitoring:** TSO would certify physical capability of capacity providers seeking to offer into the DAH auctions. Any options exercised would be notified to the TSO in the same way as physical energy. Transparency over TSO procurement strategy would be important.

3.5.6 Such Flexibility market would secure the cost optimal provision of flexibility to meet system requirement, and it would maximise the utilization of low cost generation assets to generate electricity. It would also provide transparent price for all flexibility providers to compete in flexibility and energy markets. Clear DAH reference prices can allow long-term financial contracts to be struck between flexibility providers and market players or the TSO.. The total volume of flexibility requirement is known through the TSO procurement strategy which provides stable volumes and liquidity in the flexibility market. With the proposed setup, the market would recognise the daily need and value for flexibility, needed to attract investments in flexible capacity. In addition, such capacity would reduce the system operating costs of high RES power system.

3.5.7 Central **Capacity market** would be established if the energy together with a flexibility market are not delivering investments or are not able to keep existing plants in the system. The purpose of the capacity market is to ensure capacity adequacy by providing administrative capacity payment to replace the “missing money” issue. The future markets (energy and flexibility market) are volatile by their nature. Investors may require stable cash flows to be able to finance their new projects. In this case a capacity market could enhance the bankability of new projects. Capacity market (like any capacity mechanism) should concentrate on securing the capacity adequacy, not specifying what type of capacity is needed. It should be technology neutral and treat all forms of capacity (demand and supply) on equal basis. Well functioning energy market together with flexibility market would reward capabilities, when capacity market only provides the “all-in price” required by investor to make the investment.

3.5.8 It is important to realize that European power systems differ country by country and some are facing the adequacy issues earlier than others. Therefore some countries might start to implement capacity mechanisms, even though the electricity market framework is not established for the new market situation. This can lead to a situation where inflexible capacity enters the market, and through capacity payments is locked-in longer periods leading to excess costs for consumer (like Spain). To implement the optimal market design for future power system, we propose a four step approaches presented in figure 10.

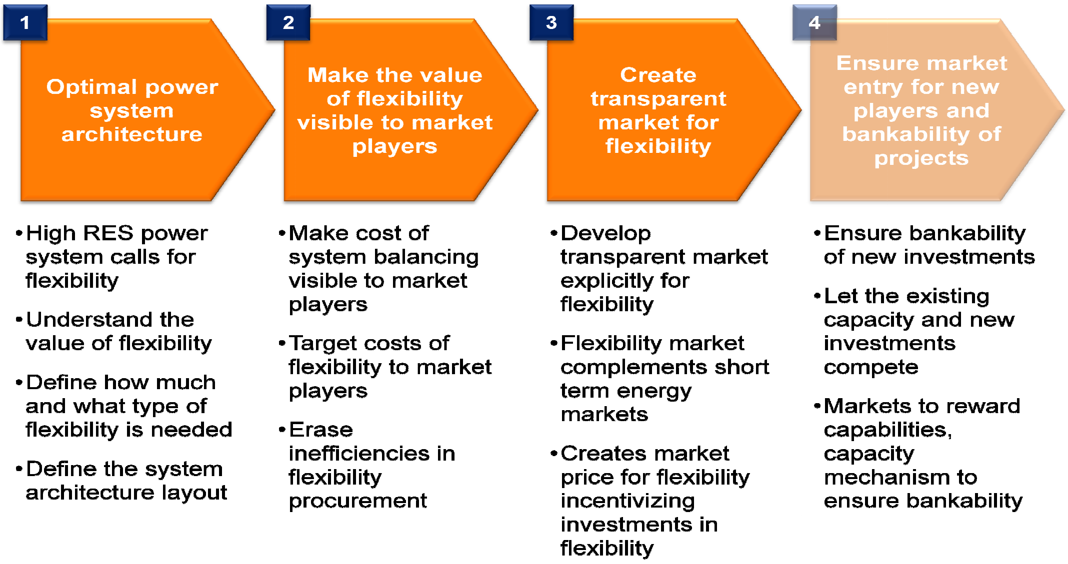

Figure 10 Steps to develop competitive electricity markets for a system with a high penetration of RES

1. **Define the optimal power system architecture** for Europe. European power system and electricity markets will change dramatically due to increasing amount of subsidized renewable production. The deployment of variable renewable capacity will increase the need for flexible resources. Inflexible power generation will cause major cost to consumer whereas flexible power generation could provide significant savings to consumers. New flexible generation can provide annual savings of several billion Euros to consumers in this new market environment. To attract new investments in flexibility, market designers need to understand the value of this feature.

2. **Make the value of flexibility visible to market players.** We note that under current market arrangements the value of flexibility is not appropriately rewarded and the value is not visible to market players. Therefore, first, the true cost of system balancing should be made visible for market players. This requires revision of balancing responsibilities, cost targeting of balancing actions, TSO's reserve procurement, imbalance pricing, and utilization of reserves in short term market timeframes. Higher imbalance risk exposure encourages market participants to balance their position before gate closure or hedge their imbalance risk thru markets, which leads to increased liquidity in short term markets.

3. **Create transparent market for flexibility** enabling efficient procurement of system services, and providing clear market signals for flexibility providers to invest in flexibility. If the market does not provide clear signal for flexibility, then investors will not take these features into account while making investment decisions, even though flexibility could provide significant savings in the system level. Transparent flexibility market is required to

provide clear price signals for flexibility leading to increased willingness to invest in flexible assets.

4. **Ensure market entry for new players and bankability of new projects** by introducing a capacity market, if the markets are not delivering investments. If opting for a capacity market without a flexibility market, investments in less flexible capacity would emerge due to a lack of price signals for flexibility, leading to a suboptimal system and increased costs to consumers. Therefore, it is essential that well functioning energy markets with flexibility markets are introduced before capacity markets.

4 RESPONSES TO INDIVIDUAL CONSULTATION QUESTIONS

4.1 Question 1: Do you consider that the current market prices prevent investments in needed generation capacity?

4.1.1 Increasing penetration of renewable power generation resources into a system has several effects on the remaining (mostly thermal) generation fleet of such system. Operating hours of this fleet are reduced, whilst at the same time the average electricity price is lower. As a result the market based revenues for thermal plant is increasingly uncertain. Several EU member states have identified a concern that the market may bring forward insufficient new capacity under such arrangements.

4.1.2 However, we believe that there is another issue that must be addressed. It is not simply "capacity" that is required. Consideration must be given to delivering the "right types" of capacity, and in particular, that a sufficiently flexible mix is available. Without appropriate price signals, there is an equally important concern around "missing flexibility".

4.1.1 We note that under current market arrangements the value of flexibility is not appropriately rewarded and believe this prevents investments in flexible power generation, needed to achieve the EU decarbonisation targets at lowest costs to consumers.

4.2 Question 2: Do you consider that support (e.g. direct financial support, priority dispatch or special network fees) for specific energy sources (renewables, coal, nuclear) undermines investments needed to ensure generation adequacy? If yes, how and to what extent?

4.2.1 The EU decarbonisation and renewables agenda is driving member state support schemes for renewable power generation and will change the generation mix, leading in particular to a much greater level of intermittent generation on the system. In additional to creating a "missing money" problem, these support schemes also creates a "missing flexibility" problem.

4.2.2 Flexibility in any power system having a large share of RES (or aiming to increase the share of RES) helps to deliver secure and affordable energy whilst optimising the use of low carbon renewable energy on the system. Despite market wide acknowledgment that market flexibility is vital, insufficient focus has been given on putting the appropriate provisions in place to deliver flexible generation.

4.2.3 We recognise that resource adequacy is clearly high on the agenda in some member states and capacity mechanisms are under discussion. While this may increase capacity margin and reduce risks to security of supply, it is unlikely to deliver the required market flexibility at least cost to consumers.

4.3 Question 3: Do you consider that work on the establishment of cross-border day ahead, intraday and balancing markets will contribute to ensuring security of supply? Within what timeframe do you see this happening?

4.3.1 In our view the harmonisation of electricity balancing arrangements is a critical component of the EU Target Model. Cross-border exchange of resources in balancing timeframes can play an important role in maintaining security of supply and in maximising output from intermittent renewable generation sources across Europe.

4.3.2 ACER's Framework Guidelines on Electricity Balancing (and the subsequent Network Codes) provide an opportunity to define a common set of balancing rules across Europe. Greater harmonisation can lower barriers to entry for flexibility providers, enhance liquidity in balancing markets, and most importantly enable the integration of renewables under the RES Directive at least cost.

4.3.3 While there may be sound reasons to take an incremental approach, we suggest that the priority should be on creating liquid competitive balancing energy markets as soon as practically possible.

4.4 Question 4: What additional steps, if any, should be taken at European level to ensure that internal market rules fully contribute to ensuring generation adequacy and security of supply?

4.4.1 Wärtsilä supports the adoption of the EU Target Model to create a single electricity and gas market across Europe. We believe that, once implemented, it has the potential to result in significant collective benefits, including:

- Efficient use of cross-border transmission capacity,
- Efficient cross-border flows, based on economic fundamentals,
- Enhanced security of supply,
- Lower barriers to entry, enhanced competition and increased market liquidity.

4.4.2 We recognise the divergence in starting points across the EU and the need to achieve consensus. What is important is that the 'end-game' is clearly defined, and then the path to reach that end-game can be adjusted appropriately. In our view this can be achieved by setting out a clear vision for the harmonisation of electricity balancing arrangements across Europe in both the medium and long term.

4.5 Question 5: What additional steps could Member States take to support the effectiveness of the internal market in delivering generation adequacy?

4.5.1 Regional or Member State initiatives should be encouraged and supported as they provide valuable experience that can be shared across Europe to aid the learning process. However in order to deliver maximum benefits from harmonisation, the focus should be on the delivery of a single European-wide target model and the timeframes should reflect this.

4.6 Question 6: How should public authorities reflect the preferences of consumers in relation to security of supply? How can they reflect preferences for lower standards on the part of some consumers?

4.6.1 There are probably many possibilities to reflect the preferences of consumers in relation to security of supply. The most transparent and market-based approach is to roll out smart meters to facilitate the replacement of flat price tariffs by more dynamic approach. If consumers can see the cost impact of scarcity events in their electricity bill, and they are able to react to these events in advance, this would increase demand side elasticity and reflect the preferences of consumers in relation to security of supply.

4.6.2 Customers, who are willing to avoid the price spikes, are also more willing to reduce their consumption during scarcity events. However this requires a service model between supplier and consumer, since unexpected change in consumer load will increase the imbalance risk of supplier. Therefore, suppliers need to be aware of demand responsiveness of end consumers to take into account the demand elasticity in its procurement. Suppliers could develop different service categories for consumers according their preferences in relation to security of supply. The roll out of smart meters will not enable demand response without reflective electricity pricing and service models between suppliers and consumers. As this kind of service model between supplier and end customer would provide savings (or additional earnings) for both parties, the benefits must be split between the contracts parties.

4.6.3 Voluntary demand response programs are the most transparent and the best way to reflect the preferences of consumers in relation to system adequacy. Demand response could also provide flexibility to TSO's use, but this requires forced load adjustment without the control of end consumer, since the need to utilize the contracted flexibility may not be seen far in advance.

4.7 Question 7: Do you consider that there is a need for review of how generation adequacy assessments are carried out in the internal market? In particular, is there a need for more in depth generation adequacy reviews?

4.7.1 The increasing amount of intermittent renewable generation brings a new aspect to system balancing, in that it causes unpredictable fluctuations in the generation fleet output. These fluctuations have to be balanced – or 'mirrored' – with other generation units or with some other source of flexibility (e.g. storage, demand side response) to maintain system balance.

4.7.2 An assessment of generation adequacy therefore needs to take, in addition to traditional resource adequacy (ensure there is sufficient reliable capacity on the system to meet peak demand), also market flexibility into account (ability of the generation fleet to vary output / demand in response to changes in load and generation output).

4.7.3 With increasing amounts of intermittent renewable generation across Europe, the flexibility of the remaining capacity on the system will become at least as important as its total volume. Generation adequacy assessments should therefore take this also into consideration.

4.8 Question 8: Looking forward, is the generation adequacy outlook produced by ENTSO-E sufficiently detailed? In particular:

a) Is there a need for a regional or European assessment of the availability of flexible capacity?

4.8.1 On a European level, the "Scenario Outlook & Adequacy Forecast" produced by ENTSO-E analyses resource adequacy of the ENTSO-E interconnected transmission system, based on different scenarios. Though the report provides welcome insight on available capacity, peak load and resulting margin, it does not address market flexibility. We would welcome a detailed analysis of:

- The magnitude of changes in intermittent renewable power generation (wind, solar) output over a 10 minute and 1 hour period, and;
- The dynamic capabilities of the operational resources in the power system available. Such capabilities are:
    - Fast starting and stopping, without impacting on product reliability and operating costs,
    - Fast loading: ramp up / down from standstill (matching the speed of change of wind power output),
    - Capability for continuous cyclic operation,
    - Wide load range (preferably as close as possible to 0-100%), while maintaining high efficiency,
    - Low carbon and other emissions (high efficiency and gas and/or bio fuel operation where reservoir hydro is not available),

4.8.2 Such analyses would provide valuable and much needed insight in

- The flexibility required to balance intermittent renewable power generation, and;
- The available flexibility within the power generation resources in the system

An identified 'gap' between required and available flexibility under different scenario's can be used as the basis for further analyses and follow-up actions such as targeted market reform.

4.9 Question 9: Do you consider the Electricity Security of Supply Directive to be adequate? If it should be revised, on which points?

4.9.1 No answer.

4.10 Question 10: Would you support the introduction of mandatory risk assessments or generation adequacy plans at national and regional level similar to those required under the Gas Security of Supply Regulation?

4.10.1 The risk assessment under the "Gas Security of Supply Regulation" investigates consumer security of supply based on defined criteria, looking at national and/or regional circumstances, and using different scenarios. The criteria for security of supply in the Regulation defines cases such as partial disruption of gas supplies, or periods of exceptionally high gas demand during periods of cold weather, causing stress events to the system.

4.10.2 We believe a major stress event for future power systems with considerable amounts of renewable generation will occur when consumer demand and the varying output of intermittent renewable generation are changing in opposite direction. The system reliability impact of such events will be more severe with increasing amounts of intermittent generation on a system.

4.10.3 Given the EU decarbonisation targets, we would support a detailed analysis of:

- The magnitude of changes in intermittent renewable power generation and;
- The dynamic capabilities of the operational resources in the power system available.

As in the Gas Security of Supply Regulation, this analysis can be performed under different scenarios. Such analysis would fit within ENTSO-E's "Scenario Outlook & Adequacy Forecast" (see also our answer to question 8 above).

4.11 Question 11: Should generation adequacy standards be harmonised across the EU? What should be that standard or how could it be developed taking into account potentially diverging preference regarding security of supply?

4.11.1 Wärtsilä supports the adoption of the EU Target Model to create a single electricity and gas market across Europe. We believe that, once implemented, it has the potential to result in significant collective benefits, including:

- Efficient use of cross-border transmission capacity,
- Efficient cross-border flows, based on economic fundamentals,
- Enhanced security of supply,
- Lower barriers to entry, enhanced competition and increased market liquidity. This would lead to stronger incentives for new investments.

4.11.2 We recognise the divergence in starting points across the EU and the need to achieve consensus, but believe generation adequacy standards are part of the harmonization process and are needed to achieve full collective benefits. What is important is that the 'end-game' is clearly defined, and that the path to reach that end-game can be adjusted appropriately.

4.12 Question 12: Do you consider that capacity mechanisms should be introduced only if and when steps to improve market functioning are clearly insufficient?

4.12.1 We support an approach to make all cash flows visible to market players before introducing a capacity mechanism. As the need for flexibility will increase in a system with high penetration of RES, and flexibility clearly provides system level costs savings, it is essential that market mechanisms rewarding flexibility are transparent, enabling investors to assess the value of flexibility in their investment analysis.

4.12.2 Currently, TSOs are mainly responsible for flexibility procurement through non-transparent procurement strategies, and poor allocation of reserve costs into the moments when reserves are needed. This approach undermines the value of flexibility to market players, since the imbalance prices do not reflect the total costs of balancing, but the costs are spread over longer periods and socialised into the network tariffs.

4.12.3 Capacity mechanisms do not replace energy markets but complements those. When investors are planning new investments in generating assets, or owners of existing generation assets assess either closure or life time extension of their asset, they assess the future revenue streams and profitability of the asset. They analyze revenues from long-term contracts, day-ahead, intra-day, balancing and reserve markets, and the all-in revenues must be sufficient to cover the operational and capital expenses. In a situation, where revenues from these markets is not transparent or part of the revenues are kept out of the market (e.g. TSO's long term reserve procurement and misallocation of availability fees), investor would require higher revenues through capacity mechanisms to justify the investment or life-time extension. Consequently, it is essential to bring all revenue streams visible to the market players before introducing a capacity mechanism.

4.12.4 For instance, the absence of a flexibility market while introducing a capacity mechanism could lead to a situation where inflexible capacity is in a better position in the capacity auction, since its revenues through visible markets are higher and therefore it requires lower capacity payments than a flexible plant. However, the cost to consumers is higher, since less flexible plants are providing the required flexibility with higher cost than a flexible plant. As we have shown in the chapter 3, the cost of inflexible plant providing required flexibility can be very high compared to flexible plant. In the worst case, capacity mechanisms could lock-in wrong type of capacity for long-periods (depending on the capacity payment contract duration), and consequently block investments in more flexible capacity in a later stage. We therefore recommend that any European electricity market introducing capacity mechanisms should make the value of flexibility visible to market before introducing a capacity mechanism.

4.12.5 We also realize the challenging investment environment from the investor point of view, and are concerned about the capabilities of energy-only approach to provide required investments in new generating capacity to secure system reliability. In a system with high penetration of RES, the energy-only market design means highly volatile prices and volumes for thermal units, causing a risk premium for investments and possible inefficiently increasing the overall cost to consumers. Reduced operating hours of thermal units will also increase price volatility and cause price spikes, since owners of these assets try to recover their fixed costs during reduced number of operating hours. Even though these price spikes are needed to justify new investments in required flexible capacity, severe price spikes are also politically unpopular. Price spikes raise discussions on the legitimate of scarcity pricings and risk of market manipulation. This is the first step towards price caps, which in the first place is the cause of "missing money" problem and capacity adequacy concerns.

4.12.6 Electricity markets with high RES penetration are characterized by extreme price volatility due to both inelastic and volatile demand and supply, which induces costly risks to both sides of the market. The risk related to volatility, lack of long term contracts, and political uncertainty around further interventions (e.g. price caps) increases the cost of investments and reduces willingness to invest in new flexible capacity, which is required to balance the system. Common good character of reliability and associated incentives to "free ride" means that scarcity pricing mechanisms are vital to proper market function, but markets have struggled with getting it right. Improving market functioning is definitely required to get the price signals right, incentivize new flexible investments, and reduce the overall cost to consumers before introducing capacity mechanisms. However, we see that substantial uncertainties and public policy risks remain about the energy-only design's ability to achieve resource adequacy in the high RES system, and therefore, some form of capacity mechanisms or out-of-market mechanism will be introduced in EU member countries.

4.13 Question 13: Under what circumstances would you consider market functioning to be insufficient

a) to ensure that new flexible resources are delivered?

4.13.1 In the past, flexibility could be considered as a side product of energy production without any remarkable value to system or costs to consumers. Massive amount of intermittent renewable generation will change this philosophy. Inflexibility of generation fleet would lead to unnecessary part load operation of thermal units, curtailment of renewable generation, extra cost to consumers, and increasing CO2-emission. To ensure that new flexible investments are delivered, the old philosophy on system balancing and flexibility need to be updated.

4.13.2 Flexibility has value in short market timeframes from day-ahead to balancing timeframes. In the first place, these markets should be liquid enough to provide market place for flexibility. The price and volume volatility for thermal generation in short term markets should provide more competitive position for flexible assets that are able to stop when the prices are low and to start when the prices spike.

4.13.3 Key market design principles to encourage liquidity in short term markets are balancing responsibility of all players, and cost reflective imbalance pricing. We agree with ACER's proposal in Framework Guidelines on Balancing that the pricing method should be based on marginal (pay-as-cleared) pricing. Marginal pricing has the following advantages:

- It is more cost reflective, allowing market participants to adjust their positions based on costs at the margin,
- It encourages self-balancing and drives liquidity in intra-day and spot markets, and
- It provides correct incentives to invest in flexible capacity and demand-side response, and to offer balancing energy and reserve services.

4.13.4 Imbalance settlement prices should provide strong incentives to market participants to balance their own position ahead of gate closure. They should reflect the costs of balancing the system in real time. However, the current market arrangements in electricity markets in EU depress the imbalance prices leading to reduced incentivise to be in balance at gate closure, and in the end reducing the need for flexibility in the short term markets. These effects have been explained more in detail in the chapter 3.4 of this response.

4.13.5 Long term reserve procurement contracts were justified in the systems with predictable load and generation patterns, since the need and cost for reserves was easy to predict. This situation will be changed by variable RES generation, when the amount of reserves needs to be adjusted according the RES output forecast. For example National Grid (the GB system operator) estimates that the reserves needed to manage wind uncertainty in GB in 2020 could fluctuate by up to 6GW on a daily and intra-day basis. This is illustrated in figure 11 for January 2020.

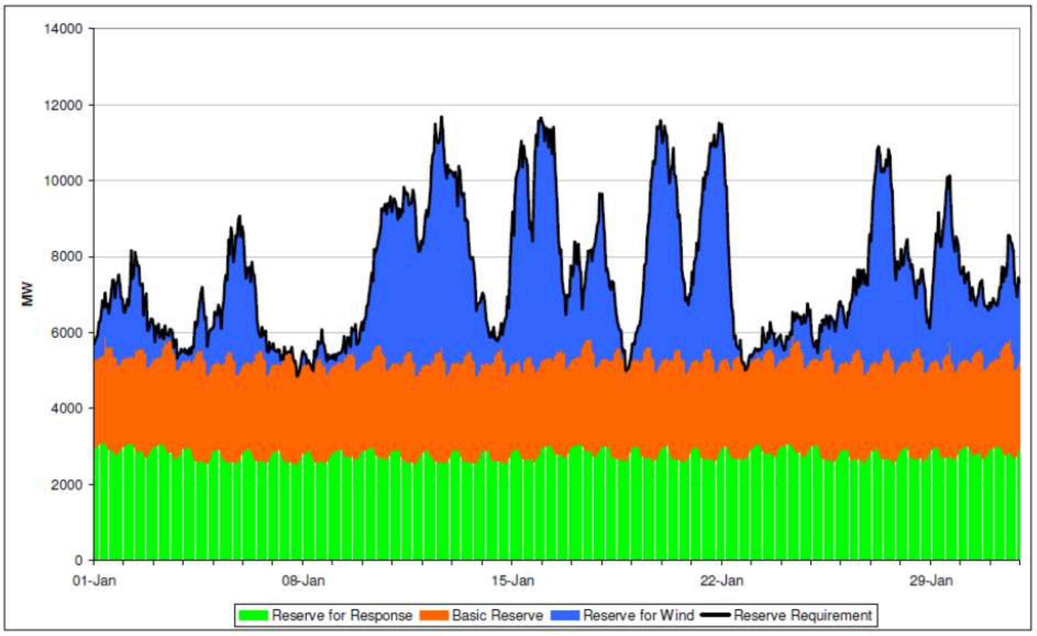

Figure 11 Volatility of operating reserve requirement in GB, January 2020

4.13.6 Given the increasingly dynamic needs of the system, the reserve procurement should take place as close to real-time as possible (for example at the day-ahead stage as in Germany for tertiary reserve). Day-ahead reserve contracting would have the following advantages:

- It would allow TSOs (and possibly also market participants) to procure reserves on a more dynamic basis, consistent with increasingly dynamic needs as the penetration of intermittent renewable generation increases.
- It would lower the cost of reserve procurement, since the need for reserves would be adjusted daily.
- It would optimize the utilization of generating assets between energy and reserve provision, which would minimise the overall system cost.
- It would promote competition among flexibility providers, avoiding the potential market foreclosure associated with longer term contracting.
- It would create a liquid near-term reference price for flexibility, useful for the purposes of long-term hedging.

4.13.7 Shorter term reserve contracting should also make the availability fee allocation much more straight-forward, and minimising distortions to the common merit order. To be clear, such an approach would not preclude TSOs or market participants from entering into long-term reserve contracts on a financial basis. However all physical reserve requirements would be procured on a shorter term basis at the day-ahead stage.

4.13.8 The second important factor to make imbalance prices cost reflective is the right allocation of availability fees of reserves to the periods of utilization of reserves. In order to create a level playing field between pre-contracted reserve and 'pure' balancing energy in the common balancing merit order, reserve availability fees need to be fully reflected in balancing energy prices. This is also important from the point of view of reflecting the full marginal costs of system scarcity and encouraging self-balancing ahead of gate closure. If reserve availability fees are not factored into balancing energy prices, reserve plant may receive an inefficient advantage.

4.13.9 We believe that the proper allocation of reserve availability fees together with short term procurement of reserves and cost-reflective balancing energy pricing are important in driving liquidity and efficient price discovery in intra-day and day-ahead markets for flexibility.

4.13.10 Day-ahead procurement of flexibility, cost reflective imbalance prices and transparent balancing arrangements would create market based incentives for new flexible plants. Sharp imbalance prices would create incentive to market players to balance their position before gate closure. This would increase liquidity in short term markets and would create a need for hedging tools against short term prices. Introduction of day-ahead flexibility market for system operator to procure reserves and market participants to hedge against short term prices would create a liquid near-term reference price for flexibility, useful for the purposes of long-term hedging. Day-ahead flexibility market together with secondary trade within day would also provide opportunity to adjust reserve levels within day for market players and system operators. The benefits of this was recognised as an one of the potential measures in the Study on Synergies between Electricity and Gas Balacing Markets prepared by KEMA to European Commission in October 2012.

4.13.11 Fixing the market imperfections described above would create a clear reference price for flexibility, and potentially a market where flexibility explicitly could be rewarded. These arrangements would not require any additional administrative payment for flexibility, but only making the costs of system balancing transparently visible to the market. However, these short term markets would be relatively volatile, and the absence of long-term financial contracts (at least in the first place) might not encourage investments in flexible assets. Therefore, we see that some form of stable payment for capacity is required to bring new investments online.

4.13.12 Increasing amount of variable renewable generation requires flexibility from the rest of the system fleet to balance the fluctuations of variable generation. Nowadays, the need for flexibility is widely accepted in countries with high RES penetration. However, the dominant view is still that the existing thermal capacity is able to provide the required flexibility, when there is no need for new flexible investments. From one perspective, this is correct: while the wind and solar is providing energy, it pushes thermal capacity out of the merit order and this capacity is available to provide reserves. However, there is a huge cost related to this sort of flexibility as we have shown in the chapter 3.3. If EU targets to have an optimal power system in the future, which contains significant amount of variable renewable generation, then the system ability to provide flexibility with the least cost must be one key design principle of future electricity markets.

b) to ensure sufficient capacity is available to meet demand on the system at times of highest system stress?

4.13.13 Firstly, we need to define the situation when system is under highest stress. This critical period used to be the peak demand that took place during winter period. To ensure that sufficient capacity is available to meet demand was straightforward, since the peak demand could be predicted quite accurately. Resource adequacy was dominated by investment timescales and looked whether the system has access to enough firm capacity to serve the highest expected level of demand. In the systems with high share of variables the definition for critical period is different. It is no longer matter of adequate capacity in the long term, but capabilities to react on changes in variable renewables output in short term. As Europe will have significant amount of variable renewables in the power system, the critical period will be when demand and the availability of variable renewables are changing in opposite directions. It will occur to the greatest extent in situations where demand is either increasing towards system peak whilst the availability of variable renewables is reducing to a minimum, or falling to system minimum levels whilst the availability of variable renewables is increasing to a maximum.

4.13.14 Secondly, we need to define what kind of capacity delivers sufficient reliability during the critical period. In the old paradigm, the amount of firm capacity was sufficient measure, since the critical period could be predicted well in advance and even very slowly starting units were available during the highest system stress. In the high RES system, the reliability is not anymore related to capacity itself but to capabilities of the capacity. Under the new paradigm, resources that can respond to a rapidly changing level of net demand are as important as the overall quantity of firm capacity. These critical periods can occur as well during winter time and highest demand as during summer weekend with lowest demand.

4.13.15 We recognise that the current reserve margins are in relatively healthy level in EU countries according the ENTSO-E's generation adequacy outlook, and there should not be need for instant action to secure adequate capacity by market interventions. If EU member states and overall EU regions has healthy capacity margins the critical period according the old paradigm should not be an issue.

4.13.16 To handle the critical period under the new paradigm (high RES penetration) is more challenging with existing assets. As there is not flexible assets available that can response to system needs by ramping up, ramping down, and turning on and off quickly and often, system operator needs to lock-in more capacity running at part load to meet the system security in critical period. System can handle the fluctuations, but consumers will pay the price in higher system operating costs and wholesale electricity prices as was shown in chapter 3.3.

4.13.17 Even though we are witnessing quite high reserve margins in EU member states now, the situation might not be sustainable in longer term. As subsidized renewable generation depresses market prices, reduces operating hours, and increases maintenance cost for thermal units, there is a concrete risk that the existing plants will be closed down prematurely and investment are not made in new assets. The approach, where market designers think that sufficient capabilities to balance the system in short term could be sourced cost-effectively from whatever supply portfolio emerged from the energy market, is not applicable anymore in high RES system. Flexibility can't be seen anymore as a side product of energy, but it is critical element of affordable, reliable and sustainable system. The future market design should not target to keep the existing plants in the system as long as possible to secure availability of sufficient capacity, but to find ways to incentivize right type of capacity to stay and enter the market.

4.14 Question 14: In relation to strategic reserves:

a) Do you consider that the introduction of a strategic reserve can support the transition from a fossil fuel based electricity system or during a nuclear phase out?

4.14.1 In principle we are not supporting strategic reserves as a solution for European electricity markets. Strategic reserves might support to ensure security of supply during transition phase, but those will not lead to optimal system architecture in the short or long term. Strategic reserve should be seen as temporary solution, but it won't fix the overall problem that the market is facing: lack of flexibility and risk of investment hiatus.

4.14.2 The purpose of strategic reserve is to keep existing plant in the system, not incentivizing new investments. If the life-time extension of old units would lead to the optimal power system in future, the implementation of strategic reserves should be encouraged. As we have indicated many times in this response, this is not the case, but new investments in flexibility are required to meet future challenges cost effectively.

4.14.3 Strategic reserves have been implemented in Finland and Sweden without any major impact on energy markets and Sweden is planning to reduce the amount of strategic reserves in near future. However, it is important to notice that neither Finnish nor Swedish system has significant amount of intermittent renewables, and these countries are not facing intermittency challenges in the near future.

4.14.4 Strategic reserve is a temporary solution to meet reliability standards, if the system is facing the risk of capacity shortfall. It does not provide any market enhancement to enable investments in new capacity or more importantly in flexibility. To secure sufficient capacity in the system level, strategic reserves might be the least cost option, but it won't provide the least cost option to consumers in a system with high RES penetration. Strategic reserve would be "too easy solution" to fix the market issues Europe is facing. It must be understood that the market environment has changed and system requires new type of capabilities to address the raised challenges with the least costs. Politicians and market players must think tools to tackle these issues, not to artificially keep the old market and system philosophy alive.

b) What risks, if any, to effective competition and the functioning of the internal market do you consider being associated with the introduction of strategic reserves?

4.14.5 The major risk of strategic reserves is that those postpone, or in the worst case prevent, investments in new flexible capacity that would provide significant system level savings in the new market environment. Strategic reserve can help to tackle the critical period of old system design (winter peak), but it does not provide any concrete tool to address the critical period of new market environment (variable generation and demand changing fast to opposite directions). If new investments are not made in new flexible generation, the old capacity running at part load needs to provide the required flexibility causing extra cost to consumers, higher wholesale prices, and increased emissions.

4.14.6 More detailed design issues of strategic reserves are covered in following:

- Even though the nature of strategic reserve is seen as temporary solution, it can easily become a permanent design element of electricity markets.
- Strategic reserves introduce market distortion if bidding in the energy markets with too low prices, which can lead to depressed electricity prices and reduced

investment incentives. The strike price for utilization of strategic reserves should be high and the reference market carefully selected. E.g. in Finland the reference market is day-ahead, when strategic reserves have enough time to react. In the new market environment, the system stress in balancing timeframes comes increasingly important. If strategic reserves are introduced they should be able to react on system needs in all timeframes.

- System operator’s incentive to use strategic reserves to balance the system if market based prices are high. This depresses short term prices and market participants incentivize to balance their position, since the imbalance risk is reduced.
- Slippery slope effect, whereby more and more plants must form part of the reserves, if old plants, which are not selected into strategic reserve, choose to close down the asset.
- May increase gaming, since generators may threaten to mothball the plant if they will not receive strategic reserve payments from system operator.

4.15 Question 15: In relation to capacity markets and/or payments

a) Which models of capacity market and /or payments do you consider to be most and least distortionary and most compatible with the effective competition and the functioning of the internal market, and why?

4.15.1 The liberalization of electricity markets has mostly evolved in a period with excess generation capacity. Consequently, the question whether there are appropriate incentives to invest in new generation capacity was not an issue for quite some time in Europe, but now the changing market environment is increasing the debate on capacity adequacy issues. Adequate generation is the most fundamental reliability issue, since if there is not enough generation capacity in the long-term, it will not be possible to serve all load and achieve security and firmness in the short term. Capacity mechanisms complementing the energy markets are one method of assuring resource adequacy in restructured electricity markets.

4.15.2 The European internal market should provide market framework that leads to sustainable, reliable and affordable power system. To meet these objectives new investments are needed in flexible capacity. In principle capacity mechanisms should focus to secure adequate amount of capacity, while the energy market provides signals for investors on which type of capacity they should invest in. As the value of flexibility is inevitable in system with high RES penetration, the future market design should reward flexibility, when investors could value the flexibility before capacity auction. If the market does not reward flexibility, then the required flexibility could be procured through capacity mechanism, but this model contains some drawbacks which are discussed more in detail in the following answer to question 15 b.

4.15.3 We believe that some form of capacity mechanism is required to keep the existing plants in the system and to incentivise investments in new generation capacity. However, the energy market, together with flexibility market, should drive the decision on technology selection, and capacity mechanism only covers the "missing money" and provides long-term stability for new investments. In capacity markets as well as energy-only markets, the all-in "price" paid by customers must be sufficient to support investment in new generation. It is even conceivable that such all-in prices could be lower with a capacity market, if it reduces revenue volatility and regulatory risk, thereby lowering investors' cost of capital.

4.15.4 We support energy markets with forward centralized capacity markets as a best solution to secure affordable, reliable and sustainable system in Europe. The objectives and key design principles of capacity market should be following:

- Firstly, make the value of flexibility visible to market players, when this revenue potential can be taken this into account before capacity auction. This approach guarantees that flexible capacity can compete on an equal basis in the auction.
- Central procurement of capacity e.g. by the system operator and costs covered from consumers through network tariffs.
- Capacity assessment carried out e.g. three years in advance which provides the basis for capacity demand curve in the capacity auction.
- Forward procurement of capacity e.g. 3 year lead time to allow capacity new build.
- Competitive bidding process with a downward sloping demand curve to decrease volatility in capacity prices.
- Allow demand and supply side resource bid in equal basis and do not differentiate payments to new and existing capacity.
- 1 year payment for existing capacity to ensure efficient exit of old and inefficient capacity, and 10 year payment for new capacity to assure bankability of investments. We recognise the issues of long term capacity payments e.g. risk of over procurement and locking in wrong type of capacity, but to secure efficient competition and efficient market entry of new players, the long-term capacity payments are necessary for new capacity.

- Capacity market needs to define availability requirements for cleared capacity to ensure availability of the cleared capacity. The unavailability should be penalized to avoid gaming possibility in the capacity auction.

4.15.5 If the forward capacity market is implemented after the establishment of flexibility market, it would help to meet the objectives of future European energy market, with minimum level of market intervention. The benefits of forward capacity market to European electricity market are following:

- Capacity mechanism solves the energy market failures which come even more visible in the high RES system.
- Helps to meet the reliability standards of the power system.
- With capacity market there is reduced need for out-of-market capacity, when the energy market operations and price formation is more transparent.
- By rewarding flexibility and energy in competitive markets, regulation could be focused on determining the adequate level of capacity and market would define right type of capacity mix.
- Competitive central capacity market with flexibility market could provide long-term stability for investors and attract new flexibility investments which are essential part of cost optimal power system.
- Competitive, transparent, and well design capacity market enables new market entry and enhances competition in European electricity market.

4.15.6 Capacity mechanism is of course always some level of market distortion and has an impact on energy markets (e.g. reduced price volatility). However, the main implementation criteria for capacity mechanisms should not focus on the level of distortion, but the impact of capacity mechanism in meeting the objectives of the future power system. We agree that e.g. strategic reserves could be the least distortionary option to secure adequate capacity levels in the future power system, but it will not lead to optimal power system neither least cost to consumer.

b) Which models of capacity market and /or payments do you consider to be most compatible with ensuring flexibility in a low carbon electricity system?

4.15.7 We see that market should value the flexibility and there needs to be a separate market for flexibility as described in the chapter 3.5. Together with well functioning short term energy markets, the flexibility market could provide clear market signals for flexibility, and investors could assess this value in their investment analysis. Several market failures in the existing energy markets together with the challenging investment environment for any thermal plants, there is a need for capacity market to ensure adequate capacity and boost investments in new flexible capacity. We propose an approach, where the flexibility market is establish first, and in the second phase, a technology neutral capacity market will be implemented to provide long-term investment certainty.

4.15.8 There are also potential models for capacity mechanism to reward flexibility. These potential models are described in the following chapters, and could be seen as secondary options to reward flexibility. These proposed models could enable investments in flexibility, but compared to preferred model (presented earlier in our response), these models have some drawbacks.

Reliability options

4.15.9 This model consists of forward auction for reliability options to meet centrally determined capacity requirement, with a high strike price and a reference price set close to real-time to encourage flexibility. Reliability option models have been implemented e.g. in ISO New England in the USA, and in Colombia, but these implemented models focus only on capacity adequacy, not flexibility. Reliability option model would be a one-way option contract which provides a regular availability fee in exchange for payments whenever the reference price exceeds a strike price. Reliability options with a high strike price and payback provide two major benefits for capacity mechanism design. Firstly, the strike price limits the market power of generators, and secondly it provides a market based incentive to be available when required.

4.15.10 To incentivize flexibility, the reference market for strike price needs to be close to real time, preferably balancing market. In a system with high penetration of RES, the day-ahead market as a reference market is not sufficient, since the need for flexibility occurs typically within day and there will be situations, where the need for flexibility is invisible in the day-ahead timeframe. For truly flexible plants, balancing market as a reference market is not an issue, but on the whole system level, this approach could provide too strong signals for flexibility. Reliability option with e.g. balancing market as a reference market would enable investments in flexibility, but with following drawbacks:

- Signals for flexibility are too strong. In the high RES penetrate3d system the short term prices (balancing or intra-day) can't be seen in a day-ahead stage, when less flexible capacity might not be awarded in day-ahead market. This situation could happen in high RES situation during a windy day with low demand. However, the flexibility could be needed within day timeframes, but the less flexible capacity is not able to start and response to high reference market prices. This would impose too high risk for less flexible capacity to participate in capacity auction, and could cause early closures of generation units.

- The selection of the reference market and strike price is very challenging. Too low strike price would create excessive financing risk and too high strike price could enable gaming in the auction. If the reference market is selected too far away from real time, it might not incentivise truly flexible capacity at all, but the flexibility would be provided by less flexible plant causing unnecessary system costs. On the other hand, a reference market very close to real time would easily incentivize flexibility too much and not delivering the right capacity mix causing extra cost to consumer.
- Reliability option was discussed as an option for capacity mechanism in GB in 2011. This option with a day-ahead reference market was resisted heavily by industry mainly because it would discourage forward trading. In addition, it was noticed that day-ahead market as a reference market would not really incentivize flexibility.

Capacity auction for flexibility

4.15.11 This capacity mechanism model would consist of forward auctions to deliver central requirement for multiple reliability option products (baseload, mid-merit and flexible), with varying strike and reference prices for each option contract. Reference market for flexible capacity could be balancing market, e.g. 4 hours ahead market for mid-merit and day-ahead market for baseload capacity. System operator or regulator would define the required amount of each type of product and would hold a separate auction for each product 3 to 4 years in advance. There would be separate auctions for different products according to set demand curves (figure 12).

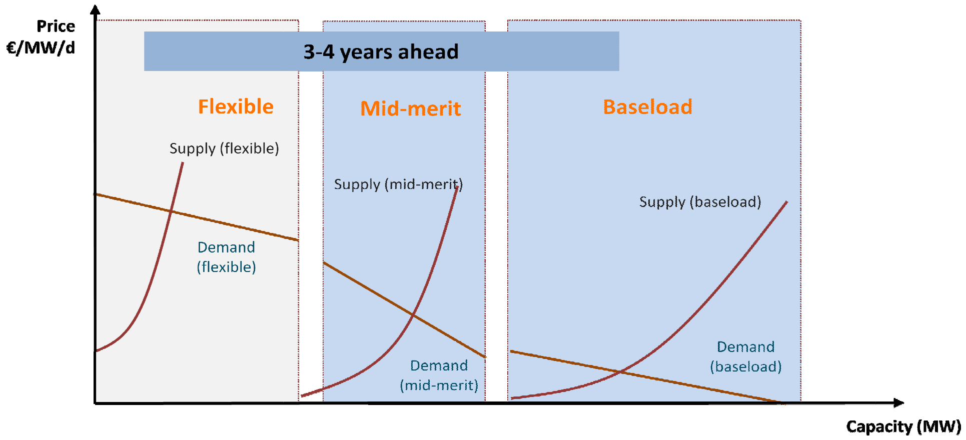

Figure 12 Auction process for multiple reliability options

4.15.12 This design would deliver the desired amount of flexibility and capacity, and would mitigate some of the design issues described in the reliability options design. However, there are some drawbacks with the market design:

- Regulator must define what type of capacity is needed, not only the amount of total capacity. Central determination of volume requirement for individual capacity products may lead to subjective decisions and systematic over-procurement.
- Given level of centralised decision-making, there is an increased risk of further intervention.
- Capacity assessment to determine volume requirements for each product may be complex and subjective. It may be difficult for investors to forecast probability of reference price exceeding the strike price, which could make deriving capacity mechanism offers complex.
- Heavily reliant on liquid reference markets, so that capacity providers can hedge their position by ‘earning’ the reference price.

c) Are there any models of capacity mechanism the introduction of which would be irreversible, or reversible only with great difficulty?

4.15.13 The market environment has dramatically changed due to RES deployment and the existing investment environment is challenging for new flexible investments. European electricity market requires capacity markets to incentivize new investments and to keep feasible existing plants online in the high RES system.

4.15.14 Capacity mechanism would not be needed at all, if the existing fleet provided optimal back-up for RES in this changed environment. However, this is not the case as we have shown in our analysis. New investments in flexible generation would increase system reliability, reduce emissions and most importantly reduce cost to consumers. Capacity markets are needed to secure new investments in this environment.

4.15.15 We understand that a central capacity market is more complex and more difficult to reverse than e.g. strategic reserve that can be seen as a temporary solution. Decision on capacity mechanism introduction should not be seen as temporary fix, because there is not a temporary problem. The market environment has changed for good and the electricity market must be adjusted according the new market environment. Each introduced market model could be further developed after implementation or reversed if not required anymore, but this should not be one of the key evaluation criteria for capacity mechanism design. As well as investors in energy business, we are also calling for long term investment climate and regulatory stability, not temporary fixes or constant market interventions.

4.16 Question 16: Which models of capacity mechanisms do you consider to have the least impact on costs for final consumers?

4.16.1 In markets with capacity payments as well as in energy-only markets, the all-in price paid by customers must be sufficient to support investment in new generation and guarantee capacity adequacy. The elements of this “all-in price” define the overall cost to consumer, not only the form of capacity mechanism.

4.16.2 Deployment of variable renewable generation will have a major impact on the electricity market environment. As a consequence of this market environment change, it is likely that EU member states are going to implement some form of capacity mechanism. We have done analysis on the potential capacity mechanism for a system with high penetration of RES, and come to a conclusion that the competitive central capacity market would lead to the least cost to consumer. However, capacity market by itself will not provide the least cost to consumer, but the introduction of transparent energy and flexibility markets are needed before implementation of capacity market.

4.16.3 Flexible generation can provide annual savings of several billion Euros to consumers in Europe, when the share of variable renewable generation increases. To materialize these savings, the value of flexibility must be recognised in transparent markets, when the flexibility can be seen as valuable feature among investors. This approach, together with competitive capacity market auctions, guarantees that capacity market does not overpay for existing or new capacity. If truly flexible capacity can earn more thru flexibility and energy market than inflexible plant, it is also more competitive in the capacity auction. In addition, open and competitive capacity market for all capacity providers (demand and supply side) guarantees efficient competition and prevents gaming in the capacity auction.

4.16.4 As we have analysed different market models to ensure capacity adequacy, we want to highlight the weaknesses of these models in a system with high penetration of RES and the causes behind the excess costs to consumers:

- **Strategic reserves** try to ensure adequate capacity by signing targeted reliability contracts with existing generation assets. Those are easy to implement, and if designed correctly, strategic reserves have very minor impact on energy markets. The additional cost of strategic reserves can be rather small to consumer, but the overall cost of system operations is higher. Value of flexibility, or cost of inflexibility, will be high as shown in chapter 3.3. This value can't be materialized by modifying existing inelastic generation assets, but new investments in flexible generation are needed to extract this savings potential. As strategic reserves focus on keeping the existing plants in the system, those don't provide any additional incentive to invest in new capacity. Therefore, strategic reserves will lead to suboptimal system, where the system operating costs are higher, which lead to excess cost to consumers.

- **Capacity auctions for certain type of capacity** would increase the central decision making and jeopardize the investment signals from electricity markets. Even though the model could provide optimal capacity mix in the short term, the central determination of volumes of different products may lead to higher costs than necessary, particularly if the system operator or central body is more risk averse than market, leading to over-procurement. In addition, capacity assessment to determine volume requirements for different type of capacity may be complex and subjective.

4.17 Question 17: To what extent do you consider capacity mechanisms could build on balancing market regimes to encourage flexibility in all its forms

4.17.1 We don't believe that the capacity mechanism design that rewards also flexibility could deliver the optimal power system for Europe. Introduction of flexibility market and development of short term electricity markets should provide incentives to market players to provide flexibility and electricity voluntarily, while capacity mechanism focuses to ensure capacity adequacy in all situations. As balancing market would be one of the key markets for flexibility providers, it is natural that this capacity is available when the price signals indicate the need for flexibility. If the flexible asset is not available in the balancing market during high prices, it will lose these earning opportunities. If the flexible plant constantly misses these opportunities, it will exit the market as it is not competitive enough in the market.

4.17.2 The capacity mechanism could be built on balancing market timeframes either thru obligations or thru option contracts with payback whenever the price in the balancing market exceeds the set strike price. There is some experience on the capacity mechanisms with reliability option design, but the reference market for availability is typically day-ahead market. If the balancing market is set as a reference market, the market design might provide too strong signals for flexibility. If the capacity mechanisms auctions are split in to several capacity products, and only flexible capacity must be available in balancing timeframes, the role of central decision making would increase and the investment risk would be gradually shifted from investor to consumer.

4.17.3 We want to highlight that capacity market should ensure adequacy and flexibility market together with short term energy markets will ensure the right capacity mix for systems with a high penetration of RES. As flexibility has significant value in the future European power system, investors are more willing to invest in flexible generation instead of inflexible assets, and exploit the opportunities that more flexible generation provides, if this value is visible in the market. Balancing markets are important reference markets for flexible generation.

4.18 Question 18: Should the Commission set out to provide the blueprint for an EU-wide capacity mechanism?

4.18.1 As it is very likely that many member states will implement some form of capacity mechanisms in near future, cooperation in EU-level is required to design a capacity mechanism, which is compatible with the internal energy market. Blueprint for an EU-wide capacity mechanism is a good objective, but the implementation might be challenging especially if member states have already implemented a capacity mechanism.

4.18.2 The Commission should develop criteria to assess the compatibility of capacity mechanisms in member states with the internal energy market and other future objectives of energy system. Based on the criteria, the Commission could evaluate the impact of proposed capacity mechanism in EU-level and suggest changes and enhancements in proposed mechanism.

4.19 Question 19: Do you consider that the European Commission should develop detailed criteria to assess the compatibility of capacity mechanisms with the internal energy market?

4.19.1 We encourage the European Commission to develop detailed criteria to assess the compatibility of capacity mechanism with the internal energy market. Firstly, European Commission needs to understand the value of flexibility in the future power system. Secondly, the European Commission should take actions to develop the short term energy markets, and develop transparent market for flexibility. After these markets are established the capacity mechanism can focus purely on securing capacity adequacy on national, regional and EU-level.

4.20 Question 20: Do you consider the detailed criteria set out above to be appropriate?

4.20.1 The energy market environment has permanently changed due to deployment of variable renewable generation. Two major changes which affect the market development discussion are:

- **Flexibility** is no longer invisible and low cost side product of power generation taken care by system operator, but a key factor in the power system design and optimization. By adding flexibility to the power system, significant savings in generation costs and CO_2 emissions can be achieved. Existing generation assets are able to provide system flexibility requirements, but this increases significantly cost to consumer. Value of flexibility can't be materialized by modifying existing inelastic generating assets, but new flexible power generation is needed.
- **Capacity adequacy** issues will increase in member states and energy-only market approach will not solve these issues. Support for specific variable generation sources undermines investments needed to ensure capacity adequacy. Increasing subsidized variable generation will reduce the operating hours of thermal plants, depress electricity prices, and cause greater volatility in the electricity markets. In this market environment, thermal capacity is still needed to back-up renewable generation, but the profitability is low and the investment risk (and cost of financing) will be higher. In theory thermal capacity could price the energy above the short run marginal cost, and compensate the loss occurring from reduced operating hours and lower electricity price levels during the price spikes. The reality is different. The price spikes are not politically acceptable and this would raise discussion on the price caps or other regulatory intervention to limit the

pricing of energy. In the end, these interventions increase the uncertainty and prevent investments in new capacity in energy-only market environment.

4.20.2 In EU, we must accept that the market environment has fundamentally changed and the electricity markets need to be modified. If the objectives of EU future power system are sustainable, affordable and reliable power system, then the value of flexibility needs to be recognised by markets to boost investments in new flexible generation, which will provide significant savings to consumer. To ensure bankability of new investments in this volatile energy market, investor will require some long term certainty for their investments. Consequently, the capacity markets will be needed.

4.20.3 If capacity mechanism helps to meet the future objectives e.g. by enabling investment in flexibility, then the implementation of capacity mechanism will be beneficial. The criteria to capacity mechanisms should not assess the impact of capacity mechanism alone, but as an integrated part of future market design.

4.20.4 Wärtsilä supports the proposed criteria with following amendments, changes and comments:

Number	Criteria description	Wärtsilä's comments
(1) a.	The potential of the identified needs being met in the normal operation of the internal energy market, in particular:	**Amendment** Steps to make the value of flexibility visible to market players and develop transparent and competitive market for flexibility
(1) d.	The necessity for a capacity mechanisms should be clearly established in the context of:	**Amendment** Introduction of capacity mechanism enables investments in new generation or demand side capacity providing system level savings
(2)	The effectiveness of the capacity mechanism addressing the identified market failure should be demonstrated and that it is additional to what would have occurred under normal market rules.	**Comment** We support the criteria. In addition, the benefits of capacity mechanism should be assessed, by demonstrating that capacity mechanism enables the formation of optimal capacity mix to meet the future objectives e.g. by boosting investments in new flexible capacity which would not be bankable without stable cash flow from capacity mechanism
(3)	The duration of the application of the capacity mechanism should be clearly limited and clearly specified	**Change** The capacity mechanism should be clearly specified and subject to review and further development **Comment** The market environment has changed permanently and temporary fixes like strategic reserves will not lead to optimal power system architecture, since new investments are needed to meet the future targets. Commission should have long term vision on the future market design, where capacity market can play a role. We agree that the mechanisms should be subject to review and monitoring, but it should not be seen as temporary solution in the first place.
(4)	Any capacity mechanism should be open to electricity undertakings operating in other Member States, to the extent they are able to make the electricity available in markets to which the capacity mechanism is established	**Comment** Fully agree. The capacity mechanisms in EU should allow and not limit the cross border trade of electricity.

(5) b.	Any capacity mechanism should not act as a barrier to cross border trade or competition in the internal market by distorting dynamic incentives/crowding out	**Change** The incentive on consumers or generators to respond to high prices at periods of scarcity (capacity or flexibility) should not be diminished **Change** The mechanism should not undermine incentives on the electricity market to deploy new techniques for demand reduction, flexibility, or electricity storage and generation
(5) c.	The mechanism should not act to maintain inefficient market structures or undertakings, acting to deter new entry.	**Change** The mechanism should not act to maintain inefficient market structures, undertakings or not optimal capacity, acting to deter new entry **Comment** Market design should have a holistic view on targets to achieve the optimal power system design. Models that artificially keep the existing units in the system do not provide optimal system in the long run. All capacity should be able to compete on equal in capacity mechanism as well as in other markets. If e.g. more flexible capacity provides more value to the system than inelastic generation, then markets should reward these flexible features and new flexible investments push inflexible and not competitive capacity out of the market.
(6) a.	To be non-discriminatory a capacity mechanisms should be allocated after an open competitive bidding process	**Comment** Fully agree. All capacity (demand and supply side + existing and new capacity) should be also able to participate in the energy and flexibility market on equal basis.. Markets should be open for all capacity when every bidder can participate in the auction on equal basis. If some capacity is compensated for flexibility thru long term contracts by TSO, this capacity is in better position in capacity auction and it can prevent the entry of entry of new, and optimal, capacity into the market.
(6) b.	To be non-discriminatory a capacity mechanisms should allow demand response and energy efficiency solutions to bid into capacity markets on an equal basis to generation	**Comment** Agree, but these solutions should compete fully on equal basis to generation. Especially demand response, which is able operate also in energy and flexibility markets.
(7)	Not be confined to any particular generation technology, i.e. being tech. neutral (insofar as the mechanism is directed towards security of supply concerns – this may not apply if other objectives are also being pursued).	**Comment** We support technology neutral approach since it allows competition among all forms of generation and supply. However, this approach requires that all features, which system requires are rewarded transparently in the market (electricity + flexibility). Before implementing capacity mechanisms in EU, the market should recognize the value of flexibility and there should be a transparent and competitive market place for flexibility in place. With this market design, the market players could assess the value of features based on the system needs, and would invest in the capacity which is the most suitable to meet these needs.
(8) a.	The direct costs imposed on suppliers or others electricity undertakings must be kept to the minimum necessary	**Comment** The overall cost of electricity should be kept minimum necessary. To achieve this target flexibility needs to be procured transparently thru markets, since the cost of system balancing will form large portion of overall system cost in the high RES system.
(8) b.	Persons providing capacity under the obligation must not be overcompensated	**Comment** Agree. If there is enough competition in the capacity auction, and energy market + flexibility markets are open for all generation, the capacity mechanism will not overcompensate any type of capacity.

(8) c.	Any selection process in the mechanism should be conducted in a transparent, open and non-discriminatory way which is market based	**Comment** Agree. In addition, all capacity should have access to same revenue streams from energy and flexibility market, where their competitiveness is based on their capabilities. This requires that all out-of-market contracts between e.g. TSOs and generators are dissolved.
(8) d.	The duration of any compensation to generators under the mechanism should be clearly justified.	**Comment** Agree, but there is need to differentiate the contract duration for new and existing assets to secure the bankability of new investments and efficient market entry for new players. The need for longer term contracts has been seen e.g. in PJM (the USA) where the short contract duration has led to out-of-market procurement of capacity.