Impact assessment support study on: "Policies for DSOs, Distribution Tariffs and Data Handling"

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INDEX OF CONTENTS

0. EXECUTIVE SUMMARY 5

1. INTRODUCTION 12
   - 1.1 Objectives of the study 12
   - 1.2 Research and assessment tools 12
   - 1.3 Structure of the report 12

2. REVIEW OF THE 2015 PUBLIC CONSULTATION "NEW ENERGY MARKET DESIGN" 14
   - 2.1 Public consultation 2015 14
   - 2.2 Stakeholder assessment 15
   - 2.3 Outcome of 2015 public consultation ""New Energy Market Design" 16

3. TASK 1: PROBLEM DEFINITION, POLICY CONTEXT AND STATUS QUO ANALYSIS 19
   - 3.1 Problem definition 19
   - 3.2 Policy context 23
   - 3.3 Status quo analysis and best practice for efficient operation of the DSO grid 24
   - 3.4 Status quo analysis and best practice for distribution tariffs 30
   - 3.5 Status quo analysis and best practice for data handling 37
   - 3.6 Subsidiarity principle – rationale for EU action 45

4. TASK 2: DEFINITION OF POLICY OPTIONS 48
   - 4.1 Considering the policy options for section 1: DSO as an efficient grid operator 48
   - 4.2 Considering the policy options for section 2: Distribution tariffs 51
   - 4.3 Considering the policy options for section 3: Data handling 55

5. TASK 3: ANALYSIS OF IMPACTS OF POLICY SCENARIOS 57
   - 5.1 Cost drivers for distribution grid expansion and the role of EU policy options 57
   - 5.2 Additional grid reinforcement costs due to distributed generation and load growth 59
   - 5.3 Quantifying the grid savings potential from increasing demand flexibility 62
   - 5.4 Quantifying the grid savings potential from increasing supply flexibility 65
   - 5.5 Overall assessment of impact on grid reinforcement costs 70
   - 5.6 Qualitative evaluation of the specific policy options – cost efficient operation of DSOs 73
   - 5.7 Qualitative evaluation of the specific policy options – distribution tariffs 75
   - 5.8 Qualitative evaluation of the specific policy options – data handling 80

6. TASK 4: COMPARING THE OPTIONS 85
   - 6.1 Explanation of the scoring methodology 85
   - 6.2 Section 1: Cost efficient grid operation 86
   - 6.3 Section 2: Distribution tariffs 87
   - 6.4 Section 3: Data handling 89

7. TASK 5: CONCRETE POLICY RECOMMENDATIONS 92
   - 7.1 Cost efficient operation of DSO grids 92
   - 7.2 Distribution tariffs 93
   - 7.3 Data handling 94

8. LIST OF APPENDIX 96

8.1 Appendix A - Abbreviations 96
8.2 Appendix B – Bibliography 98
8.3 Appendix C – List of stakeholders 101
8.4 Appendix D – Interview guide 106
8.5 Appendix E - Review of the 2015 public consultation "New Energy Market Design" 107
8.6 Appendix F - Updated stakeholder assessment methodology 120
8.7 Appendix G – Governance and public intervention 123

INDEX OF TABLES AND FIGURES

Table 1: Share of costs related to future smart grid outside regulated cost base 21

Table 2: Expected increase in electric vehicles by country 25

Table 3: Status Quo on DSOs incentives to procure flexibility services 27

Table 4: Status Quo on demand response programs 28

Table 5: Status Quo on DSOs controllability of RES 29

Table 6: Network pricing options 31

Table 7: Status quo on volumetric and capacity tariffs among Member States 32

Table 8: Status quo on time-of-use tariffs in Member States 33

Table 9: Are distribution tariffs visible for consumers 34

Table 10: Status quo on grid tariffs for DER 34

Table 11: Tariff structure element 36

Table 12: The three general models of data handling 40

Table 13: Important design choices and best practice examples 43

Table 14: Legislative stepping-stones 47

Table 15: Benefits of demand response and cost reduction for potential grid costs 63

Table 16: Measures to reduce DSO grid expansions and associated costs based on the German case 68

Table 17: Avoided grid investments from flexibility 72

Table 18: Summary of policy options for cost efficient grid operation 86

Table 19: Summary of policy options for distribution tariffs 87

Table 20: Summary of policy options for data handling 89

Figure 1: Degree of variable renewable energy challenge 2014-2030 26

Figure 2: Stakeholders and applications of smart meter data 38

Figure 3: Relation between policy options and impacts 58

Figure 4: DSOs annual extra reinforcement costs at the EU-level............................61

Figure 5: Estimated DSOs annual extra reinforcement costs in Germany 62

Figure 6: Potential reduction of DSOs annual reinforcement costs at the EU-level from activation of demand response 64

Figure 7: Savings potential through curtailment 66

Figure 8: Illustration of wind/solar peaks and the curtailment potential 67

Figure *9*: Simplistic illustration of the effect from flexible supply and demand on grid reinforcements 71

Figure 10: Summary Table of Governance - cost efficiency grid operation.............124

Figure 11: Summary Table of Governance – Distribution tariffs 126

Figure 12: Summary Table of Governance - Data handling 129

0. EXECUTIVE SUMMARY

Power markets are changing all over the EU. Driven by policy objectives of greening the economies, significant technological progress and new digital solutions, the sector is faced with new opportunities and new challenges. The entry of new variable energy sources and high-load consumption units in the distribution grid is likely to result in substantial new investments in grid infrastructure. Estimates suggest that unless these new supply and demand sources obtain some degree of flexibility, EU DSOs will face an additional cost of reinforcing distribution grids of approximately €11 billion yearly towards 2030. The total costs will differ between countries depending on the growth of load and distributed generation and the spatial and dynamic interlinkages between these resources.

Being natural monopolies, DSOs are heavily regulated entities. Regulation is in place on allowed income, roles and activities, and typically also the tariff structures applied to collect revenue. As the environment is changing around the DSOs, so is the efficiency of the current legal framework. As an example, most remuneration regulation schemes across Member States have shown to have weaknesses in incentivising new technologies and solutions or by favouring traditional CAPEX grid expansions over new OPEX based solutions.

To an extent, the regulation in question is a national prerogative. Unlike the transmission system, where market coupling and interconnectors can integrate EU markets, the distribution systems are operating most of the times at local level. The basic framework for DSOs and distribution tariffs is set in the Third Energy Package, while there are also some specific pieces of EU legislation in this area, particularly addressing energy efficiency and renewable energy developments. Moreover, the new challenges faced across Member States are similar, but different solutions are already being developed e.g. in the area of data handling where different Member States and regions are developing different approaches. This spurs the question to what extent EU rules should be updated and/or strengthened with due respect of subsidiarity and proportionality?

In this study, we explore a range of different policy options aimed at 'modernising' EU regulation on a number of topics related to distribution networks. Specifically, we assess options to:

1. Improve DSOs ability to operate grid cost efficiently by acquiring flexibility resources from distributed energy resources.
2. Enhance the framework for setting distribution tariffs
3. Ensure efficient data handling from new smart meters

We have considered the following policy options:

1. Improve DSOs ability to operate grid cost efficiently

0	***Business as usual:*** *no change in EU legislation on tasks of DSOs; Member States are responsible for deciding on a number of non-core tasks as well as on remuneration*
1	• *Allow and incentivize DSOs to acquire flexibility services from distributed energy resources.* • *Establish specific conditions for DSOs to use flexibility, and ensure the neutrality of DSOs when interacting with the market or consumers.* • *Clarify the role of DSOs only in specific tasks such as data management, the ownership of local storage and electric vehicle charging infrastructure.* • *Establish mandatory cooperation between DSOs and TSOs on specific areas, alongside the creation of a single European DSO body.*
2	• *Allow DSOs to use flexibility but without any constraints or cooperation with TSOs.* • *Define specific tasks for all DSOs across EU and apply stricter unbundling rules.*

2. Enhance the framework for setting distribution tariffs

0	***Business as usual:*** *NRAs competences include full and exclusive powers for setting or approving distribution tariffs or methodologies in the framework of existing TEP and EED provisions.*
1	***Clarify the framework for NRAs*** *in terms of authorisation and calculation of distribution tariffs, impose obligations on more detailed transparency requirements, and introduce common EU performance indicators to be made publicly available. Introduce new requirements on DSO development plans.*
2	*In addition to option 1,* ***harmonize distribution tariff elements*** *regarding distributed energy resources and self-consumption in order to ensure that discrimination among grid users or distortion of competition does not happen.*
3	*Harmonization of distribution tariffs across EU:* ***fully harmonize distribution tariff methodologies*** *at EU level for all EU DSOs.*
4	***Introduce a time-element*** *in the distribution tariffs obliging Member States to differentiate tariffs according to time. Specific calibration up to Member States discretion*

3. Ensure efficient data handling from new smart meters

1. ***Business as usual:*** *each Member State develops its own data handling model in line with rules in the TEP, the EED and upcoming data protection and security legislation*
2. ***Update and strengthen EU rules*** *for access to consumer data and related processes to guarantee transparency, objectivity, non-discrimination, and interoperability by any market actor currently responsible for handling data, including DSOs and data hubs.*
3. ***Mandatory data handling model:*** *A specific data handling model and responsible entity (-ies) in each Member State, with uniform processes and access rules to the data. EU rules for access and processes to guarantee transparency, objectivity, non-discrimination and interoperability.*

0.1.1 Cost efficient operation of DSO grids

The current state of DSO regulation in most Member States is not sufficiently able to incentivise cost efficient grid planning and operation going forward. This is the case both with respect to

1) clarifying the new roles and activities which the DSOs could conduct, where some of these roles are clearly within the DSOs core business, some roles are clearly outside the core business, and several new roles are in a grey area.

2) allowed remuneration regulation incentivising DSOs to utilise new technologies instead of the traditional grid expansions. With new technologies such as smart meters and storage solutions, a number of new roles and activities are taken up by DSOs and need to be defined.

In the absence of a common EU approach, it is likely that Member States will opt for different definitions in clarifying the role and activities of DSOs. This may have implications at EU level as the DSOs activities in balancing and congestion management have spill-overs to the wholesale power market. Different national regulation for local DSO's use of flexibility services will hamper an efficient wholesale market across Member States particularly in balancing markets Moreover, different market regulations and degrees of allowed DSO activity in commercial activities may affect other actors such as demand aggregators and their role in the internal market.

Based on this, we assess that EU-level action is warranted. Specifically, we assess that policy option 1 appears to be the most attractive option. It is appropriate to allow DSOs to acquire flexibility services if specific conditions are established for its application. Specifically, to ensure neutrality of the DSOs and non-discrimination of third parties operating in the markets.

An important part of policy option 1 is to clarify the role of the DSOs in tasks such as ownership of local storage and electric vehicle charging infrastructure. It is important to define these roles in order to clarify the conditions both for DSOs and for commercial actors in the market. It may be less obvious that such clarification needs to be common across Member States. Some questions could have different answers depending on local circumstances, and so far there is no consensus on for example, whether DSOs should be able to own local storage solutions.

Policy option 1 also includes mandatory cooperation between DSOs and TSOs on specific areas. As a general rule, if DSOs become active in acquiring flexibility resources, enhanced cooperation with TSOs is warranted. It should be kept in mind though, that this may strictly not be necessary for all TSO/DSO relationships, for example in small distribution networks with limited need and possibilities for flexibility where cooperation may be overly burdensome and add little value to overall system balancing objectives. The need for cooperation is exemplified in the possible situation where the wholesale market price signal to a distributed energy resource is opposite from what the local distribution grid situation would dictate. More frequent exchange of data or other cooperation structures may also be useful.

Policy option 2 goes significantly further than policy option 1 in providing DSOs with more comprehensive possibilities for acquisition and use of flexibility services. While this gives DSOs the most flexibility to ensure efficient grid operation, it also runs the highest risk of disrupting activities, which are also suited for commercial operation. Indeed, several flexibility actions are better in commercial entities than in regulated monopolies.

In addition, the risk of discrimination against commercial parties is also the highest. This is because bundled DSOs to a larger extent could be able to take actions discriminating in favour of its own entity competing in the commercial market. This risk could be mitigated by stricter unbundling rules.

0.1.2 Distribution tariffs

In the current situation where NRAs have full and exclusive powers for setting and approving tariffs, methodologies are different across Member States. Based on our analysis, we do not see strong evidence that this difference in methodologies is a problem that warrants strong intervention in terms of harmonisation of tariffs. Nonetheless, there are good reasons for introducing guidelines on tariff methodologies. Especially with respect to how to treat variable generation sources such that non-discrimination and cost-reflectiveness is ensured.

A main point is that different tariff methodologies may be appropriate in different Member States due to underlying characteristics of local distribution grids. For instance, where a time based tariff can be useful in changing demand patterns in some grids, it may be an unnecessary burden in others.

Currently there is no well-established best practice, which could be the basis of harmonisation. On the contrary, due to the changing conditions of distribution grids it may be beneficial to ensure that there is ample room for testing new tariff designs and exchange practices across different DSOs. This could be related for instance to electric vehicle charging tariffs which are inherently difficult to design.[1]

One argument for adopting a common tariff framework could be that it might affect the internal market for goods (not electricity). If the decision to locate an electricity intensive production facility depends on arbitrarily set grid tariffs between Member States, this would distort placement away from its most efficient location. However, this argument does not seem to find much support.

It has been highlighted that the current tariff practices across DSO are not transparent both in terms of the tariff level for specific consumers and for the overall methodology for calculating tariffs. Policy option 1 addresses this issue by imposing more detailed transparency requirements and requiring performance indicators to be made available, which seems appropriate. Defining several relevant and meaningful performance indicators to compare DSOs against each other will however be difficult, as DSOs to a large extent are responding to external factors. While difficult to conclusively assess, based on the analysis, policy option 1 seem broadly appropriate.

Policy option 2, where tariff elements for distributed energy resources are harmonised, has merit in particular for setting guidelines on how to address distributed renewable energy sources and prosumers. Similarly, to other generation facilities, renewable energy sources make use of grid services, and non-similar treatment of generators may be discriminatory. This falls under EU interest, as generation in the distribution grid affects the cross-border wholesale market and consequently the EU internal market for electricity. It provides an argument for clarifying tariff methodologies in terms of for example cost reflectiveness and non-discrimination. In addition, guidelines could include good practice in tariff setting such as including capacity and time elements into the tariff methodology, while still preserving flexibility to design tariffs according to the underlying grid characteristics. Such guidelines could also include best practice principles on DSO remuneration schemes, as discussed in Section 1.

0.1.3 Data handling

Member States are increasingly adopting new models for handling data related to electricity consumption. In some Member States this is driven or accelerated by the prospect of smart meter roll out and increased data availability, but several Member States are pursuing data handling models also for other reasons such as to facilitate market processes (e.g. switching, settlements etc.). So far, several different data handling models are in place or being developed. The overall model design typically falls into three categories:

1) Centralised data hub

2) DSO as a facilitator and

[1] *So far, no convincing model has been designed for a cost reflective tariff which is also transparent and relatively stable, when the marginal cost of connecting and charging an addition electric vehicle may be substantially higher than the prior vehicles*

3) Data access manager (DAM) model.

Moreover, the specific design of the different categories also varies across Member States.

Based on our analysis, the current developments to a quite large extent seem compatible with EU objectives despite the differences between Member States. We observed that the decision on the data management model follows the local conditions of each Member State. Where a large number of DSOs exist the tendency is to create some sort of central data hub.[2] However, in light of the changing nature of data collection and sometimes novel data handling models being developed, it will be appropriate to update and strengthen current EU provision in line with policy option 1. We find that particularly a few elements are important to address specifically. An important element is whether it should be stipulated that DSOs should have access to so-called technical data from smart meters concerning grid conditions. This would improve DSOs ability to operate and maintain the grid cost-efficiently. In some models it has been seen that smart meter data is routed from smart meters directly to third party data handlers, thereby not allowing DSOs full and timely access to the technical data. There may be reasons for this – in particular for ensuring non-discrimination towards unbundled suppliers and consumer privacy concerns – and the extent to which strong provisions should be taken on this issue given such trade-offs should be assessed. Our assessment is that most existing data models would be capable of ensuring sufficient use of the technical data for DSOs without compromising other objectives.

With the increasing amount of data from smart meters, it is even more important to ensure that non-discrimination is sustained in ensuring that data is provided in a timely manner and of sufficient quality to all energy suppliers and relevant third parties (given consumer accept). Especially so, when DSOs also share ownership with e.g. energy suppliers. To our knowledge, in all data handling models currently being developed and implemented, ensuring non-discrimination is a priority. It remains a priority to ensure that new data handling models in other Member States also live up to this objective.

We have also explored the value of ensuring interoperability between different data handling models across Member States, e.g. reducing barriers for supporting third party aggregation services, energy supply services or other energy related services in the internal market. While interoperability will be beneficial, non-interoperability does not seem to be a sufficiently large problem for these actors. Some regions are looking into ensuring interoperability between data models e.g. in the Nordic region, and it would be interesting to follow this development.

Adopting a standardised data handling model across the EU – as suggested in policy option 2 – does not seem appropriate in terms of costs and benefits. Based on our analysis, we assess that there would be quite limited net benefits from adopting a standardised data handling model across the EU. The objectives of the EU in terms of protecting consumer privacy, ensuring access to data for consumers, and especially timely and non-discriminatory access to data for commercial energy suppliers can be met also when the data handling model differs across the EU. Conversely, the costs of harmonising a data

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2 *Different data hub models exist but the principle behind them is the same: to centralise the information collection and the retail market operations.*

handling model are likely to be significant. This is mainly because several models have already been devised and implemented often resulting in substantial cost for developing and investments in e.g. IT infrastructure. Scrapping these models would imply substantial costs.

1. INTRODUCTION

The study "Policies for DSOs, Distribution Tariffs and Data Handling" (Reference: ENER/B3/2015-642) has been prepared for the Directorate General for Energy (DG ENER) of the European Commission. The study has been implemented by Copenhagen Economics and VVA members of the Deloitte consortium under the Framework contract: ENER/A4/516/2014.

1.1 Objectives of the study

The objective of the study is to assess the different policy options tackling the new challenges faced by Distribution System Operators (DSOs). Indeed, the energy system is in constant change and the role and responsibilities of DSOs must be reconsidered in light of the recent evolutions: increased integration of intermittent renewable energy sources, peak demand with the rise of electric vehicles and electric heating, assimilation of distributed energy resources and of energy from prosumers, deployment of smart meters.

Therefore, this study aims to evaluate potential policies for promoting the cost-effective and efficient operation of distribution grids, including through the use of flexibility services by DSOs, whilst minimizing distortions to the markets for these flexibility services. The study also assesses different options regarding the framework for distribution tariffs as the remuneration schemes and tariff setting may differ and integrate different elements (e.g. time element) across Member States. Moreover, the study evaluates potential policies in the field of data handling to take account of the deployment of smart meters and of the new challenges faced to handle data while ensuring data protection.

The purpose of the study is to support the Commission in evaluating different policy options on the context of the impact assessment exercise concerning the new energy market design initiative. Its output will complement other parallel studies on closely inter-related policy options concerning, inter alia development of demand response.

1.2 Research and assessment tools

The results of the study are based on extensive desk research of relevant literature (papers, studies and reports from energy experts and energy industry) as well as on stakeholder consultation.

In terms of stakeholder consultation, we have on the one hand extracted information from the results of the 2015 Commission public consultation on "*New Energy Market Design*" as well as from the 2014 Commission public consultation on "*Retail Energy Market*". In addition, we have completed a number of face-to-face or phone interviews with representatives of energy industry associations and DSOs. Furthermore, we have carried out a survey with DSOs by sending out two rounds of questionnaires.

1.3 Structure of the report

The remaining part of the final report is structured as follows:

- Chapter 2 Review of the 2015 public stakeholder consultation (summary)

- Chapter 3 Task 1: Problem definition, policy context and problem analysis
- Chapter 4 Task 2: Definition of policy options
- Chapter 5 Task 3: Analysis of impacts of policy scenarios
- Chapter 6 Task 4: Comparing the options
- Chapter 7 Task 5: Concrete policy recommendations

Appendixes:

- Appendix A - Abbreviations
- Appendix B - Bibliography
- Appendix C - List of stakeholders
- Appendix D - Interview guide
- Appendix E - Review of the 2015 public consultation (full version)
- Appendix F - Updated stakeholder assessment methodology
- Appendix G - Governance & Public intervention

2. REVIEW OF THE 2015 PUBLIC CONSULTATION "NEW ENERGY MARKET DESIGN"

2.1 Public consultation 2015

This section provides a summary of the responses to the European Commission's public consultation on "*New Energy Market Design*" launched from 15 July 2015 to 9 October 2015.

The objective of the public consultation was to seek stakeholder's views on the issues that may need to be addressed in redesigning the European electricity market. These issues include:

(i) Improvements to market functioning and investment signals;
(ii) Market integration of renewables;
(iii) Linking retail and wholesale markets;
(iv) Reinforcing regional coordination of policy making, between system operators and of infrastructure investments;
(v) The governance of the internal electricity market;
(vi) A European dimension to security of supply.

The present study supports the impact assessment concerning the new role and tasks of distribution system operators (DSOs), in a context of increased variety of electricity sources such as renewable energy systems (RES) and the deployment of new smart technologies. Therefore, we specifically focused on the questions from the open consultation addressing demand-side response measures (DSR), the distribution tariff framework and data handling models, namely:

- Question 10*: "where do you see the main obstacles that should be tackled to kick-start demand-response (e.g. insufficient flexible prices, (regulatory) barriers for aggregators / customers, lack of access to smart home technologies, no obligation to offer the possibility for end customers to participate in the balancing market through a demand response scheme, etc.)?"*
- Question 14: "h*ow should governance rules for distribution system operators and access to metering data be adapted (data handling and ensuring data privacy etc.) in light of market and technological developments? Are additional provisions on management of and access by the relevant parties (end-customers, distribution system operators, transmission system operators, suppliers, third party service providers and regulators) to the metering data required?*"
- Question 15: "s*hall there be a European approach to distribution tariffs? If yes, what aspects should be covered; for example, framework, tariff components (fixed, capacity vs. energy, timely or locational differentiation) and treatment of own generation?*"

Our findings are also compared with the main conclusions of the 2014 public consultation on "Retail Energy Market".

Given the open nature of the questionnaire accompanying the consultation document this summary report is of a qualitative nature and structured as follows:

- "**Stakeholder assessment**": overview and selection of respondents;
- "**Outcome of public consultation**": a summary of respondents' views to each selected question from the consultation questionnaire.

2.2 Stakeholder assessment

The Commission received in total 320 replies to the public consultation. Approximately 50 per cent of these answers came from national or EU-wide industry associations, 26 per cent of the answers stem from undertakings active in the energy sector (suppliers, intermediaries, customers) and 9 per cent from network operators. The remaining answers from national governments and several national regulatory authorities and a significant number of individual citizens and academic institutes participated as well.

The selected answers were chosen from the approved list of stakeholders (Annex C) and additional interested parties forming a sample of 43 stakeholders grouped in five main categories:

- **National Governments:** Czech Government, Danish Government, Dutch Government, Estonian Government, Finnish Government, French Government, German Government, Hungarian Government, Norwegian Government, Polish Government, Swedish Government, Slovak Government, UK Government.
- **Regulators**: ACER and CEER (joint answer);
- **Aggregators:** KiwiPower, Next Kraftwerke and Swisscom Energy Solutions (joint answer);
- **Electricity consumers:** BEUC – European Consumer Association, BusinessEurope, EUROCHAMBERS, CEFIC - European Chemical Industry Council, CEPI - European Paper Industry, EUROFER - the European Steel Association, EURACOAL - European Association for Coal and Lignite, Eurometaux - European Association of Metals, European Aluminium, European Copper Institute and IFIEC Europe - Industrial energy users in Europe;
- **Electricity industry:** EASE - European Association for Storage of Energy, Energy Community, Eureletric - the association of the electricity industry in Europe, ,, EUROBAT - European manufacturers automotive, industrial and energy storage batteries, GEODE - European voice of local energy Distributors, CEDEC - European federation of local energy companies, EDSO - European distribution system operators' association for smart grids, ENTSO - European network of transmission system operators, ESMIG - European Smart Energy Solution Providers, ETP - European Technology Platform for Electricity Networks of the Future (ETP

SmartGrids), EWEA – European Wind Energy Association, RGI - Renewables Grid Initiative, Friends of the Supergrid, SEDC - Smart energy demand coalition.

Members of the categories "National Governments", "Regulators", "Electricity consumer" and "Electricity industry" provided exhaustive answers to all the questions. However, the members of the category "Aggregators" expressed their opinion only to the question related to demand-side response.

2.3 Outcome of 2015 public consultation ""New Energy Market Design"

The outcome of the public consultation is presented for each of the three selected questions in the form of a summary of respondents' views followed by more detailed comments by each group of correspondence.

2.3.1 Flexibility and Demand-Response

Question 10: where do you see the main obstacles that should be tackled to kick-start demand-response (e.g. insufficient flexible prices, (regulatory) barriers for aggregators / customers, lack of access to smart home technologies, no obligation to offer the possibility for end customers to participate in the balancing market through a demand response scheme, etc.)?

Summary of findings:

National governments believe that the lack of incentives for consumers to engage in demand side response should be tackled by dynamic prices and the deployment of smart meter technology.

Smart energy management systems are indeed considered as precondition to make the field of demand response accessible to a broad range of consumers by circa 60 per cent of the "Retail Energy Market" respondents.

Some stakeholders from the energy industry believe that consumers will only be willing to engage in demand-response when they know that it will work smoothly and fully guarantee the protection and privacy of their data. In addition, they believe that regulated prices, lack of price volatility and market restrictions to the integration of aggregators (the latter shared with electricity consumers and aggregators), are the main obstacles to the development of flexibility services.

Regulators and some energy consumers think that consumers' awareness should be increased providing transparent information. This finding is also highlighted by the fact that in "Retail Energy Market" consultation circa 68 per cent of respondents agree that a large number of consumers would engage in demand response programmes if they were offered simple services and hassle-free technical solutions.

Most of members of the energy industry and some national governments consider that there is no European-wide solution that will provide benefits to all Member States and recommend that any future legislation should take into account the different realities throughout Europe.

2.3.2 *Governance rules for DSOs and Models of data handling*

Question 14: "How should governance rules for distribution system operators and access to metering data be adapted (data handling and ensuring data privacy etc.) in light of market and technological developments? Are additional provisions on management of and access by the relevant parties (end-customers, distribution system operators, transmission system operators, suppliers, third party service providers and regulators) to the metering data required?"

Summary of findings:

In the 2014 "Retail Energy Market" public consultation circa 81 per cent of the respondents agreed with the statement that "*allowing other parties to have access to consumption data in an appropriate and secure manner, subject to the consumer's explicit agreement, is a key enabler for the development of new energy services for consumers.*"

Similarly, in the 2015 "New Energy Market Design" public consultation, all stakeholder groups agree that access to data by consumers and relevant third parties and data privacy must be ensured.

With regards to the data handling models, regulators and some stakeholders from the electricity industry believe that DSO should act as neutral market facilitator. The majority of the respondents of the 2014 "*Retail Energy Market*" public consultation also viewed the DSOs as the most appropriate entities to manage the consumption data flows.

As for data management model, some members of the electricity industry suggest that the DSOs as data hub could provide an effective way to govern the data generated by smart meters.

However, one member of the electricity industry is in disagreement and considers that most data should remain in the meter itself and should be stored in and regulated by a public server.

IFIEC does not see favourably the role of DSOs as market facilitator either, considering that the involvement of a third party better supports neutrality and a level playing field.

National governments are divided on the best suitable model for data access and data handling, but half of them (among the respondents) advocate central data hubs. Most of the Member States consider that the role of DSO and the model for data handling should be best decided at national level.

2.3.3 *Distribution tariffs*

Question 15: "Shall there be a European approach to distribution tariffs? If yes, what aspects should be covered; for example, framework, tariff components (fixed, capacity vs. energy, timely or locational differentiation) and treatment of own generation?"

Summary of findings:

Stakeholders appear divided regarding a EU approach to distribution tariffs:

Some electricity consumers believe that harmonising the tariff methodology and structure would be beneficial and reduce barriers to cross-border trade.

However, other electricity consumers, the regulators and most Member States do not perceive that a "one fits all" solution is appropriate for distribution tariffs. The electricity industry and some national governments consider that setting out common principles at EU level is more advisable than a harmonised framework for distribution tariffs.

The 2014 "Retail Energy Market" public consultation covered the stakeholders' perception about European wide principles for setting distribution network tariffs. However, the results do not show a strict dominance of one of the options. The same number of stakeholders responded "neutral" or "positive".

All stakeholders agree that future tariffs design should ensure cost efficiency and a fair distribution of network costs among grid users. The electricity industry supports the importance of the capacity, time and location components to enhance the flexibility of network price signals. Time-differentiated are also supported by circa 61 per cent of the respondents of the "Retail Energy Market" consultation.

3. TASK 1: PROBLEM DEFINITION, POLICY CONTEXT AND STATUS QUO ANALYSIS

3.1 Problem definition

The electricity system in the EU is going through significant changes in several dimensions. The main changes stem from the 'greening' of the system including increased electrification while also the increased digitalisation and technological improvements pose new opportunities and challenges. In this study, we focus on the changes related to the electricity distribution system. In short, depending on the different starting conditions and characteristics of each distribution grid the disrupting trends can be summarised as follows:

- Increased local generation of variable renewable power (distributed generation) will require the existing distribution grid to adapt as flows are becoming more complex and less predictable.
- Increased deployment of volatile power generation from wind and solar will increase the need and therefore the value of procuring flexibility services in the distribution system.
- Increased peak power demand in the distribution grid through e.g. household electric vehicles charging stations and electric heating (such as heat pumps) will challenge the distribution grid.
- Technological improvements and mainstreaming of digital solutions provide numerous opportunities for the system; however, challenges must be overcome before the potential can be realised.

In the light of these new trends, it has become clear that existing widespread regulation of the distribution system is no longer adequate to address the challenges or harness the opportunities arising. In order to update the EU energy framework and adapt it to the new challenges and objectives, the Commission is preparing a review of the energy legislation and a new energy market design. This study will support the impact assessment by addressing the main regulatory weaknesses of the current system, and evaluates different approaches for how these weaknesses could be addressed at the EU-level. We assess three overarching themes, namely: 1) Cost efficient operation of distribution grids, 2) Distribution network tariffs and 3) Data handling.

Cost efficient operation of distribution grids

The transition in the energy system imposes challenges but also opportunities in the way that distribution grids are operated. Both the overall introduction of variable RES in the power sector and the deployment of distributed energy resources create a need for flexibility in the distribution grid. Especially the deployment of distributed generation and new peak load demand requirements from e.g. electric heating and vehicles have the potential to increase system stress in the distribution system.

Traditionally, DSOs respond to bottlenecks by expanding the grid. However, this may not be the most efficient choice. Instead, it has been suggested that harnessing flexibility from grid users (both consumers and so-called prosumers or regular generators) may be a relatively cost-efficient and effective way of alleviating bottlenecks. **Flexibility services** include demand side response (load management, interruptible contracts), flexible generation (adjustment between variable renewable energy and traditional energy sources), balancing in the distribution network and storage. Flexibility services thereby work both ways; they can provide additional power when needed to maintain system balance or reduce power availability in the system[3].

While many DSOs across the EU to some extent engage in these services, harnessing this flexibility is associated with at least two challenges: 1) roles of the DSO are not clearly defined and 2) remuneration schemes of DSOs are typically incentivising traditional grid expansions over more efficient solutions.

Roles for the DSO

The core tasks of the DSOs are defined in the Electricity Directive (Article 25). Today, The DSOs are responsible for the management and operation of the distribution grid. The core tasks of the DSOs include network investments, maintenance and reinforcement, voltage control, load/generation curtailment, losses management and the provision of non-discriminatory access to the grid.

Many activities around harnessing flexibility from grid users are new for DSOs and many not typically thought to be the core business of DSO. Consequently, the un-clarity as to whether the DSOs can undertake these activities can be preventative for DSOs to explore this new market. The default is to prohibit the DSO from undertaking new activities if there is a potential that a competitive market could provide these services instead. However, in some instances there might be specific circumstances justifying DSO involvement for example for grid balancing or where the DSO could be a potential market facilitator.

Where some activities clearly fall within DSO core tasks, and some clearly do not, several of the new tasks are less obvious. In this 'grey area', activities fall into a category where they are significantly important for grid operation but also potentially commercially operable. Any DSO involvement here increases the need for regulatory control and unbundling. As the market matures in these "grey area" it is likely that DSO involvement can be reduced again creating room for commercial operators.[4]

Remuneration schemes

Traditionally national remuneration schemes for DSOs were typically designed to provide incentives to grid investments (CAPEX). Going forward, a larger share of costs related to the distribution networks will be outside the traditionally regulated cost base. An example from Denmark illustrates that only about half of investments related to smart grid costs going forward are included in the regulated cost base, cf. Table 1. [5] This implies that DSOs would not be able to cover its expenses related to such – otherwise cost efficient – activities,

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[3] *(SWECO, 2014)*

[4] *CEER, (2015), The Future Role of DSOs – A CEER conclusion paper*

[5] *See also Think (2013): From Distribution Networks to Smart Distribution Systems: Rethinking the Regulation of European Electricity DSOs.*

and will have financial incentives to opt for the traditional – and more expensive – solution of expanding the cables.

Table 1: Share of costs related to future smart grid outside regulated cost base

CAPEX and OPEX solutions	Examples of main elements	Included in cost base	Percentage of smart grid costs
Net expansion	Investments in i 0,4kV, 10kV and 50kV cables in order to prevent network overload	Yes	53%
System stability	Installation of synchronous condenser and Static Var Compensators, in order to create inertia and short-circuit power	No	22%
Software	Installation of software by the system responsible, which can aggregate and treat all information collected in the distribution network and for consumers	No	4%
Meters	Installation of meters in all 10kV and 50kV substations including one third of all 0,4kV substations	No	22%
Share of cost outside the regulated cost base			**47%**

Source: Copenhagen Economics based on Energinet.dk and Dansk Energi (2010)

Distribution tariffs

Distributions tariffs are the charges levied by the DSOs to user of the distribution grid in order to recuperate its costs. The total income from these tariffs is defined by national remuneration mechanisms. The structure of the tariffs has implications for the use of the grid and the costs of the grid. In the following, "tariffs" will always refer to distribution grid tariffs (not e.g. transmission grid tariffs).

National regulatory authorities (NRAs) are in charge of setting or approving tariffs or the methodologies to calculate them before they enter into force,[6] regulated by the framework of existing EU legislation.[7]

Historically, tariff structures in most Member States depend on the consumed volume (volumetric charges). As consumed volume traditionally was correlated with e.g. capacity, the tariff structure used to reflect the users' imposed costs to the grid. With the introduction of prosumers and larger peak demand requirement from e.g. electric heating and electric vehicles, costs imposed on the grid is less linked to consumed volume. For example, if a consumer is close to self-sufficiency by generating its own energy from solar panels, the average consumed volume from the grid is likely to be very low. However, as long as this user stays connected to the grid the costs imposed on the grid from this user continues to exist as the grid still has to be able to handle both peak demand in a situation where the sun does not shine, and the opposite when peak power production flows back in the grid. In short, even in cases where the energy injected into the grid equals the amount of energy withdrawn from the grid, if the production and consumption of energy is not synchronised it is likely that the system user will continue to impose similar costs to the system.

6 *Article 37 of the Electricity Directive*

7 *Such as the Energy Efficiency Directive and legislation under the Third Energy Package*

This situation implies a number of challenges:

- Users are not always paying the costs that they inflict on the grid, while instead socialising this cost on other grid users leading to discrimination. This may be the case for resources that are exempted from tariffs but still impose costs on the grid through e.g. reverse flows or continued reliance on the grid in some periods.
- Users are not always behaving in an efficient manner as they are not exposed to sufficient economic signals which reflect the costs they impose on the grid (e.g. load optimisation) leading to economic distortions.

Data handling

The advent of digitalisation is also affecting the energy sector, especially with the expected large scale roll out of smart meters in several Member States.[8] Smart meters collect granular consumption data, which can enable several applications such as facilitating new energy services and providing technical data for grid investment and maintenance decisions.[9]

Several *new energy services* are relying on the collection of granular consumption data and their swift processing. This is for instance the case for activating flexible demand for congestion management purposes. Such services rely on the fact that this consumption data is at the disposal of the service provider in a timely manner and without discrimination in favour of other providers. Two challenges may be present here:

1) obtaining these data may be prohibitively expensive for third parties, as this typically requires tapping into each consumers' meter and/or individual communication with each consumer in order to get access to data,

2) the data collectors (typically the DSOs) may face commercial disincentives to put data forward to third parties in a timely and complete manner.

Smart meters are also collecting more technical type of data besides 'consumption data used for billing purposes'. These data can be used to detect weaknesses or challenges within the network, and therefore be used to do both short-term grid management operations and more long term decisions on grid reinforcements.

Ensuring consumer data protection and security is an important criterion and some provisions are included in EU legislation.[10] This encompasses both objectives to ensure that important consumer data does not fall "into the wrong hands" hence potentially violating

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[8] *16 Member States have committed themselves to installing 245 million smart meters worth some €45 billion by 2020, according to "Benchmarking smart metering deployment in the EU-27 with a focus on electricity" (COM(2014) 356):*

[9] *Ruester et al (2013): From Distribution Networks to Smart Distribution Systems: Rethinking the Regulation of European Electricity DSOs, Final report, Topic 12 FP7 THINK project*

[10] *Most importantly the Network and Information Security (NIS) Directive, the Data Protection Impact Assessment (DPIA) Recommendation and the General Data Protection Regulation (GDPR).*

sensitive industrial trade secret or consumer rights, and to ensure that the system is not vulnerable for cybersecurity breaches and potential control of individual power supply. To some extent, these objectives may come at the expense of the above-mentioned objectives of facilitating both commercial and grid management operations based on individual data. For instance, data privacy concerns can come at the odds of getting third parties easy access to data in order to develop a market for new energy services.

Different Member States have developed – or are in the process of developing – models for data handling. From a European perspective it is important to ensure that impartiality of the entity handling the data and **ensure uniform rules** for which the data can be shared. This goes both within Member States but also across European borders.

So far, Member States apply their national framework on data protection, and entitle free access to their data for consumers but also set the conditions for access by third parties. General emerging risks and changes with data handling is addressed[11] and will be further handled with the Commission's proposals for the Network and Information Security Directive and for a General Data Protection Regulation.

3.2 Policy context

Regulation of electricity distribution networks is to a large extent a national prerogative. However, EU legislation provides the general framework; especially in the Electricity Directive and the Energy Efficiency Directive.

The **Electricity Directive 2009/72/EC**[12] provides the main framework for the role and tasks of DSOs. DSOs are defined in Article 2 as "natural or legal persons responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity". The National Regulatory Authority (NRA) is in charge of fixing or approving the distribution tariffs or their methodologies. The Electricity Directive states in its recital that the NRAs shall ensure that transmission and distribution tariffs are non-discriminatory and cost-reflective, and that they take account of the long-term, marginal, avoided network costs from distributed generation and demand-side management measures.

The **Energy Efficiency Directive**[13] stipulates that DSOs, together with TSOs, shall:

(a) guarantee the transmission and distribution of electricity from high-efficiency cogeneration;

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[11] *Directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data*

[12] *Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC*

[13] *Directive 2012/27/EU of the European Parliament and of the council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC*

(b) provide priority or guaranteed access to the grid of electricity from high-efficiency cogeneration;

(c) when dispatching electricity generating installations, provide priority dispatch of electricity from high-efficiency cogeneration in so far as the secure operation of the national electricity system permits.

It is also states that Member States shall ensure that national energy regulatory authorities encourage demand side resources, such as demand response, to participate alongside supply in wholesale and retail markets.

The **Renewable Energy Directive**[14] states that Member States shall ensure that TSOs and DSOs in their territory guarantee the transmission and distribution of electricity produced from renewable energy sources and make public their standard rules relating to the bearing and sharing of costs of technical adaptations such as grid connections and grid reinforcements, supporting the integration of new renewable energy sources into the interconnected grid.

In addition, article 16 (8) of the RES Directive foresees that "Member States shall ensure that tariffs charged by transmission system operators and distribution system operators for the transmission and distribution of electricity from plants using renewable energy sources reflect realisable cost benefits resulting from the plant's connection to the network. Such cost benefits could arise from the direct use of the low-voltage grid".

The European Commission is currently preparing a review of the energy efficiency legislation (Energy Efficiency Directive and Energy Performance in Buildings Directive) and an electricity market design initiative, based on the objectives and actions exposed in the **Roadmap for the Energy Union**, the **Communication on a New Deal for Consumers** and the **Market Design Consultative Communication**.

3.3 Status quo analysis and best practice for efficient operation of the DSO grid

The distribution grid will face two major challenges in the future due to:

1) Load growth from EV penetration and heat pumps
2) Integration of VRES

Electric vehicles represent a completely new demand for electricity and will challenge the DSO grid because it implies high capacity charging plugged into the lower voltage grid. Currently, penetration rates for electric vehicles are low among the European countries ranging from around 700 cars in Portugal to 44,000 cars in the Netherlands in 2014, cf. table 2. While difficult to predict, the uptake of electric vehicles is estimated to increase substantially by over 50 per cent per year going forward to 2030 in several EU Member

[14] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

States. Germany is expected to have the highest amount of electric vehicles with over 10 million cars in 2030.[15]

Table 2: Expected increase in electric vehicles by country

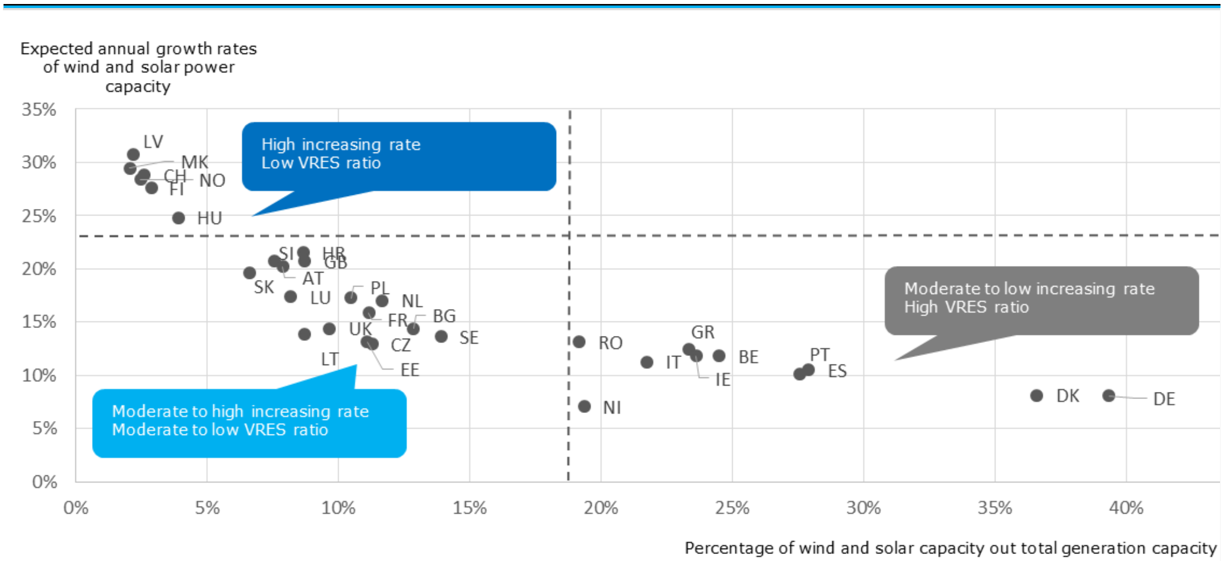
Country	2014	2030	Average annual expected increase
Portugal	743	867.000	55%
Denmark	2.799	436.000	37%
Spain	3.536	4.263.000	56%
Sweden	6.990	517.000	31%
Italy	7.584	6.638.000	53%
UK	21.425	3.735.000	38%
Germany	24.419	10.024.000	46%
France	30.912	5.431.000	38%
Norway	40.887	429.000	16%
Netherlands	43.762	982.000	21%

Source: Copenhagen Economics based on Selectra (2015) and Global EV Outlook (2015)

Another challenge for the distribution grid is the integration of variable renewable energy today and going forward. The degree of this challenge differs among the Member States. A group of Member States such as Germany, Denmark, Spain, Portugal already have integrated significant amounts of wind and solar power in the grid and are expecting more moderate growths rates in variable renewable energy capacity going forward to 2030, cf. figure 1. The majority of Member States have integrated a moderate amount of wind and solar power but will experience higher growth rates of variable renewable energy compared to the group with high variable renewable energy ratio. A minority of Member States have variable renewable energy ratios of less than 5 per cent but are expected to have the highest growth rates going forward to 2030.

[15] *Global EV Outlook 2015*

Figure 1: Degree of variable renewable energy challenge 2014-2030



Note: Excluded from graph (less than 1000 MW total of wind or solar power): Serbia, Montenegro, Bosnia & Herzegovina.
Source: Copenhagen Economics based on E-highway 2050 project results – national green transition scenario.

The DSOs can avoid or delay network reinforcement caused by load growth and distributed generation by procuring flexibility services. The successful implementation of flexibility services in the planning and operation of the DSO grid depends on:

- Is there a legal framework for the procurement i.e. is the DSO allowed to procure?
- Is the DSO incentivised to procure flexibility services when it would be cost-effective?
- Have the DSO actually taken actions to activate flexibility services – for example by implementing demand response programs?
- Does the DSO have the ability to control generation from renewable energy?
- Does the TSO and DSO exchange information regarding the activation of flexibility services?

Assessment of existing measures

According to a study by EvolvDSO[16] most DSOs surveyed (France, Ireland, Italy, Portugal) are not able to contract flexibility for constraints management although discussions on the topic take place in these countries. In Belgium and Germany, DSOs have the possibility to

[16] *EvolvDSO ("Development of methodologies and tools for new and evolving DSO roles for efficient DRES integration in distribution networks") is a FP7 collaborative project funded by the European Commission. The project lasts 40 months (September 2013- December 2016) (http://www.evolvdso.eu/Home/About).*

obtain system flexibility services via the connection and access contract. These types of contracts provide a reduced network fee in exchange for the control of the unit.

The majority of the country surveyed by EvolvDSO and by our stakeholder questionnaire cannot currently procure flexibility services partially because there is a lack of a legal framework and partially because the services are not covered in the regulated cost base, cf. table 3.

Table 3: Status Quo on DSOs incentives to procure flexibility services

Procurement of flexibility services	Number of Member States	Member state
DSOs cannot contract flexibility services	8	FI, FR, IE, IT, PT, EL, NL, ES
DSOs can contract system flexibility services for constraints management in certain situations	3	UK, BE, DE

Source: Copenhagen Economics based on EvolvDSO (2016) own stakeholder questionnaire (VVA & Copenhagen Economics 2016).

In Belgium, such contracts target new production units requesting connection at high voltage and medium voltage grids. The contract allows to temporally limit the active power of the unit via tele control. In Germany DSOs offer these "non-firm" access contracts to controllable thermal loads, i.e. heat pumps and overnight storage heating[17].

Current status in both countries is that there is a discussion on broadening these contracts to also include flexibility contracts for congestion management under normal operation state and not just emergency situations. This also includes a discussion on a possible financial compensation mechanism[18].

Incentives for procuring flexibility services

Another important issue is how DSOs' incentives to undertake such activities strongly depend on the detailed remuneration regulation adopted by Member States. Many of the new activities are not part of the traditional cost-base de facto preventing DSOs from engaging in such investments even though they have the legal basis to pursue them.

Some smart grid infrastructure investments are not necessarily held by the DSOs but by final consumers. How should a DSO regulation model be designed in order to ensure that the regulated entity namely the DSO can understand the full system cost options and then choose the most optimal overall configuration, thereby minimising the total system costs? Some countries (e.g. the UK) have addressed this challenge by implementing a TOTEX approach. The TOTEX approach focuses more on measuring desired levels and contents of services that customers are getting and then minimising costs for all actors. It may require

[17] *EvolvDSO, D1.2 – Current framework and role of DSOs FINAL v1.0,2016*

[18] *EvolvDSO, D1.2 – Current framework and role of DSOs FINAL v1.0,2016*

more regulatory dialogue around the optimal solutions. Another solution would be to provide additional incentives by WACC regulation similar to Italy.

Similar results were found in our stakeholder questionnaire. The Finnish DSOs for instance cannot procure flexibility for grid management purposes, because the regulatory model does not treat the costs of such action on a level playing field with investments to renewing or enforcing the grid, as it is not covered by the regulated cost base.

Demand response programs

Demand response is always part of the best flexibility mix because it is a cost-effective way to avoid or delay costly grid reinforcements (Tractebel, 2015). However, currently EU DSOs have only taken limited actions in terms of contracting demand response[19]. A survey by the EvolvDSO project have shown that only six Member States (Denmark, Belgium, France, Italy, Portugal and Germany) have undertaken demand response programs and these are mainly targeted towards large industrial consumers (Ireland and Austria are in the progress of developing demand response programs). In some of these six Member States it is the TSO that proposed and run the demand response programs, cf. table 4.

Table 4: Status Quo on demand response programs

Procurement of flexibility services	Number of Member States	Member state
Demand response programs are available	6	BE, DE, DK, FR, IT, PT
Demand response programs are currently being developed	2	IE, AT

Source: Copenhagen Economics based on EvolvDSO (2016).

Controllability of renewable energy sources

Another way to view the question on flexibility is to ask the question whether or not the DSO is able to affect the operation of renewable energy sources connected to the DSO grid. When the DSO can control a generation resource, it can alleviate congestion, e.g. by curtailing in emergency situations, some grid reinforcements could be prevented, as the need for grid capacity decreases.

Currently controllability of RES is limited among the countries surveyed in the EvolvDSO project[20] and the Mercados tariff study[21].

[19] *EvolvDSO, D1.2 – Current framework and role of DSOs FINAL v1.0,2016*

[20] *EvolvDSO, D1.2 – Current framework and role of DSOs FINAL v1.0,2016*

[21] *Mercados (2015), Study on Tariff Design for Distribution Systems*

In those countries where controllability of RES connected to the distribution grid is possible it is limited because it often only applies to RES above a certain capacity:

- **Belgium:** based on a flexible contract
- **Austria:** RES above 50 MW capacity
- **France:** RES above 5MW capacity and applies both to constraints and emergency situations
- **Germany:** RES above 100 kW capacity
- **Italy:** RES above 100 kW capacity but requires acceptance by TSO

In those Member States where the DSO cannot control RES connected to their own grid it will most often be the TSO that controls the RES and instruct the DSO to taken action in emergency situations. Currently, this is the case in nine Member States, cf. table 5.

Table 5: Status Quo on DSOs controllability of RES

Controllability of RES	Number of Member States	Member state
DSO can control RES to some extent	5	AT, BE. DE, FR, IT
DSO cannot control RES connected to the distribution grid not even in emergency situations	9	NL, PT, SI, LT, IT, EL, FI, ES, CY

Source: Copenhagen Economics based on EvolvDSO (2016) and Mercados (2015)22.

Going forward, as the penetration of RES increases, the need for curtailing in emergency situations might increase even though curtailment is a last resort only due to priority dispatch in all systems. This depends on the speed of RES penetration and the hosting capacity of the DSO grid in the individual Member States.

Therefore, flexibility to control RES could potentially limit the situations where the DSO need to curtail for security reasons to a minimum and thereby provide benefits for the DSO. Such actions should take place on the basis of a market based approach and under specific rules.

DSO-TSO coordination

Increased penetration of variable renewable energy and new loads in the distribution grid, as well as the activation of distributed energy resources to provide flexibility, will increase the frequency of situations where congestion appears and where a coordinated approach from system operators will be required. Therefore, cooperation between TSOs and DSOs is

[22] *EvolvDSO, D1.2 – Current framework and role of DSOs FINAL v1.0,2016. Mercados (2015), Study on Tariff Design for Distribution Systems.*

particularly relevant when dealing with congestions and RES connections at distribution system level. [23]

A way to strengthen this collaboration might be to share information to a larger extent, and inform the DSOs about the activation of reserves provided by generation connected at distribution system level. Traditionally, DSOs were not aware of the results of the balancing market run by the TSO[24] Instead, if the DSO is aware of the provision of reserves from distributed generation it might be able to foresee contingencies and implement corresponding correction measures.[25]

3.4 Status quo analysis and best practice for distribution tariffs

Distribution tariffs are used to collect the allowed revenue for the DSO. Tariffs usually include connection charges and use-of-system charges; however, there is a huge variety in the specific structure of tariffs across the Member States. In the following, we focus on use-of-system charges.

Use-of-system charges are generally based either on energy consumption (volumetric) or on contracted/measured capacity (capacity based tariffs), while the final tariff often includes both elements (a two-part tariff). Tariffs often also include a fixed component intended to cover metering or administrative costs. Within volumetric tariffs, the charge can also be time dependent i.e. different charge at day/night, different months or even in real time. In practise, we observe four types of distribution tariffs for use of system charges:

1) Volumetric
2) Capacity-based
3) Two-part tariffs
4) One of the above + system services

The details of these different tariffs types are explained in table 6 below.

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[23] *Eurelectric (2014), Flexibility and Aggregation - Requirements for their interaction in the market.*

[24] *evolveDSO deliverable 1.2*

[25] *As suggested by the EvolvDSO project: EvolvDSO, D1.2 – Current framework and role of DSOs FINAL v1.0,2016*

Table 6: Network pricing options

Network tariff type	Options within this approach:
Volumetric tariffs (€/kWh)	• **Flat** (fixed price for a fixed amount of energy) • **Fixed** (fixed price per unit of energy/kWh) • **ToU** (price per kWh depends on time of consumption) • **Event driven including critical peak pricing** (higher prices if peak occurs) • **Dynamic including real time** (dynamic prices e.g. depending on wholesale prices)
Capacity tariff (€/kW)	• **Flat** (fixed price for a predefined capacity) • **Variable – e.g. two capacity levels** (different capacity levels defined, one price for each level) • **ToU** (price per kW depends on time of consumption)
Two parts tariffs (€/kW) + (€/kWh)	• **Combination of the above** (for example ToU, event driven, dynamic options possible within the energy component)
One of the above + System services contract	• **Interruptible tariff options** (e.g. lower network tariffs for giving the option to control a predefined amount of load) • **Other**

Source: Eurelectric (2013) Network tariff structure for a smart energy system, p. 16.

The different tariffs structures each have their advantages and disadvantages. Volumetric tariffs are in general very easy to understand for consumers and promote energy efficiency. The issue from a DSO perspective is that grid costs are mainly driven by the peak energy flows which determine the necessary installed capacity and not so much from the amount of the distributed energy which impacts for instance losses in the grid. Today and especially in the future with the expected rise of almost self-sufficient prosumers, purely volumetric distribution tariffs will not be cost reflective. For instance, even a self-sufficient consumer might have to use the grid for few hours a year, however the same grid capacity will be required and thereby impose nearly the same costs as regular consumers, depending on the different network topologies, the flows that each system user incite in the network and the impact of energy flows on an aggregated level.

Most distribution tariffs in the EU are volumetric, occasionally in a way that varies across time. This structure has been inherited from previous regimes, where the electricity service was provided by vertically integrated companies with an overall economic approach to system operation, generation and supply. Moreover, grid costs were strongly correlated to electricity volumes as consumers with high peak- load/capacity requirements also tended to be those who were consuming the most energy. However, going forward this will be less the case with e.g. almost self-sufficient consumers and the deployment of demand units with very high load capacity.

Currently, the majority of DSO revenue is indeed collected through volumetric tariffs, i.e. 69 per cent of the revenue from household consumers, 54 per cent for small industrial consumers and 58 per cent for large industrial consumers, cf. table 7. The rest is then collected through a capacity and/or fixed component in a two-part-tariff.

Only three Member States (Spain, Sweden and the Netherlands) have a capacity and/or fixed component that weighs over 50 per cent of DSO tariff for households' consumers. Netherlands is the only EU country that applies a 100 per cent capacity based tariff for households and small industrial consumers, while, on the other hand, Romania applies a 100 per cent volumetric tariff. For small and industrial consumers, the weight of the capacity and fixed element typically increases, and in 6-8 Member States this makes up over 50 per cent, cf. table 7.

Table 7: Status quo on volumetric and capacity tariffs among Member States

Tariff structure elements	Number of Member States/name of member state	Tariff component for household consumers	Tariff component for small industrial consumers	Tariff component for large industrial consumers
Member States where the volumetric element weights over 50 per cent of the DSO tariff	**No**	**15**	**11**	**13**
	MS	AT, CY, CZ, FR, DE, EL, HU, IT, LU, PL, PT, RO, SK, SI, GB	CY, CZ, FI, FR, DE, EL, HU, RO, SE, SK, GB	AT, CY, FI, FR, EL, HU, PL, RO, SE, SK, SI, NL, GB
Member States where the capacity element + fixed charge weights over 50 per cent of the DSO tariff	**No**	**3**	**8**	**6**
	MS	ES, SE, NL	AT, IT, LU, PL, PT, SI, ES, NL	CZ, DE, IT, LU, PT, ES
EU capacity element + fixed component average		**31%**	**46%**	**42%**
EU volumetric element average		**69%**	**54%**	**58%**

Note: Bulgaria and Latvia are not included in the survey, Netherlands have a 100 per cent capacity based tariff for households and small industrial consumers as the only country in the EU. In DK, Finland, Luxembourg and Malta time-of-use tariffs are not available for household customers.
Source: Copenhagen Economics based on Mercados (2015) and Eurelectric (2013).

In 17 countries a time-of-use distribution tariff is applied, typically for non-residential consumers and with daily (night/day) or seasonal (winter/summer) structure[26]. Very few of these have a real-time dimension, which can be used to incentivise flexible demand.[27] France is one of very few – if any – examples where the tariff promotes also demand response programme based on critical peak pricing. Under the critical peak pricing scheme, the consumer is requested to reduce demand with a 24-hour notice signal for some given days a year.

Some Member States use grid tariffs as a tool to promote social policies. Social tariffs elements are prevalent in Spain, Italy, France, Portugal and Greece, cf. table 8. The social tariffs are available for vulnerable consumers who meet certain criteria such as being a

[26] *Mercados, (2015), Study on Tariff Design for Distribution Systems*

[27] *Mercados, (2015), Study on Tariff Design for Distribution Systems.*

large family, pensioner older than 60 years on minimum state pension, families where all members are unemployed etc. A common feature of the social tariffs is that they are used as a mechanism to subsidise costs for specific consumer categories including vulnerable and low-income ones. In some Member States producers pay the burden whereas in other Member States the cost is spread on all consumers through public service obligation fees.

Table 8: Status quo on time-of-use tariffs in Member States

Tariff structure elements	Number of Member States	Member state
Time-of-use tariffs	17	AT, HU, CZ, DK, FI, FR, EE, EL, IE, LU, LT, MT, PL, PT, SI, ES, UK
Critical peak pricing	1	FR
"Social tariff element" to cross-subsidize low income consumer	5	ES, IT, FR, EL, PT

Source: Copenhagen Economics based on Mercados (2015) and Eurelectric (2013).

Transparent distribution tariffs help the efficiency of the economic signals received by network users, thus also promoting competition and market functioning. Transparent distribution tariffs also help incentivising peak demand reductions and promote flexibility.

Questions have been raised on the transparency of national regulators' tariff calculation methodologies and the underlying costs used to calculate the level of the tariffs. The lack of transparency makes it difficult to assess and compare practices between Member States.

Transparent tariffs imply that consumers should be able to see on their energy bill each cost component they are getting charged for. Often this is not the case as the overall bill consists of energy charges, taxes and network tariffs. For example, in Spain distribution tariff includes subsidies to renewable generation (Mercados, 2015).

According to the information gathered from our stakeholder questionnaire, it is perceived that in Greece, Spain, Finland, France, Germany, Netherlands, Norway and in UK, consumers have a transparent picture of their tariffs. Examples of transparent tariffs are:

> **Greece**: the distribution tariffs are decided by the regulator and all the relevant decisions and prices are published by the Regulator on its website. The suppliers have the obligation to show the charges for using the distribution network separately in the bill of the consumers.
>
> **Great Britain:** an average dual fuel bill has a breakdown of the costs as percentages (broken down to wholesale costs, network, environmental and social policies, corporation tax & VAT, supplier operating costs and supplier profit). Such that, the average network costs are provided as a percentage.

Examples of Member States with non-transparent tariffs are:

> **Cyprus:** The consumer cannot see how the costs derives from grid cost, ancillary services, generation cost and retail cost

Poland: The current tariff structure is quite complicated for customers, as it contains components having the form of taxes (due to temporary fee and qualitative fee) and these components are not directly derived from the costs incurred by the DSO. Therefore, the tariff structure itself is not transparent for consumers.

Out of the 11 Member States that participated in our stakeholder questionnaire 7 Member States stated that distribution tariffs are visible for consumers whereas 4 stated that DSO related costs is not explicitly shown on the bill, cf. table 9.

Table 9: Are distribution tariffs visible for consumers

Transparent tariff structures	Number of Member States	Member state
DSO tariffs are transparent for customers	7	EL, DE, FI, FR, NL, NO, UK
DSO related costs is not explicitly shown on the bill	4	CY, PL, PT, ES

Source: Data collection from own stakeholder questionnaire (VVA & Copenhagen Economics 2016).

Another challenge for the distribution tariffs is the treatment of distributed energy resources. In several Member States, such as Germany, Netherlands, Norway, Belgium, Poland and Portugal distributed energy resources producers do not pay use-of-system tariffs (UoS), cf. table 10. In other Member States distributed energy resources does not pay full UoS charges. In France for example this applies to generation connected to the 130 voltage grid or below and in Belgium to generation units below 10 kW[28].

Table 10: Status quo on grid tariffs for distributed energy resource (DER)

Grid tariffs for DER	Number of Member States	Member state
DER does not UoS grid tariffs	7	DE, NL, NO, PL, PT, BE, DK
DER does pay UoS tariffs	5	UK, CY, FI, ES, IE
DER partially pays grid tariffs	4	AT, FR, BE, EL

Source: Copenhagen Economics based on Mercados (2015), EvolvDSO (2016) and own data collection through stakeholder questionnaire (VVA & Copenhagen Economics 2016).

Examples of Member States where distributed energy resources do not pay any grid tariffs:

Poland: The distributed generation producers do not bear fees for energy they inject to the network. They benefit from the ability of introducing energy without participating in the costs of maintaining the network. This may be considered disadvantageous for other users especially when the costs that these generators evoke outweigh the benefits of distributed generation.

Germany: The DSO tariffs are charged to loads only, i.e. distributed generation does not pay any network tariffs[29]. In addition, there is the incentive that newly constructed storages are exempt from network tariffs for 20 years according to German law.

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[28] *EvolvDSO, D1.2 – Current framework and role of DSOs FINAL v1.0,2016*

[29] *In addition, newly created storage facility is excepted from network tariffs for 20 years according to German law.*

Portugal: distributed energy resources do not really pay tariffs to support the services of the distribution system. It is thought that smarter grids are increasingly needed to integrate distributed energy resources and thus those resources should also be eligible to share the effort to develop and maintain an innovative grid, as well as the market framework that will support all interactions.

Examples of Member States where distributed energy resources do pay grid tariffs:

UK: there are two separate tariff charging methodologies for distribution and under both methodology Distributed Energy (DE) will pay grid tariffs:

1) *22KV or above Extra-High-Voltage Distribution Charging Methodology* (EDCM)[30]: a specific tariff for each customer is produced by an incremental charging methodology based on either the forward cost pricing (FCP) approach or Long run increment costs (LRIC). Some DE above 22kV can receive a credit (i.e. paid) per kWh if they are off setting demand driven reinforcement.

2) *Below 22kV Common Distribution Charging Methodology (CDCM)*[31]: customers are allocated into different categories (around 10) and the tariff structures for each customer category are the same in each DSO area (i.e. averaged). All DE below 22kV receive a credit per kWh to reflect the fact that generation off-sets demand and voids reinforcement.

Examples of Member States that partially pay distribution tariffs:

Greece: the distributed energy resources do not pay any distribution grid tariffs. Nevertheless, distributed generators pay for the maintenance done by the DSO of the part of the grid that is used solely by them.

Best practice

In abstract terms, best practice is relatively well-established through e.g. EU guidelines:

- Cost reflective (costs should be allocated to those agents who impose the costs)
- Transparent and understandable (information needs to be publically available and easy to understand)
- Economically efficient (incentivises behaviour that maximises social welfare in short and long term)
- Economically sustainable (tariffs should cover the infrastructure cost)
- Non-discriminatory (equal tariff for equal usage under equal circumstances)
- Stable (regulatory certainty)

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[30] *Manual for the EDCM2 model, Energy Networks Association, 15 January 2013 http://www.energynetworks.org/assets/files/electricity/regulation/REFRESH%202014/WORKING%20GROUPS/CDCM&EDCM%20User%20Manuals/EDCM%20user%20manual%20(Jan%202013).pdf*

[31] *CDCM model user manual Model Version: 102, Energy Networks Association, 28 February 2013 http://www.energynetworks.org/assets/files/electricity/regulation/CDCM/CDCM%20model%20user%20manual%20(v102)%20-%20Feb%202013.pdf*

However, the more practical implementation of these principles has yet to establish a best practice approach. This is both due to the rapid evolution of distributed energy resources and to the large variations between the local conditions of the distribution grids across and within Member States. One methodology may work well in a distribution grid with much distributed wind energy and lengthy distribution channels, while another may work well with much distributed solar energy and short distribution channels.

However, some principles are more clear with respect to best practice. A pure volumetric tariff will not be cost reflective – especially going forward – hence risking both discrimination against other grid users and inefficient deployment and operation. Consequently, a larger focus on capacity in tariff setting is a move towards best practice. An argument against capacity-based tariffs is that they provide less incentive to act energy efficiently and ultimately induce grid circumvention where consumers become fully self-sufficient. While grid circumvention is a tangible risk which should be addressed locally (for an almost self-sufficient consumer, a high capacity tariff essentially becomes an insurance payment for grid availability in certain situations), energy efficiency objectives can equally or even more efficiently be addressed through regular energy consumption based taxes or charges.

Another best-practice principle is to make the tariff more reflective of underlying grid challenges. Ultimately, a dynamic tariff which sends a considerable price signal to consumers in periods of stress, will induce efficient demand response. Second-best is more granular time dependence such as increased tariffs at the typical daily peak load period around 17-19 o'clock, or even more granular such as winter/summer differences. In order to be effective however, consumers must be able to respond to changes in tariff signals requiring both very transparent signals and also technological possibilities to quickly respond in case of dynamic tariffs.

Table 11: Tariff structure element

Tariff structure elements	Advantage	Disadvantage
Volume element (euro/KWh)	Simple and promotes energy efficiency	Does not reflect the underlying drivers of distribution costs
Capacity element (euro/KW)	Potentially full cost recovery for the DSOs	Provides less incentive for energy efficiency for consumers
Time element	Encourages demand response	Complex to understand and implement

Source: Copenhagen Economics based on Eurelectric (2013).

3.5 Status quo analysis and best practice for data handling

Status quo

Data from Member States show that 72 per cent of all European consumers are foreseen to have a smart electricity meter by 2020[32] as result of a wide-scale deployment (Italy, Finland, Sweden), underway or planned (Austria, Denmark, Estonia, France, Greece, Ireland, Latvia, Luxemburg, Malta, Netherlands, Poland, Spain, Romania and UK).[33] Belgium, Bulgaria, Cyprus, Portugal and Slovenia are in the pilot phase before formal decision and might move towards a roll-out soon. Germany and Slovakia decided to provide smart meters to "relevant" customers.

Those millions of smart meters across Europe create

a) *different types of data*, which are used by
b) *different stakeholders* for
c) *different kinds of applications,*

as explained in more detail in the following.

a) Types of Smart Meter data[34]

In general, smart meters generate two types of data, *consumption data* (including production data if the consumer also owns generation) and *technical data*. Consumption data contains information on how much energy a customer has consumed (and produced) over a particular time. Technical data is related to consumption but measures more technical aspects of the energy distribution, e.g. data on voltage levels, voltage angles, power quality, frequency etc. This technical information makes it possible to predict or identify congestion or to detect other physical problems in the grid.

b) Stakeholders

Stakeholders are all current and potential users of smart meter data, namely consumers, DSOs, energy suppliers, and other third parties such as consumption aggregators or other providers of smart energy solutions.

c) Applications

Applications are all uses of smart meter data. Firstly, the data is used to fulfil regulatory obligations, namely to ensure the functioning of the core energy supply (grid management, billing). Secondly, the data is used for new commercial services, i.e. new applications like

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[32] *"Benchmarking smart metering deployment in the EU-27 with a focus on electricity" (COM(2014) 356): 16 Member States have committed themselves to installing 200 million smart meters for electricity and 45 million smart meters for gas by 2020, for a total of €45 billion.*

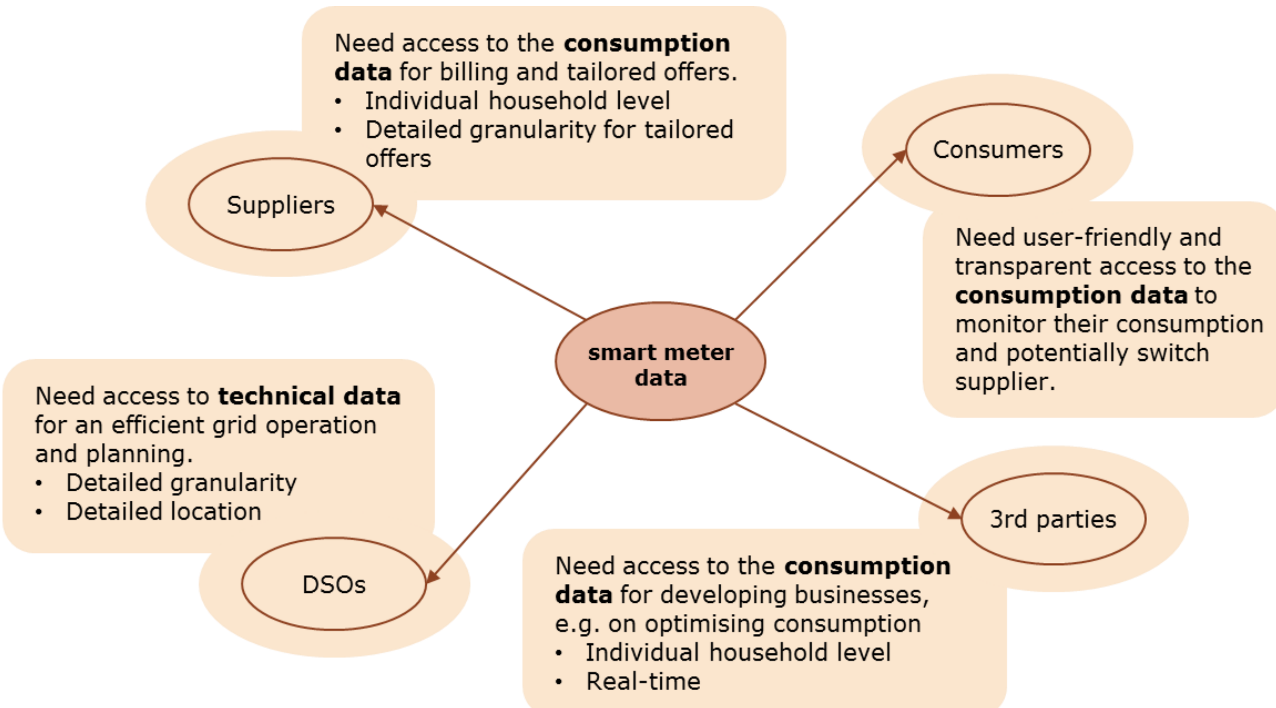
[33] *Czech Republic, Hungary, Lithuania decided against a massive roll out.*

[34] *Next to Smart Meter data, a range of other data is generated and used in a digitalised power sector. That includes data generated by smart appliances (e.g. smart plugs, smart thermostats), technical data generated from sensors in the grid as well as data from external sources (e.g. meteorological data). Since we focus solely on Smart Meter data in this report, we refer Smart Meter data handling data handling.*

flexible demand. Thirdly, consumers use their own consumption data to monitor their consumption.

An overview on the interplay of data type, stakeholders and applications is provided in Figure *2* and explained afterwards.

Figure 2: Stakeholders and applications of smart meter data



Source: Copenhagen Economics based on stakeholder interviews.

Incumbent **suppliers** need access to consumption data on individual household level for billing their customers. In case of a simple tariff with uniform, daytime-independent energy prices, time granularity of data is of less importance. For large consumers, access to daily or weekly consumption data once a month usually suffices for the suppliers' billing process, and for small consumers once-a-year readings is commonplace.

More frequent access and more detailed granularity of the consumption data is necessary if the customer has a more sophisticated tariff, or if the (incumbent or potential new) supplier wants to make an offer tailored to the customers' consumption patterns.

Consumers need access to their own consumption data to monitor their overall consumption and to understand their consumption patterns, for example in case they consider to switch suppliers. A detailed granularity of the consumption data is helpful to understand the patterns, but less important to monitor the overall consumption. A userfriendly system to get access and a transparent preparation or clear visualisation of the consumption data are desirable from the consumers' perspective.

DSOs need access to the technical data to efficiently plan and operate the distribution grid. From the technical data, the DSOs can conclude existing or potential future problems regarding for instance congestion, load or voltage range, which enables the DSOs to organise maintenance and expansion works efficiently and timely. Quick access when needed to smart meter data of detailed granularity (preferably real-time) and the detailed location (anonymised suffices typically) help the DSOs to operate in a targeted and efficient manner. In most Member States, DSOs are still responsible for collecting distribution tariffs, for which it also needs consumption data.

For new business models and smart energy services, **third parties** will need access to consumption data. The level of granularity and time of access differs according to the exact business model. For envisaged business models related e.g. to real time demand response, highly granular data is needed, and maybe even in real time.

Different data handling models

Different approaches for handling and using the data have emerged in the Member States. Approaches for the data use – including new services by suppliers as well as industry initiatives – are not covered in this report.[35] Instead, the focus is on the Member States' different data handling models.

There are different approaches to handling the data sourced by the smart meters. The Smart Grid Taskforce[36], set up by the European Commission in 2009, groups those approaches into three general models of data handling: The DSO as facilitator, the Central Data Hub (CDH) and Data Access-Point Manager(s) (DAM). When implemented separately or in combination these models cover all possible cases, while they ensure effective data access and security. However, each model has particular advantages and faces particular challenges.

The first model, using the DSO as a market facilitator, means that the DSO is in charge of handling the smart meter data. This model is likely to be the very efficient at data handling and processing, since the DSO is also collecting the data. There might be challenges related to non-discrimination and distortions as the DSO may have an incentive to restrict data access to commercial providers. This model also includes the option of the DSO running a central data hub; this approach then blends into the second model to some extent, for example regarding its advantages and disadvantages. Already the tendency is, especially where a big number of DSOs exist, to form a central hub (Nordics) or create a joint data hub under the DSOs (Netherlands) or a data exchange platform (Austria).

The second model, a Central Data Hub, involves a central, independent platform, which receives the data from the DSOs and is responsible for the data handling. The hub can for

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[35] *Examples of new services by suppliers and industry initiatives can be found in the study "The power sector goes digital – Next generation data management for energy consumers" by Eurelectric, 2016.*

[36] *Smart Grid Task Force, DG ENER http://ec.europa.eu/energy/en/topics/markets-and-consumers/smart-grids-and-meters/smart-grids-task-force*

example be driven by an independent, authorized entity, by a DSO (in that case blending in to the first model) or by the TSO. For this model there are no obvious challenges related to non-discriminatory access and transparency. Ensuring sufficient consumer protection is particularly important, since a central data hub pools all consumer data. At the same time, the fact that there is only one entity might make it easier to ensure security against cyberattacks. Potential pricing of processed data products to commercial operators will need to be defined.

The third model involves one or several Data Access-Point Managers (DAMs) that handle the data access at each metering point. These DAMs can be any certified company, including the DSOs. In this model, there is no regulated central data hub, but the model allows for the creation of a commercial data hub collecting data from each DAM. The model implies that the data handling entities are in competition thereby facing high incentives for improved services and innovation; there might however be a loss of economies of scale compared to e.g. the central data hub model. The main characteristics of the three models are presented in Table 12.

Table 12: The three general models of data handling

DSO as facilitator	Central Data Hub (CDH)	**Data Access-Point Manager(s) (DAM)**
The "DSO as market facilitator" is a model based on a data hub, which is the standardized centralized or decentralized point for the market parties to collect all operational data as well as all necessary data to facilitate the market (data about customers, their technical possibilities, and their consumption or production). The DSO provides this data to the market via the data hubs, as a regulated market facilitator.	This model consists of an independent central communication platform based on one or several data hubs, which will interact with different smart grid stakeholders, potentially storing data and processing it. This will allow equal access by all market participants to commercial data facilitating the market in a neutral manner, as the third party is by definition an independent one. The key functions of the hub are access control, receiving data from different parties and delivering it to the authorized parties, as well as aggregation and data storage for retrieval of historical data or tailor made services by end consumers.	In this model, a commercial party provides the data handling service. No official data hub exists, but trusted Data Access-Point Managers (DAMs) guarantee data access at each meter point. These DAMs can be any certified commercial company and act as data gatekeepers, providing data access to any certified market player and/or consumer/prosumer. DAMs would be designed to enhance existing market structures, roles and responsibilities and would not necessarily change them. The DAM is designed to handle access to data and remote management of functionalities needed to create value added programmes within the Smart Grid from a wide range of devices such as smart meters, distributed generation, appliances, electric vehicles, etc.

Source: Copenhagen Economics based on Smart Grid Taskforce (2013): EG3 First Year Report: Options on handling Smart Grids Data and ECN & ECORYS (2014): The role of DSOs in a Smart Grid environment. Final report for DG ENER.

Currently, the European countries use different models for the management of smart meter data. The United Kingdom, Estonia, Italy, Austria and Denmark implement centralised data storages, and also Finland and Belgium (although Belgium has no wide-scale deployment of smart meters) are heading in the direction of a central data hub model. In Denmark and Italy, the CDH is driven by the TSO. That model of a TSO-driven CDH is also going to be applied in Finland. In Austria, the CDH is a peer-to-peer platform for data exchange.[37]

Other countries like Spain, Portugal and France have opted for the DSO as a facilitator. This approach is often decentralised, and communications among parties carrying out transactions are typically subject to some form of coordination. In several Member States, a communication agent takes on this responsibility. Germany uses an extremely decentralised model where meter data is physically stored at the consumer's premises by a smart metering gateway, which is accessible to entitled users; this approach must be understood in the German context without a wide scale roll-out of smart meters. Only about 1 per cent of all metering stations are equipped with smart meters, usually customers that fit a particular profile.

One potential problem we could identify across data handling models is that the information given to DSOs typically includes which supplier is serving which customer. According to questionnaires and stakeholder interviews with representatives from the respective countries, this is at least true for Austria, Finland, France Germany, Great Britain, Greece, the Netherlands, Norway, Poland, Portugal and Spain. If there is no full unbundling – i.e. a supplier is part of the same legal entity as a DSO – then the situation of the DSO knowing each customer's supplier can evoke discriminatory behaviours. Firstly, the DSO could provide additional information to the bundled supplier that is usually not (or not so timely) accessible to third suppliers, e.g. information on detailed consumption or information regarding switching. Secondly, the DSO could maintain the grid better and more in areas where the bundled supplier is the dominating supplier. Once consumers become aware of that, they will have an incentive to choose the bundled supplier over an alternative, unbundled supplier. Both would leave the bundled supplier in an advantage compared to other suppliers and therefore mean a distortion to competition; the second argument is, however, rather a consideration of theoretical nature. In many countries, the DSOs are subject to a framework of rules that strongly incentivises them to carry out maintenance work where needed, so the DSOs cannot choose freely which parts of the grid to maintain best.

In Austria, Denmark, Finland, France, Germany, Poland, Spain and Sweden, DSOs and suppliers are not fully ownership unbundled yet, meaning that the risk of discrimination is likely higher. In Italy, Portugal, the Netherlands and Spain, most DSOs are ownership-unbundled, which reduces the risk for distortions to competition[38].

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[37] *THINK (2013) From Distribution Networks to Smart Distribution Systems: Rethinking the Regulation of European Electricity DSOs.*

[38] *THINK (2013), From Distribution Networks to Smart Distribution Systems: Rethinking the Regulation of European Electricity DSOs, table 1, page 13. Unbundling data from 2010.*

The problem of potential discrimination against unbundled suppliers from bundled DSOs could be solved by keeping the DSO unaware of the supplier that is serving each consumer. Typically, however, DSOs are informed about which supplier serves which customer, and the reason for this is that information and data is exchanged between DSOs and suppliers; that often happens directly between the two stakeholders. This information and data streams occur when the customer decides to switch the supplier when the DSO invoice the supplier for the grid use.

Best practice

There is not one data handling model that is per se the best approach. Much more important than the choice of a particular data handling model is a range of specific design choices that ensure that the overall objectives regarding access and efficiency, non-discrimination, privacy and security are met. In the following table, we list the most important design choices that we identified for each of those three categories, explain why this design choice is crucial (i.e. the negative consequences if an inferior choice is made), and provide best practice examples.

Table 13: Important design choices and best practice examples

Category	*Design element of importance*	*Reason for importance*	*Best practice example(s)*
Access & Efficiency	*DSOs* Access to technical data	Technical data helps DSOs to maintain, operate and plan the grid efficiently.	DSOs have access to the technical data in many countries, including DE, FR, AT, DK etc.
	Incumbent suppliers (Efficient) access to consumer data for both incumbent and potential supplier	Necessary information for billing (incumbent supplier) as well as to make tailored offers (both incumbent and potential supplier)	DE / FR
	3rd parties (incl. potential suppliers) Access to consumer data	Important for 3rd parties to develop their businesses, e.g. applications that optimise consumption	FR / AT
	Consumers Transparent access to their own consumption data	Necessary for the consumer to monitor his consumption as well as to make informed decisions regarding tariffs and suppliers	FR
Non-discrimination	Timely and comprehensive access for entities competing with DSOs (e.g. on flexibility procurement)	Otherwise discrimination against entities competing with DSOs	No clear best practice example
	Timely and comprehensive access for entities competing with bundled suppliers	Otherwise discrimination against entities competing with bundled suppliers	DK
Privacy & Security	Consumer privacy (incl. security regarding industrial secrets / confidential consumption patterns)	Risk of data abuse if privacy is not ensured	(FR)
	Vulnerability towards cyber attacks	Risk of data abuse and fraud if cybersecurity is not ensured	e.g. AT

Source: Copenhagen Economics.

Access & Efficiency:

Independently of the data handling model and across the EU, DSOs typically have sufficient access to the technical data; what varies is how fast and timely the access is. There is no clear best practice country example, since fast and timely access is provided in several countries. In Germany, the DSOs receive the technical data automatically on a regular basis. In Austria, the DSOs have direct access to the smart meters and can retrieve the technical data whenever they need it. France combines both forms of access.

The (incumbent) suppliers' access to consumer data is not a problem either. Incumbent suppliers typically receive the data automatically and regularly. From the suppliers' perspective, it is preferable to receive all consumer data they need for billing either from one entity ("one-stop-shop") or – if from several entities – through a standardised process. The first is the case in Denmark, where the central data hub is the only entity that the suppliers have to contact for billing data. In Germany and Austria, standardised processes ensure an efficient data influx to the suppliers.

Potential suppliers should be granted access to consumer data to be able to make tailored offers and compete with the incumbent supplier. They are in the same situation as other third parties (e.g. aggregators), which need access to consumption data to develop their business case. Typically, all third parties are granted access if the consumer gives his or her consent (e.g. in DE, FR, AT, DK). This permission might be an obstacle, since it might be cumbersome and time-intensive to obtain. At the same time, the requirement of consumer permission is important to ensure consumer privacy. This issue illustrates a main trade-off within data handling.

In France and Austria, third parties can gain access to the consumer's data via an app that directly connects to the smart meter. That is an efficient alternative, since the consumer decides whether or not to use the app – consumer privacy is therewith not curtailed. The third party on the other hand does not have to spend resources to get the permission.

Consumers need access to their own data to monitor their consumption and to make informed decisions about the consumption behaviour and choice of supplier. Consumer access is sufficiently covered in EU legislation and given in all Member States. What varies between countries is how transparent and comprehensive the data is presented. France serves as a best practice example here; French consumers have access to their data directly via the smart meters (wireless) as well as via the DSO's web portal. Using the latter, consumers can download their data in a visualised from, illustrating their own consumption compared to an average household. Such visualisations help the consumer to better understand their consumption patterns and to act accordingly if they wish to.

Non-discrimination

Ensuring non-discriminatory practices is key to building a fair and well-functioning market around smart meter data. Optimal data handling approaches are able to tackle two dimensions of potential discrimination successfully:

> Firstly, timely and comprehensive access for entities competing with DSOs (e.g. on flexibility procurement) must be ensured not to place DSOs in an advantaged position. In other words, the data handling model must assure that the DSO cannot withhold data to competitors, and that competitors can get as fast and as detailed access as DSOs. In most models, DSOs cannot withhold data to competitors; however, 3rd parties typically need consumer consent to gain access, and DSOs do not. DSOs do therewith have a competitive advantage, and so far, we could not identify a best practice example that would have solved this market distortion.

> Secondly, bundled suppliers should not have a competitive advantage over unbundled suppliers. Therefore, the latter should have timely and comprehensive access to consumption data. Again, unbundled suppliers have the right to data access, but might not get the data as fast as bundled suppliers, which could potentially avoid asking for consumer consent and receive the data from the DSO they are bundled with. The Danish data handling model solves that problem very efficiently: here, all consumer data is re-directed around the DSO and directly to the data hub. The DSOs then get access to the consumption data, but do not have any information on the supplier which the consumers have contracted with. Consequently, DSOs cannot discriminate against unbundled suppliers.

Privacy & Security

The third key area of design choices relates to consumer privacy and overall cybersecurity. Consumer privacy is important to prohibit data abuse; the consumption patterns of large industrial consumers might be confidential because they contain sensitive information. The approach towards consumer privacy is very similar across countries: typically, consumers own their consumption data and must give their permission before it is used by any market entity. DSOs and suppliers are exempted from that requirement, since they need to have access to the consumption data to meet their core obligations. Worth noting is the French approach: here, DSOs and suppliers are only partly exempted from the requirement of consumer consent. They have access by default to the consumer data once a day, aggregated for the day before, which should be sufficient for fulfilling their core tasks. For a higher granularity, they need to ask for the consumer’s permission.

Prohibiting data abuse is not only about data access, but also about general cybersecurity. In the Austrian data handling model, a lot of emphasis is on keeping the data streams secure and vulnerability towards cyberattacks low. That is achieved by a decentralised data storage combined with encrypted messages, as well as the use of hash values to track messages and to detect potential cyberattacks.

3.6 Subsidiarity principle – rationale for EU action

Article 5 of the Treaty of the European Union (TEU) defines the division of competences between the EU level and the national or infra-national level, by referring to the principles of subsidiarity, conferral and proportionality.

Under the principle of **conferral**, the EU “shall act only within the limits of the competences conferred upon it by the Member States in the Treaties”. Under the principle of **subsidiarity**, “in areas which do not fall within its exclusive competence, the Union shall act only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States, either at central level or at regional and local level, but can rather, by reason of the scale or effects of the proposed action, be better achieved at Union level.” Under the principle of **proportionality** finally, “the content and form of Union action shall not exceed what is necessary to achieve the objectives of the Treaties”.

The principle of subsidiarity therefore aims at determining the level of intervention that is most relevant in the areas of competences shared between the EU and the EU countries. The relevance of an EU intervention should stem from the following criteria:

- Does the action have transnational aspects that cannot be resolved by EU countries?
- Would national action or an absence of action be contrary to the requirements of the Treaty?
- Does action at EU level have clear advantages?

The Inception Impact Assessment proposed by the Commission[39] reminds that the EU has a shared competence with Member States in the field of energy pursuant to Article 4(i) of the Treaty on the Functioning of the European Union (TFEU). In line with Article 194 of the TFEU, the EU is competent to establish measures to ensure the functioning of the energy market, ensure security of supply and promote energy efficiency.

Uncoordinated, fragmented national policies in the electricity sector may have direct negative effects on neighbouring Member States, and distort the internal market. EU action therefore has significant added value by ensuring a coherent approach in all Member States.

In the context of the changing environment for DSOs and the necessity of redefining their roles and responsibilities, EU action could be justified by the following levers:

- Spill-over to the wholesale power market (e.g. distributed generation and local storage)
- EU harmonised standards can facilitate the internal market (e.g. on data handling and data format)
- Renewable energy target at EU level warrants EU wide action
- Distribution grid issues may affect real economy internal market and discriminate consumers (e.g. tariffs applied asymmetrically in border regions)

In order to translate EU objectives into concrete initiatives, the main stepping-stones to address DSOs issues are especially the Electricity Directive, but also the Energy Efficiency Directive. In the table below, we outline where the different legislative pieces address issues relevant to the issues touched upon in this study, and where augmentation of existing provisions could take place. In the qualitative assessment in task 3, we will explore the different policy options alignment with subsidiarity and proportionality.

[39] *Inception Impact Assessment: Initiative to improve the electricity market design* http://ec.europa.eu/smart-regulation/roadmaps/docs/2016_ener_007_cwp_electricity_market_design_en.pdf

Table 14: Legislative stepping-stones

	Section 1	Section 2	Section 3
Electricity Directive	- Secure and reliable electricity distribution - Transparent, non-discriminatory operation - Energy efficiency and renewable may be prioritised	- non-discriminatory and cost-reflective distribution tariffs, taking account of the long-term, marginal, avoided network costs from distributed generation and demand-side management measures	- Need to clearly define data collection roles - Access to consumers' own data - Conditions for third party access
Energy Efficiency Directive	Encourage energy efficiency and demand side flexibility	- Encourage energy efficiency and demand side flexibility - Non-discriminatory, transparent, cost-reflective tariffs	- Access to consumers' own data - Ensuring compliance with data protection and privacy legislation
Renewable Energy Directive	Encourage renewable energy deployment	Article 16 – tariffs - Encourage renewable energy deployment, including through self-consumption systems - Non-discriminatory, transparent, cost-reflective tariffs	
Network Codes	Well-functioning cross-border electricity market transactions and system operation		
State aid guidelines for environmental protection and energy	Transparent, non-discriminatory operation		
General Data Protection Regulation (GDPR)			Data protection and privacy
Network and Information Security Directive (NIS)			Smooth functioning of digital internal market through increased online security
Recommendation on Data Protection Impact Assessment Template for Smart Grid and Smart Metering Systems (DPIA)			Data protection and privacy
MiFID 2.0			Principles for reasonable pricing of data in case of market power

Source: Copenhagen Economics and VVA Europe.

4. Task 2: Definition of policy options

In this section, we define a number of different policy options that could be considered to address the challenges raised in task 1.

4.1 Considering the policy options for section 1: DSO as an efficient grid operator

As addressed in Task 1 the current DSO regulation may not necessary ensure an efficient grid operation, therefore the following policy options have been proposed:

0	***Business as usual:*** *no change in EU legislation on tasks of DSOs; Member States are responsible for deciding on a number of non-core tasks as well as on remuneration*
1	• *Allow and incentivize DSOs to acquire flexibility services from distributed energy resources.* • *Establish specific conditions for DSOs to use flexibility, and ensure the neutrality of DSOs when interacting with the market or consumers.* • *Clarify the role of DSOs only in specific tasks such as data management, the ownership of local storage and electric vehicle charging infrastructure.* • *Establish mandatory cooperation between DSOs and TSOs on specific areas, alongside the creation of a single European DSO body.*
2	• *Allow DSOs to use flexibility but without any constraints or cooperation with TSOs.* • *Define specific tasks for all DSOs across EU and apply stricter unbundling rules.*

Policy option 0

Policy option 0 implies no change in the EU legislation such that Member States are still responsible for clarifying future roles of DSOs as well as remuneration.

The Electricity Directive (Art 25(7)) touches upon the issue by mandating that *"when planning the development of the distribution network, energy efficiency/demand-side management measures or distributed generation that might supplant the need to upgrade or replace electricity capacity shall be considered"*.

This gives a lever for considering both demand side and supply side management in grid planning decisions. Policy option 0 does not make this provision more concrete.

While this option preserves flexibility for Member States it also goes not further in addressing the challenges to the operation of the distribution grid.

Policy option 1

Policy option 1 involves a number of new legislative actions:

a) *Allow and incentivize DSOs to acquire flexibility services from distributed energy resources.*
b) *Establish specific conditions for DSOs to use flexibility, and ensure the neutrality of DSOs when interacting with the market or consumers.*
c) *Clarify the role of DSOs only in specific tasks such as data management, the ownership of local storage and electric vehicle charging infrastructure.*
d) *Establish mandatory cooperation between DSOs and TSOs on specific areas, alongside the creation of a single European DSO body.*

Item a) entails that DSOs should be allowed to acquire flexibility services directly from distributed energy resources, both demand resources and supply resources. Moreover, incentives for the DSOs should be aligned such that they will acquire these resources if it is cost efficient to do so. Aligning incentives should follow examination of national remuneration mechanisms for DSOs, which to a large extent reward traditional physical infrastructure investments over potentially more cost efficient solutions such as e.g. acquiring flexibility.

A possible way to incentivise DSOs to procure flexibility services is to establish EU guidelines for remuneration schemes. An element of this guideline would be to ensure that incentives are not skewed towards traditional network CAPEX investments over e.g. OPEX solutions. At the same time the guidelines should still recommend a reasonable return on investments. The optimal regulatory approach will depend on the characteristics of the DSO i.e. size, structure, achieved cost-efficiency, maturity of assets and network characteristics such as overhead/underground lines and distributed generation penetration.[40]

Item b) entails defining conditions for how DSOs can use the acquired flexibility, e.g. solely for grid operation or for other purposes.[41] Moreover, it entails defining conditions for how neutrality of DSOs can be ensured when interacting with market actors or consumers directly.[42] This is especially relevant where DSOs are not fully unbundled and therefore could use its position as a DSO to distort competition in the commercial market for e.g. energy supply or consumption aggregation.

Item c) entails a clarification of the role of DSOs in a number of specific tasks such as data management, the ownership of local storage and electric vehicle charging infrastructure. These tasks are characterised by having the potential to also be serviced by commercial entities such as energy suppliers or demand aggregators.

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[40] *CEER, (2015), The Future Role of DSOs – A CEER consultation paper*

[41] *How should the DSO handle acquired flexibility in the situation where it was acquired in advance to address an expected grid congestion issue, but congestion did not materialise.*

[42] *This concern was e.g. voiced by CEER in its Bridge to 2025 conclusion paper.*

Item d) entails that cooperation between DSOs and TSOs should be mandatory on specific areas. This is spurred by the potentially prevailing situation where DSO acquisition of flexibility for local grid issues may be out of sync with the wholesale power market's instruments for acquiring such flexibility. For instance, in a situation where the overall wholesale market prices are low thereby sending a signal to increase consumption to a distributed energy resource, but the local grid is in a situation where the DSO would need to scale down demand. Cooperation could e.g. be in the form of real time exchange of data, more coordinated planning and decision making, and greater transparency and communication with stakeholders.[43]

Policy option 2

Policy option 2 defines the following:

a) *Allow DSOs to use flexibility but without any constraints or cooperation with TSOs.*
b) *Define specific tasks for all DSOs across EU and apply stricter unbundling rules.*

Item a) entails more comprehensive possibilities for acquisition and use of flexibility services by the DSOs in order to ensure efficient grid operation. However, the risk of market distortions is likely to increase as DSOs actions will overlap more with commercial activities, also increasing the risk of discrimination against not-bundled energy suppliers.

Item b) entails a comprehensive definition of tasks and activities for which the DSO should be able to engage in. The item is similar to item c) in Policy option 1, however more comprehensive as it defines a larger set of tasks and activities. In addition, it entails stricter unbundling rules which can be seen as an alternative to Policy Option 1's definition of conditions for neutrality and use of flexibility. This item follows the logic that the more that DSOs are involved in non-core activities, the greater the need for regulatory control or unbundling.

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[43] *See e.g. CEER (2015), The Future Roles of DSOs – A CEER conclusion paper*

4.2 Considering the policy options for section 2: Distribution tariffs

The following policy options have been proposed to address that challenge related to distribution tariffs:

0	***Business as usual:*** *NRAs competences include full and exclusive powers for setting or approving distribution tariffs or methodologies in the framework of existing TEP and EED provisions.*
1	***Clarify the framework for NRAs*** *in terms of authorisation and calculation of distribution tariffs, impose obligations on more detailed transparency requirements, and introduce common EU performance indicators to be made publicly available. Introduce new requirements on DSO development plans.*
2	*In addition to option 1,* ***harmonize distribution tariff elements*** *regarding distributed energy resources and self-consumption in order to ensure that discrimination among grid users or distortion of competition does not happen.*
3	*Harmonization of distribution tariffs across EU:* ***fully harmonize distribution tariff methodologies*** *at EU level for all EU DSOs.*
4	***Introduce a time-element*** *in the distribution tariffs obliging Member States to differentiate tariffs according to time. Specific calibration up to Member States discretion*

Policy option 0

Option 0, business as usual: NRAs competences include full and exclusive powers for setting or approving distribution tariffs or methodologies in the framework of existing TEP and EED provisions.

The Energy Efficiency Directive (ANNEX XI) states that network tariffs shall be cost-reflective of cost savings in networks. Also, network tariffs shall not prevent:

(a) the shifting of the load from peak to off-peak times by final customers;
(b) energy savings from demand response of distributed consumers by energy aggregators;
(c) demand reduction from energy efficiency measures undertaken by energy service providers, including energy service companies;
(d) the connection and dispatch of generation sources at lower voltage levels;
(e) the connection of generation sources from closer location to the consumption; and
(f) the storage of energy.

Additionally, the Energy Efficiency Directive (ANNEX XI) Network or retail tariffs may support dynamic pricing for demand response measures by final customers, such as:
(a) time-of-use tariffs;
(b) critical peak pricing;

(c) real time pricing; and
(d) peak time rebates.

The Renewable Energy Directive (Article 16) states that 'Member States shall ensure that the charging of transmission and distribution tariffs does not discriminate against electricity from renewable energy sources, including in particular electricity from renewable energy sources produced in peripheral regions, such as island regions, and in regions of low population density.

Furthermore, Member States shall ensure that tariffs charged by transmission system operators and distribution system operators for the transmission and distribution of electricity from plants using renewable energy sources reflect realisable cost benefits resulting from the plant's connection to the network. Such cost benefits could arise from the direct use of the low-voltage grid.

While providing substantial guidance on tariff setting, current legislation leaves much room for interpretation and therefore variation between Member States. This runs the risk that different national approaches are not fully in line with non-discrimination and gives rise to cost reflective incentives.

In particular, Article 37(1) (a) of Directive 2009/72/EC and Article 41(1)(a) of Directive 2009/73/EC state that the NRA shall have the duty of "Fixing or approving, in accordance with transparent criteria, transmission or distribution tariffs or their methodologies".

In addition, Article 37(8) of Directive 2009/72/EU and Article 41(8) of Directive 2009/73/EC require NRAs to: "Ensure that transmission and distribution system operators are granted appropriate incentive, over both the short and long term, to increase efficiencies, foster market integration and security of supply and support the related research activities".

Policy option 1

Policy option 1 aims at making the distribution tariffs more transparent across the Member States and introducing common EU performance indicators to be made publicly available. Policy option 1 also suggests requirement for DSOs in providing development plans, which is a requirement for TSOs today.

Currently, distribution tariffs are typically not transparent either within or across the Member States. If tariffs are not transparent, they will neither be able to incentivise a cost reflective demand response.

A transparency requirement could be that the DSOs should provide basic information regarding the tariff structure components and average tariff level for residential and industrial consumers to be publically available on an EU-website.

Another element of transparency would be to introduce common EU performance indicators that tracks to what extent Member States are adopting best practice. Such indicators should live up the following:[44]

Relevant: answering a specific research question of interest

Measurable: the indicator should be measurable

Facilitate objective assessments: The calculation methodology used should eliminate ´background´ or other country-specific factors that are unrelated to the aspect being measured

Facilitate comparison: of different countries to allow benchmarking of performance evolution over time

Examples of performance indicators that potentially would fulfil these criteria are:

- Percentage of grid tariffs collected through capacity + fixed components
- Tariff levels for different consumer types (€c / kWh – net of taxes)
- Information on to what extend distributed energy resources pay use of system tariffs and to what extent they benefit the system
- Information on to what extend distribution tariffs are explicitly shown on the final consumer bill

Such information could be published as part of the DSO development plans. Today, only Germany, Poland, Portugal, Holland, Hungary and UK publish their network development plans.[45] (Mercados, 2015).

Policy option 2

Policy option 2 builds on top of policy option 1 and includes EU harmonisation of specific tariff elements for distributed energy resources and self-consumption.

Such harmonisation could be in terms of e.g. a standardised approach to exposing distributed energy resources to tariffs e.g. fully reflecting underlying costs and benefits to the grid.[46]

As illustrated in task 1, Member States have different approaches as to the tariffs associated with distributed energy resources, and that some approaches can lead to cross-subsidization between grid users and counteract the principles of cost-causality and economic efficiency. Harmonisation of a specific methodology could ensure that all Member

[44] *Mercados (2015), Study on Tariff Design for Distribution Systems*

[45] *Mercados (2015), Study on Tariff Design for Distribution Systems*

[46] *As recommended in the THINK report (2013) From Distribution Networks to Smart Distribution Systems: Rethinking the regulation of European Electricity DSOs*

States have the same, cost-reflective and non-discriminatory approach to the tariffs imposed on distributed energy resources.

Policy option 3

Policy option 3 implies a full harmonisation of distribution tariffs methodologies across Member States. While still allowing room for national regulators to set the tariff level, the methodology to determine the tariff structure should follow a harmonised approach.

A common framework could identify the specific structure of distribution tariffs. As discussed in section 3.4 the following elements could comprise the final tariff:

- A capacity element
- A time element
- Specific framework for dealing with large consumption units (such as electric vehicles and heat pumps)

Policy option 4

Policy option 4 implies that Member States are obliged to include a time dependent element in the tariffs. The main argument is to incentivise consumers to take into account the costs they impose on the grid and thereby reducing (and/or shifting) demand in periods of stress for the grid.

The specific implementation will be up to the Member States discretion, and could involve the following:

- Time of use tariffs
- Critical peak pricing (variation of time-of-use)
- Dynamic pricing

In the current legislation it is already possible to include a time-element in the distribution tariffs as the Energy Efficiency Directive (ANNEX XI) states that: Network or retail tariffs may support dynamic pricing for demand response measures by final customers, such as:
(a) time-of-use tariffs;
(b) critical peak pricing;
(c) real time pricing; and
(d) peak time rebates

In 17 countries a time-of-use distribution tariff is already applied, typically for non-residential consumers and with daily (night/day) or seasonal (winter/summer) structure.[47]

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[47] *Mercados (2015), Study on Tariff Design for Distribution Systems*

4.3 Considering the policy options for section 3: Data handling

In order to address that challenge related to data handling, the following policy options have been proposed:

1. ***Business as usual:*** *each Member State develops its own data handling model in line with rules in the TEP, the EED and upcoming data protection and security legislation*

2. ***Update and strengthen EU rules*** *for access to consumer data and related processes to guarantee transparency, objectivity, non-discrimination, and interoperability by any market actor currently responsible for handling data, including DSOs and data hubs.*

3. ***Mandatory data handling model:*** *A specific data handling model and responsible entity (-ies) in each Member State, with uniform processes and access rules to the data. EU rules for access and processes to guarantee transparency, objectivity, non-discrimination and interoperability.*

In the following section, we present and explain those options. Our findings from the desk research phase and the stakeholder interviews did only give rise to some minor refinements within option 1. The three options cover the relevant routes that EU-level legislation can take; they are well-developed and there is no need to refine them.

Policy Option 0

The first policy option reads as follows in the Terms of Reference:

Option 0, business as usual: each Member State develops its own data handling model in line with rules of the TEP, the EED and upcoming data protection and security legislation.

This policy option reflects the status quo, or business as usual option. It means that the EU does not intervene with further EU-level legislation regarding data handling. Consequently, the Member States would keep their current authority to define and develop their own data handling model, as long as it is in line with the relevant current legislation.

Policy Option 1

The second policy option reads as follows in the Terms of Reference:

Option 1, Update and strengthen EU rules for access to consumer data and related processes to guarantee transparency, objectivity, non-discrimination, and interoperability by any market actor currently responsible for handling data, including DSOs and data hubs.

This policy option foresees that the EU still intervenes to a higher level but more specific than today through strengthened EU rules, without introducing an obligatory data handling model for all Member States. Based on the challenges we identified during the assessment of the status quo, we find that there are 5 relevant areas that could be strengthened: non-discrimination, interoperability, DSO-access to technical data, transparency and cybersecurity. The EU would define the legal framework of data handling in more clear and detailed way, but within that framework, it will be Member States that will have to decide on the specific model and detailed data handling procedures taking into account the specificities of their retail markets.

Policy Option 2

The third policy option reads as follows in the Terms of Reference:

Option 2, Mandatory data handling model: A specific data handling model and responsible entity or entities (e.g. central data hub managed by a regulated body, open platform for transactions of data, etc.) in each Member State, with uniform processes and access rules to the data. EU rules for access and processes to guarantee transparency, objectivity, non-discrimination, and interoperability.

This option means that the implementation of one particular data handling model would be mandatory for all Member States, i.e. there would be a compulsory "one-fits-all" solution.

5. TASK 3: ANALYSIS OF IMPACTS OF POLICY SCENARIOS

Traditionally in impact assessments, a cost/benefit ratio is derived for each policy option making it comparable with the other policy options. In this study, this approach is challenged by both the fact that several of the policy options constitute different paths to achieve the same end-result, and that most costs and benefits are very difficult to quantify. An example is increased flexibility on the demand side, which can be achieved through both 1) a more active DSO approach to acquire flexibility resources and 2) a tariff structure incentivising demand response for grid purposes. Consequently, we have chosen to pursue the following strategy:

1. Make an overall model-based quantification of the effect of increased flexibility in the distribution grid on the need to invest in grid reinforcements. In this quantification, we assess the effect from increasing the flexibility of both demand and supply sources. We are, however, not able to estimate say how much of this increased flexibility will stem from e.g. changed tariff design or DSO remuneration schemes respectively.

2. Assess the specific impacts of particular policy options vis-à-vis the alternative options using primarily literature-based quantifications and qualitative analysis. This is the more traditional cost-benefits analysis-part of an Impact Assessment, which can be used to assess each policy option against each other.

The following sections 5.1-5.5 will explore a quantitative approach to estimating the benefits of more flexibility in the distribution system. Concretely, we estimate savings from avoided grid expansion due to more flexibility in the grid. In sections 5.6-5.8, we explore each policy option more qualitatively, supplementing with quantitative analyses where possible.

5.1 Cost drivers for distribution grid expansion and the role of EU policy options

Going forward, DSOs across the EU are expected to face an increased pressure on the capacity of distribution networks. The drivers of this pressure is largely 1) increased distributed generation and 2) growth in demand sources with high peak-load.

Larger distributed generation increases the need for grid investments because the grid needs to be able to accommodate both reverse flows from prosumers (e.g. rooftop solar panels) and increased generation capacity from typical generation facilities (e.g. onshore wind turbines).[48] The need for grid investments is directly related to the capacity of the generators. The more current that flows at a particular point in time, the higher the cost

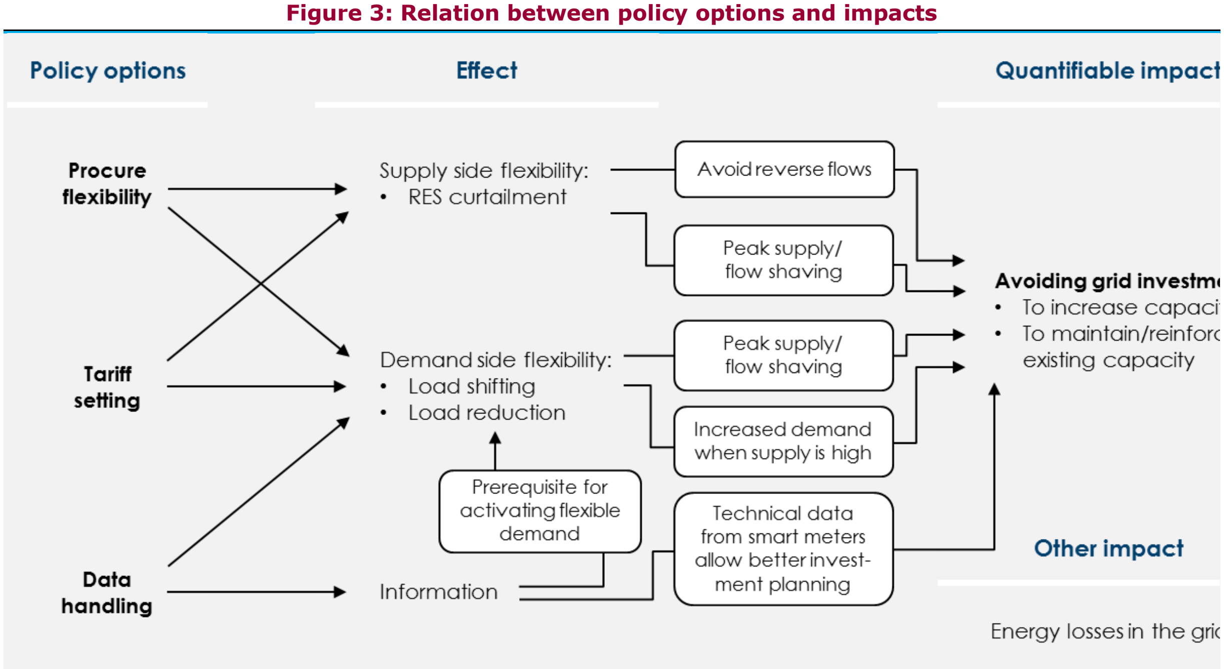
[48] *For small increases in some distributed energy resources leading to consumers becoming prosumers, grid costs can actually be reduced. This is primarily due to the reduced energy loss that occurs as power is transported in the grid.*

pressure on the existing infrastructure, both in terms of preventing bottlenecks and in terms of maintenance related costs. Consequently, if generation peaks can be reduced (curtailment), the need for grid investments will also be reduced, as grid expansions can be dimensioned for a lower peak and as physical pressure on the grid is reduced.

Demand growth especially in high-capacity installations such as heat pumps and electric vehicles will also increase the need for grid investments. The cost to the distribution grid is related to the capacity of the installations but the real cost drive is the charging pattern of the collective demand system locally. If the grid needs to be dimensioned to a situation where every electric vehicle and all heat pumps in a local distribution network simultaneously runs at full capacity, the capacity will be substantially higher than if it was dimensioned to an average situation. Consequently, by coordinating these resources in order to reduce the simultaneous peak-demand through flexibility measures (e.g. demand response), costs could be reduced as the grid dimensions could be planned for a lower peak demand. Moreover, maintenance costs would also be reduced as there will be less physical stress on the grid.

Increased generation and increased demand in isolation are likely to give rise to increased grid investments. The level of the grid investment costs depends on the degree of flexibility in the system. If demand and supply can act flexibly and in synergy with each other, some grid investment cost can be avoided. The policy options explored in this analysis is aimed at achieving these grid investment saving through different channels, cf. Figure 3.

Figure 3: Relation between policy options and impacts



Note: Storage solutions can fall into both supply and demand side flexibility
Source: Copenhagen Economics.

5.2 Additional grid reinforcement costs due to distributed generation and load growth

It is difficult to precisely estimate the costs to the distribution grid from increased distributed generation and load growth. Some attempts have been done by simulating models of distribution networks and different scenarios for RES penetration and load growth.[49] These models tend to suggest extra investments in the distribution grid due to absence of flexibility. Load growth is often estimated to be the driving factor rather than increased distributed generation.[50] To our knowledge, there has been only one attempt at modelling the extra grid investment costs at an EU level, based on the scenarios underlining the EU Energy Roadmap 2050 (see details in Box 1).[51] While we could not extract the full information from the report in terms of assumptions and interpretations of results, it offers a good base for our estimations. We therefore build on this analysis for estimating the related benefits.

Box 1: Modelling grid reinforcement costs going forward to 2030

DNV-GL energy have applied the Dynamic Distribution Investment Model (DDIM) developed by Imperial College London in order to estimate the cumulative DSO reinforcement cost until 2030 at the EU-level.

The model uses a set of typical networks called Generic Distribution Systems (GDS) which include information on population density, typical network design policies and standards in different Member States. It captures voltage levels, network topologies and load densities (rural, suburban, urban), distribution of DG, various load characteristics of different consumers (domestic, commercial, industrial) and specific devices such as heat pumps and EV's.

The model quantifies the cost related to distribution grid expansion from load growth from heat pumps and electric vehicles in combination with increased distributed generation. The need for DSO grid expansion strongly depends on the type and penetration of distributed generation and different measures can be taken to minimise this.

DNV-GL have analysed three main scenarios for the increase in RES-E; an optimistic scenario where RES increase to 68 per cent in 2050, a middle scenario with 59 per cent RES and a pessimistic scenario with only 51 per cent RES. These scenarios are based directly on the scenarios in the EU Energy Roadmap 2050 and are ambitious compared with the starting point of around10 per cent RES today (10 per cent of energy consumed is

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49 Tractebel (2015) "Identifying energy efficiency improvements and savings potential in energy networks, including the value of demand response", DNV-GL (2014) "Integration of renewable energy in Europe", Dansk Energi and Energinet.dk (2015) "Smart Energy – hoved rapport".

50 Dansk Energi and Energinet.dk (2015) estimate that grid reinforcement cost for the distribution grid in Denmark from load growth due to the expected increase in heat pumps and electrical vehicles will cost 460 million euros until 2035, Dansk Energi and Energinet.dk (2015) "Smart Energy – hoved rapport", page 10.

51 This analysis was carried out as a cooperation between DNV-GL Germany, Nera Economic Consulting and Imperial College London in 2014 for the EU-Commission where the aim was to quantify the cost related to the integration of RES going forward to 2030 based on the scenarios from the EU Energy Roadmap 2050. This analysis is one of the few that has focused on estimating the costs for the distribution network separately. The results of the analysis are published in the report "Integration of renewable energy in Europe".

produced by RES)[52]. The necessary assumptions regarding regional and technical developments were taken from the PRIMES[53] based simulations underlying the Energy Roadmap 2050. We focus on results from scenario 1 as there is very little information about the results and underlying assumptions for the other scenarios. Several sensitivity analyses are only carried out for scenario 1.

We would like to stress that the results should be interpreted with great caution as they are based on a model that tries to capture prototypes of distribution grids across the Member States and not detailed modelling of each DSO grid in all Member States. Another limitation is that the results are very depending on the assumptions of the increase in distributed generation and load growth going forward to 2030 and these types of forecast always are prone to uncertainty.

Additionally, it is assumed that generation profiles in general are stable across the years and extreme situations such as several years with an exceptional high wind generation have not been taking into account. Also, a different distribution of DG-RES in terms of size and connection level may lead to different infrastructure needs and costs than the one presented in the study. It is out of scope of this analysis to try and quantify the magnitude of these limitations.

Source: Copenhagen Economics based on DNV-GL (2014) "Integration of renewable energy in Europe".

In a scenario assuming significant load growth and distributed renewable energy growth, cf. Figure *4* the study finds that extra grid reinforcement costs[54] in the EU are likely to be €10.8 billion yearly towards 2030[55].

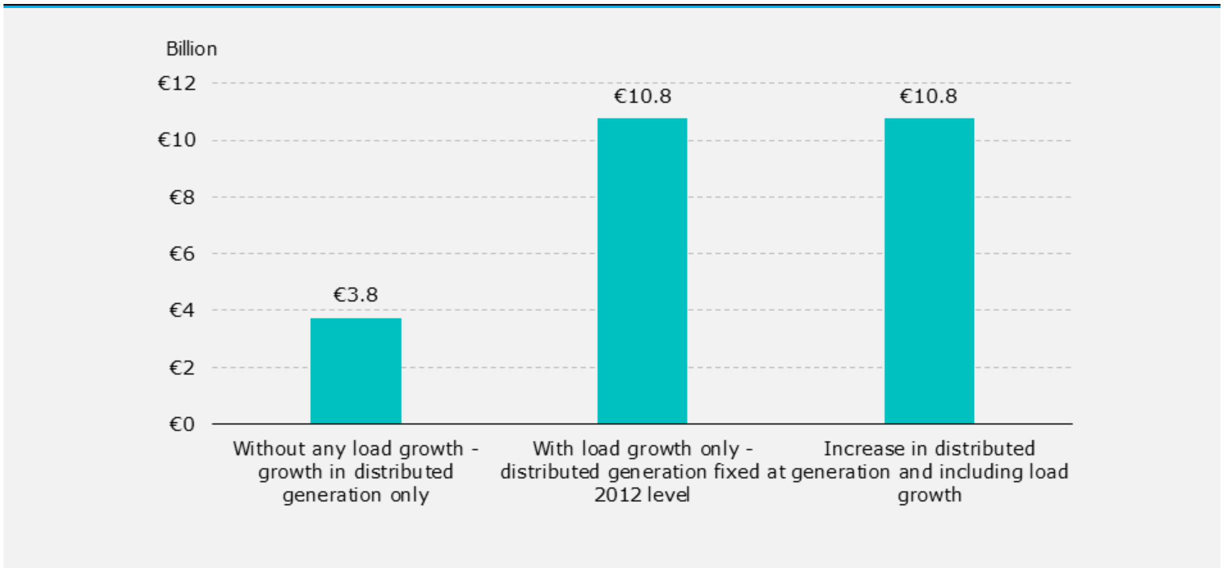
[52] *As stated in the EU Energy Roadmap 2050 Final Report on page 7.*

[53] *PRIMES is a partial-equilibrium model used by the EU-commission to gauge the system-level effects of possible proposed energy policies.*

[54] *The study estimates the additionally reinforcement cost for the distribution network in 2030 compared to the initial year 2010 (DNV-GL, 2014, 69). The accumulated costs of grid reinforcement are based on assumed cost/meter of new lines and cables required varying depending on the voltage level. Therefore, the cost of grid maintenance is not included.*

[55] *DNV-GL (2014) calculates the additional cumulative reinforcement cost in 2030 compared to the initial year 2010. The annual figure has then been found by assuming that the additional reinforcement would be uniformly distributed across the years 2010-2030. However, in reality reinforcement cost will differ from year to year due to timing of the reinforcements and also because there might not be a linear relation between an increase in RES and the need for reinforcements.*

Figure 4: DSOs annual extra reinforcement costs at the EU-level



Note: The simulation assumes that all load growth is inflexible.
Source: Copenhagen Economics based on DNV-GL (2014).

The simulations illustrate that the reinforcement costs are contingent on the concrete mix between load growth and distributed generation growth. In the high-RE scenario[56], EU with no growth in demand (no load growth), annual extra reinforcement costs are estimated to be €4 billion until 2030. In the reverse situation, with no extra distributed generation growth, but significant load growth, the annual extra reinforcement costs are significantly higher at €10.8 billion until 2030. This suggests that load growth is a more significant driver of grid reinforcement cost than distributed generation when looking across all EU distribution grids.

Given a high inflexible load growth, increased distributed generation only increases grid reinforcement cost slightly – or even not at all for EU as a whole. This is a surprising result, which hinges on the specific characteristics of the modelled distribution networks and on where load and distributed energy growth is injected. If increased distributed generation and increased load installations are located in close proximity (spatial dimension) they may interact to reduce the additional need for grid reinforcements further in the distribution network. Moreover, if demand and supply can respond to each other at a given time (time dimension), this cost may be even further reduced. In the following sections, we explore the effects of achieving flexibility in both supply and demand.

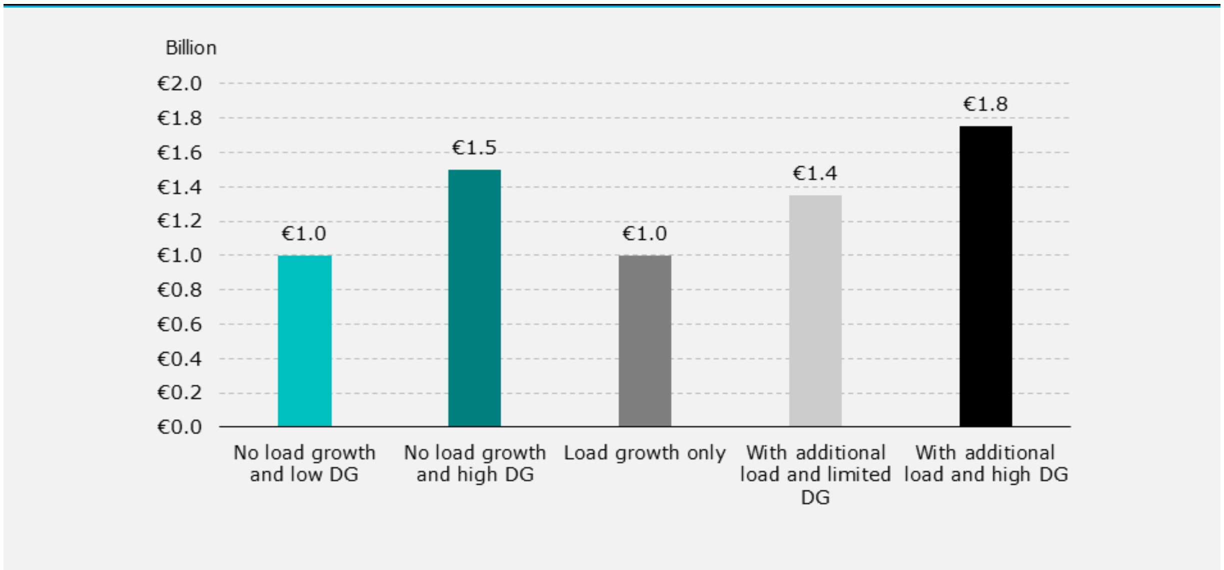
The study does not show if and how this result varies across Member States, with the exception of Germany. Germany is characterised by a relatively high growth in distributed generation and relatively low load growth[57]. Here, increased distributed energy alone will increase grid reinforcement cost by €1 billion yearly for low levels of distributed generation

[56] This scenario is based directly on the "high RES-E" scenario in the EU Energy Roadmap 2050.

[57] According to the authors, page 72. They do not show the underlying assumptions about load and distributed generation growth.

and up to €1.5 billion yearly for high distributed generation levels towards 2030, cf. Figure *5*. Additional load growth will increase this number by €300 million both when distributed generation growth is low and high respectively. This example suggests that the local characteristics of Member States' distribution networks – and of course the level of load growth and distributed energy growth – will affect the total cost of grid reinforcement.

Figure 5: Estimated DSOs annual extra reinforcement costs in Germany



Source: Copenhagen Economics based on DNV-GL (2014)

We have been able to locate few other studies estimating similar impact at national level. The DNV-GL study does not report country specific results, therefore it has not been possible for us to provide more concrete numbers at an individual Member State level.[58]

5.3 Quantifying the grid savings potential from increasing demand flexibility

The previous estimates of extra grid reinforcement costs were based on the assumption of an inflexible demand side. There are several reasons for why increased demand side flexibility can reduce the needed grid reinforcement costs, cf. Table 15.

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[58] *We have however, found a study in Denmark, suggesting that extra grid reinforcement costs is around 460 million euros, which is equivalent to 0,2 per cent of the total EU DSO grid reinforcement cost estimate from DNV-GL. These two estimates seem to be in the same ballpark taken into account that the Danish electricity generation makes up app. 1 per cent percent of the total generation in the EU-28. The Danish study uses relatively similar assumptions on load growth and distributed generation increase.*

Table 15: Benefits of demand response and cost reduction for potential grid costs

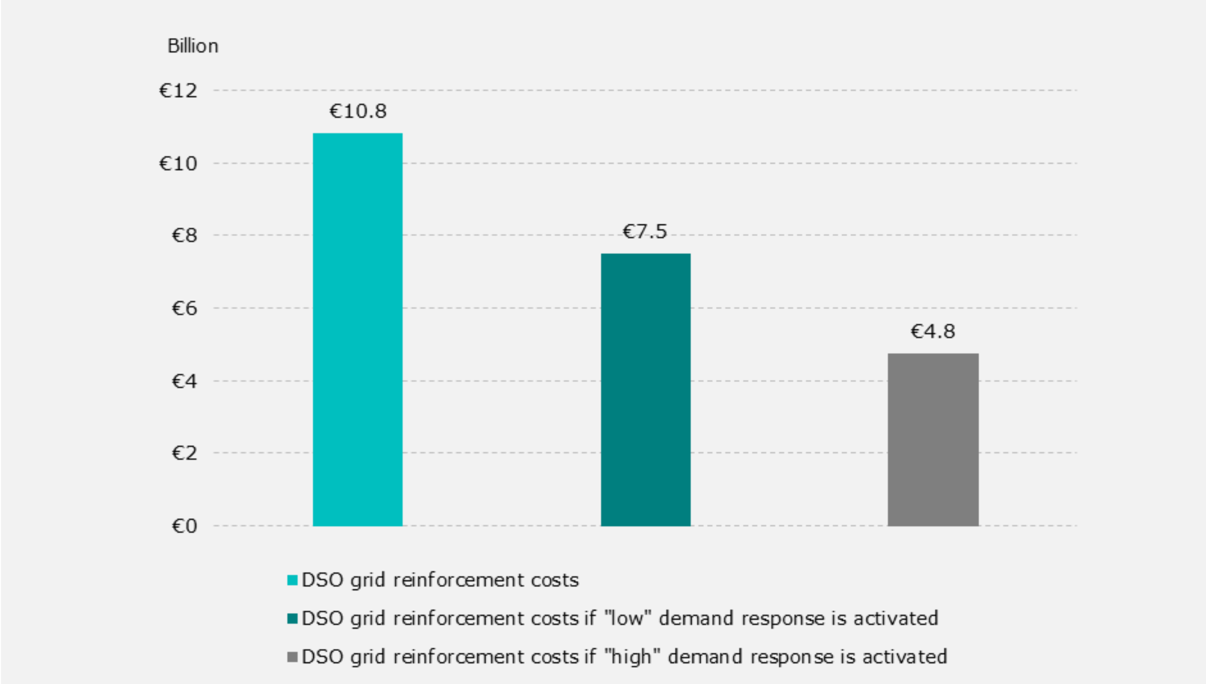
Effect	Mechanism	Cost reduction potential
Load reduction (peak load)	Temporary load reduction not substituted by later load increase – *for example industrial consumers reducing or stopping production process for a certain period and hereafter returning to the same consumption level as before*	Highest cost reduction potential
Load shift	Consumption is shifted to a later time leading to an increase in demand at that time	Highest cost reduction potential
Load increase	From shifted consumption due to activation of demand response	If load increase is done in response to an increased supply from distributed generation, it can prevent or reduce reverse flows.

Note: DNV-GL have not explicitly considered the ability to contribute to the provision of ancillary services in their analysis.
Source: Copenhagen Economics based on DNV-GL (2014)

In order to calculate the effect of demand side flexibility, the study simulated two different scenarios of demand side flexibility.[59] The simulations suggest that the annual EU grid reinforcement cost can be reduced substantially from €10.8 billion to €7.5 billion in the low demand response scenario and to €4.8 billion in the high demand response scenario, cf. Figure *6*. This represents reductions of 31 percent and 55 percent respectively compared to a situation where the demand side is not flexible.

[59] *In the high/ambitious scenario 15 percent of peak load can be shifted and 10 per cent of daily consumption is made flexible. In the low/less ambitious scenario 7.5 percent peak load can be shifted and 5 per cent of daily consumption is made flexible. Demand flexibility here does not include storage facilities. DNV-GL (2014) "Integration of renewables in Europe", page 136.*

Figure 6: Potential reduction of DSOs annual reinforcement costs at the EU-level from activation of demand response



Source: Copenhagen Economics based on DNV-GL (2014)

The net benefit of demand response depends on the activation cost as consumers would need a certain level of compensation for the inconvenience of changing their preferred demand pattern. It is very difficult to predict the activation cost of demand response, as this depends strongly on the specific use of the particular demand, and the availability of technological solutions. One study,[60] assessed different activation costs for demand response ranging from 1-150 euro/MWh. The study found that demand response brings net benefits even at the highest activation cost. High net benefits are particularly prevalent in urban areas due to higher penetration of distributed generation in the lower voltage grid.[61] These results are based on the assumption that smart meters are already implemented and that demand response has other benefits than reduced grid expansion costs.

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[60] *Tractebel (2015), Identifying energy efficiency improvements and savings potential in energy networks, including analysis of the value of demand response.*

[61] *Reverse power flows from increased distributed generation occurring in the lower voltage grid have the highest investment impact because they affect the whole distribution system.*

5.4 Quantifying the grid savings potential from increasing supply flexibility

With the increase of distributed generation, the need for grid reinforcements increases. Without flexibility of supply sources, the grid investments will be dimensioned to sustain maximum capacity utilisation. As the utilisation of wind energy is 'peaky', grid investments can be substantially reduced if they are dimensioned to only suit 'non-peak' periods.

While this effect was not modelled explicitly in the DNV-GL study (see section 5.3), we have looked towards the only available simulation to our knowledge: a concrete simulation for the German distribution network.[62] The study simulated that DSOs are allowed to cut off (curtail) distributed generation in times of peak supply. This is similar to DSOs engaging in flexibility contracts with distributed generators (e.g. through aggregators). Assuming that DSOs can sufficiently rely on the curtailment materialising, they can invest in a smaller capacity grid.

For the German distribution grid, it is found that by allowing curtailment of variable distributed generation sources by 3 per cent (of total infeed in Mwh), total grid reinforcement costs can be reduced by 44 per cent, cf. Figure *7*. These cost saving are realised both in the lower voltage grid (app 55 percent) and in the medium and high voltage grid (app. 30 percent). In this simulation, demand is not assumed to behave flexibly, and curtailment is thus the only source of flexibility. In a situation where there is both demand and supply flexibility, the grid cost reduction potential from curtailment alone will be lower (we go more in depth in section 5.5).

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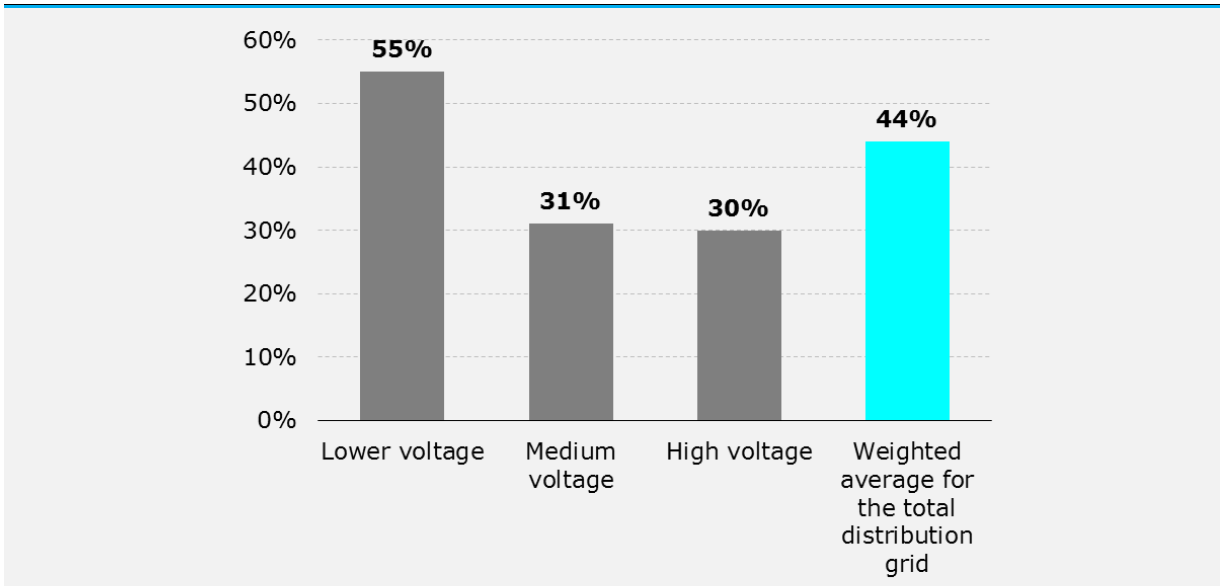
[62] *See BMWi (2014): "Moderne Verteilernetze für Deutschland" (Verteilernetzstudie). To our knowledge, no similar attempt has been made in other countries or at EU level.*

Figure 7: Savings potential through curtailment



Source: Copenhagen Economics based E-Bridge, IAEW and OFFIS for the BMWi (2014)

While this simulation is based on the German distribution network, the potential savings can be applied to EU networks in general.[63] Germany has a relatively high share of distributed generation compared to other countries,[64] which implies that the required grid reinforcement costs are also comparatively high in the absence of flexibility. Consequently, 44 percent of the excess investment in grid capacity can be avoided independently of whether the excess investments are high or low. A very simple stylised example: curtailing the supply from one on-shore wind farm will reduce the cable size from that facility. Curtailing a different on-shore wind farm will reduce that cable size by the same amount.

While this basic rule can be a good starting point, there will be differences across EU Member States. One important driver is whether renewable energy sources are wind or solar, and the local weather, which has implications on the characteristics of generation peaks. Curtailment will in general be more attractive when generation peaks are 'short and tall', which is typically the case with wind generation. Solar-driven peaks are more spread over a large time period, cf. Figure *8*. In the figure, the dotted line indicates a grid dimensioned to a lower peak generation (less costly expansion). In the wind-situation, significantly less curtailment is required in order to operate with a small grid size, while more generation needs to be curtailed in order to operate the same grid capacity in the case of solar. This implies, that curtailment is a relatively less attractive option in distribution grids where generation peaks are 'longer'.

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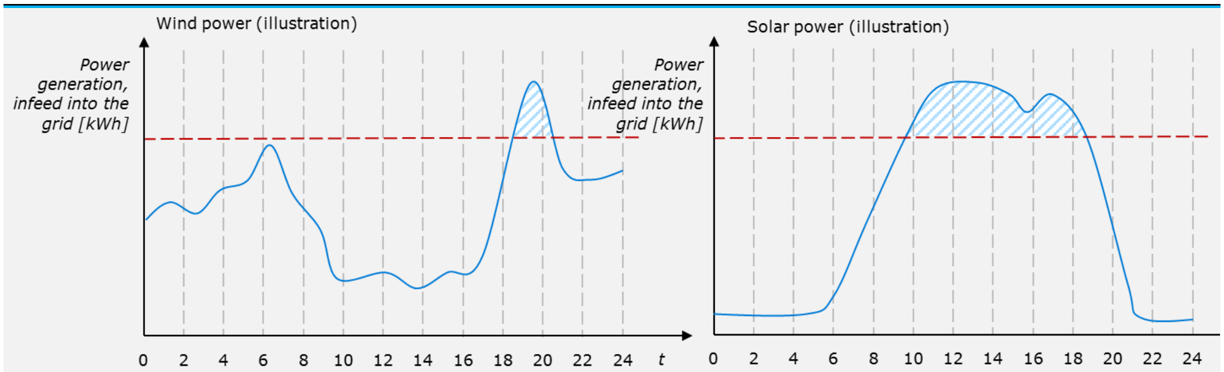
[63] *This conclusion is also based on conversations with the authors.*

[64] *See e.g. EvolvDSO (2016) deliverable 1.1*

Figure 8: Illustration of wind/solar peaks and the curtailment potential



Source: Copenhagen Economics based on DNV-GL (2014)

Indeed, 44 percent may be on the low side, as the savings in the low-voltage part of the German distribution system is even higher (55 percent). In most other EU countries, distribution grids are only low-voltage, and this part of the grid benefits the most from flexibility according to the study.

Box 2: Model simulation of potential effects of curtailment

Germany committed to the so-called Energiewende (energy transition), meaning the country aims at a structural change in power supply: within some decades, Germany wants to move from fossil and nuclear power sources towards renewables energies. The government's declared objective is to increase the share of renewable energies (at gross generation) from 23 per cent in 2012 to 80 per cent in 2050. That transition will mean that many more RES installations (windmills, solar panels, biomass plants) will have to be set up across the country, and this in turn has implications for the grid. Significant costs for expanding the grid are expected.

A study for BMWi (2014) investigates how the deployment of RES installations in Germany until 2032 in order to quantify the implications for the distribution grid, both the physical implications (additional cables in km, additional transformers etc) as well as the financial implications (costs for expanding the grid). In a second step, they calculate whether those costs can be reduced, i.e. through curtailment in network planning, the continued deployment of reactive power management, the introduction of load management or intelligent solutions like controllable grid transformers.

Compared to the reference year 2012, network lengths in 2032 will rise by 5 per cent, 14 per cent and 11 per cent on the low, medium and high voltage levels. A total of 130,000 km to 280,000 km (depending on scenario) of additional line kilometres must be constructed by 2032. Up to 70 per cent of the network expansion requirement accrues in the first ten years after 2012.

Renewable energy in Germany will increase from 60 GW in 2011 to minimum 128 GW by 2032 (the most conservative estimate) which is more than a double of the exiting capacity. This is expected to cost between 23-49 billion EUR Until 2032 in additional overall investment until 2032 depending on the exact scenario.

Curtailment in grid planning is a major source of preventing costs on new grid expansion caused by distributed renewable energy deployment. The study also investigates other methods that can facilitate a cost efficient integration of RES in the distribution grid such as reactive power management, load management, intelligent network technologies, congestion management and combinations of technologies. However, the study finds that for Germany, planned curtailment of renewables will have the most significant impact on avoiding grid reinforcement costs, cf. table 15.

Source: Copenhagen Economics based on BMWi (2014): Moderne Verteilernetze für Deutchland".

Table 16: Measures to reduce DSO grid expansions and associated costs based on the German case

Measure	Explanation	*Impact*	Quantitative effect
Curtailment of renewables	Down-regulation of feed-in levels from renewables for a few hours a year in load peaks	*Significant*	1% (3%) curtailment of the annual feed-in from renewables entails 30% (40%) less expansion requirement. Overall costs can be reduced by at least 15%.
Reactive power management	Provision of reactive power by decentralised power generation installations (further broadened in relation the thresholds specified for GER today)	*Marginal*	no quantifiable benefit
Load management	Influencing of loads for a few hours a year is permitted to compensate for renewables	*Marginal*	no quantifiable benefit
Intelligent network technologies	Deployment of controllable local grid transformers	*Significant*	Controllable local grid transformers reduce the network expansion requirement mainly on the low-voltage level and lead to a reduction in the average annual supplementary costs of just under 10%
Combination of measures	Combined curtailment and deployment of transformers	*Significant*	This optimal combination of innovative planning concepts and using intelligent technologies reduces the necessary investment by approx. 60% and the annual supplementary costs by up to 20%.

Source: Copenhagen Economics based on BMWi (2014): Moderne Verteilernetze für Deutchland".

5.5 Overall assessment of impact on grid reinforcement costs

It is clear, that in the absence of flexibility, EU DSOs will face significant costs of reinforcing the distribution grid as a response to the increasing amount of distributed generation and load growth from especially electric vehicles and heat pumps. Estimates suggest around €11 billion each year towards 2030 amounting to an accumulated total of app. €150 billion for the EU as a whole.[65]

It is equally clear, that by achieving flexibility from both the supply and demand side, the grid reinforcement costs can be significantly reduced as less copper is needed in the ground. Estimates suggest that demand flexibility alone can reduce investment costs by 30 - 55 percent depending on the degree of flexibility. Similarly, supply side flexibility alone can reduce investment cost by 44-55 per cent dependent on the relative size of low-voltage to medium/high-voltage grid (the highest savings percentage is achievable in the low-voltage grid).

By achieving both flexibility in supply and demand simultaneously, an even higher savings potential is possible. The exact level of saving will depend strongly on the local characteristics of the specific distribution grid in question. While some grid reinforcements can only be avoided either by curtailment or demand response, other grid reinforcements can be avoided by a combination of the measures.

As an example, consider a simplistic illustration of a distribution grid, cf. Figure 9. In reality, distribution grids are much more complex with more grid connections between a number of different generators, consumers and prosumers however it is possible to provide some basic understanding. Firstly, some grid connections will only be affected by curtailment, such as the cable connected to distributed generation (single orange line). Moreover, some grid connections will only be affected by demand response such as the cable connected to the flexible demand unit (single blue line). Secondly, there will be a number of grid connections where the dimensioning of the capacity can be affected by both curtailment and demand response. Consider e.g. the line between the variable generator and the flexible demand unit. The necessary capacity in this connection depends on a combination of supply flexibility, demand flexibility and the capacity of the interlinked connections.

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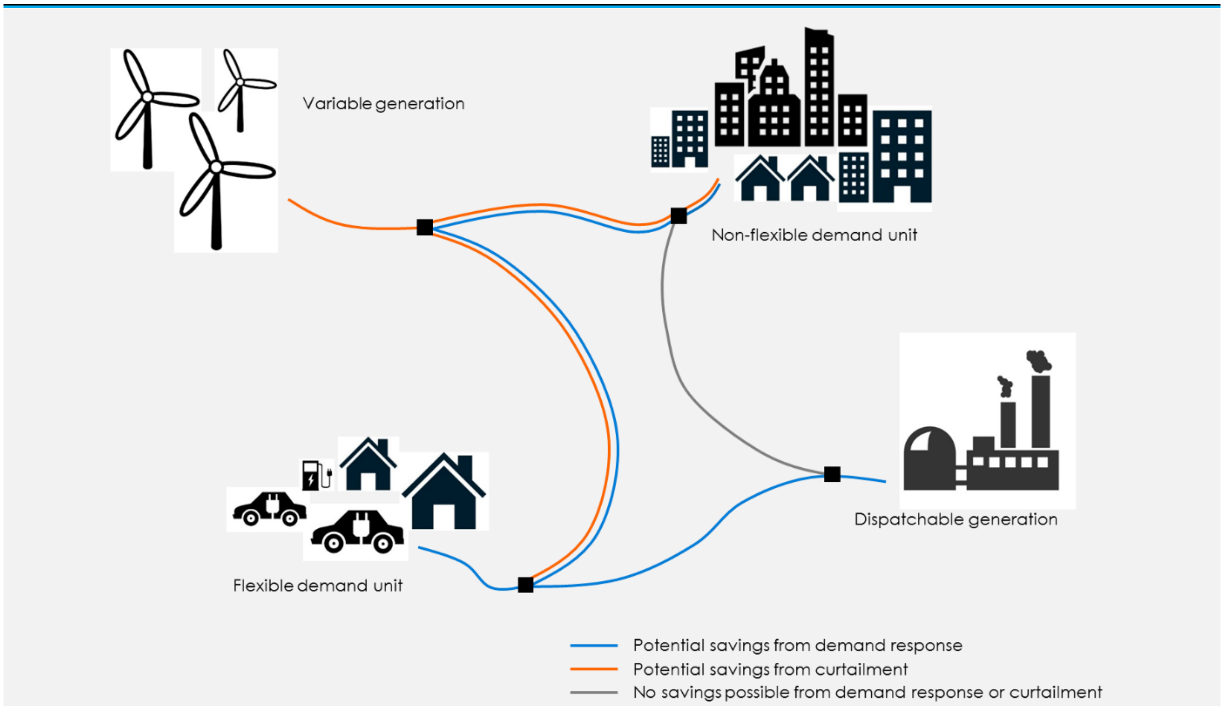
65 *DNV-GL (2014). The study calculates the additional cumulative reinforcement cost from 2010 to 2030 to be around €215 billion. The annual figure of 11 billion euros is the calculated by assuming that the additional reinforcement would be uniformly distributed across the years 2010-2030. However, in reality reinforcement cost will differ from year to year due to timing of the reinforcements and also because there might not be a linear relation between an increase in RES and the need for reinforcements.*

Figure 9: Simplistic illustration of the effect from flexible supply and demand on grid reinforcements



Source: Copenhagen Economics illustration

The effect on avoided grid investments is therefore likely to be higher than either demand flexibility alone (30-55 per cent) and supply flexibility alone (44-55 per cent), but not additive. If a particular part of the grid has already been 'downsized' due to curtailment, the same benefit will not also be accruable to demand response. In order to assess the combined effect, it would require a modelling simulation of both measures simultaneously, which to our knowledge has not been done. This is because the combined effect is strongly dependent on the exact location and scale of the particular installations, both on the demand and the supply side, and in particular how these sources are located with respect to each other.

By being very conservative and assuming that there are no additional benefits from pursuing a combination of flexible demand and supply as opposed to only one measure, we estimate that the total savings to the EU from avoided grid investments will be in the order of €3.5-5 billion in yearly investments towards 2030, cf. Table 17:. This corresponds to a total of app. €50-85 billion accumulated from 2016 to 2030. In reality, the potential is likely to be significantly higher, as a combination of supply and demand side flexibility will give rise to higher benefits than each measure in isolation.

Table 17: Avoided grid investments from flexibility

Extra grid investment from increased DG and load growth (€bn) yearly at EU level	11
Savings from demand flexibility alone (percent)	30-55
Savings from supply flexibility alone (percent)	44-55
Savings from combination of demand and supply flexibility (percent)	At least 30-44
Very conservative estimate of avoided extra grid investments from flexibility yearly at EU level (€bn)	**3,5-5**

Source: Copenhagen Economics based on DNV-GL (2014) and BMWi (2014)

The estimate on avoided grid investments was made for the EU as a whole. The value differs among Member States. Firstly, The Member States with the largest increase in distributed generation and demand growth will also have the highest value of increasing flexibility. Secondly, the relative attractiveness of supply side flexibility (curtailment) and demand side flexibility depends on the specific conditions:

- In Member States with higher penetration of distributed generation, supply side flexibility will be more relevant[66] e.g. wind farms in rural areas where load is limited and cable length is sizeable.
- In urban areas, where generation and load are more closely interlinked, the value of demand flexibility becomes more pronounced.

In addition to this benefit, there is also reduced energy losses in the distribution grid, if the distance of the power flows is reduced and/or the volume/capacity ratio for a given grid is reduced. The further power need to be transported, the higher the energy losses. The higher the capacity utilisation is (flow of power / capacity share) the higher the energy loss and the higher the maintenance costs to the grid. This has been explored in other studies, however without indicating quantifiable benefits.[67]

It has not been possible to assess how much of the benefit from avoided grid reinforcements can be reaped by the different policy options explored in this study. More detailed analysis should be undertaken in order to say how much flexibility can be harnessed by e.g. clarifying DSOs role in terms of ownership of e.g. storage across EU, and from harmonising tariff methodologies across Member States.

66 *Tractebel (2015) Identifying energy efficiency improvements and saving potential in energy networks, including analysis of the value of demand response*

67 *Tractebel (2015) Identifying energy efficiency improvements and saving potential in energy networks, including analysis of the value of demand response*

5.6 Qualitative evaluation of the specific policy options – cost efficient operation of DSOs

5.6.1 Policy option 0: Status quo

In light of the major changes the electricity system is undergoing, the status quo option is likely to be inadequate in ensuring cost efficient grid operation. In some Member States DSOs may not be allowed to operate efficiently, e.g. by engaging directly with the consumers to acquire flexibility and DSOs are not incentivised to do so through remuneration scheme either. The Third Energy Package does require DSOs to take into account distributed energy resources as well as conventional assets expansion when planning their networks. It is up to the individual Member States to ensure that this is carried out. While policy option 0: status quo preserves full flexibility for Member States, it is also likely to lead to rules and solutions of varying character, which risks distorting the internal market for energy.

The different Member State approaches allowing DSOs to acquire flexibility and defining if DSOs can own storage facilities, may lead to market distortions and discrimination:

- Unclear conditions for ensuring DSO neutrality may lead to engaging in competition with e.g. an aggregator at uneven terms or the favouritism of its bundled supplier when e.g. acquiring flexibility services.
- Different rules across Member States on DSO ownership of storage facilities could create trade barriers for entities interested in owning and operating storage in different Member States.

5.6.2 Evaluation of policy option 1

Policy option 1 addresses the key issues and risks of non cost-efficient grid operation. By allowing and incentivising DSOs to acquire flexibility services, the overall utilisation of flexibility in the system will increase, and the need to grid reinforcements will be reduced (cf. the quantification earlier in this section).

This policy option is likely to significantly reduce the risk of distorting competition compared to the status quo scenario. By defining common conditions for how DSOs can use flexibility and perform specific roles such as owning storage facilities, a level playing field of a certain standard is ensured across Member States, unlike the situation where Member States adopt different approaches to this issue. In order to be effective however, the conditions and roles should be specified as clearly as possible in order to allow for effective monitoring and compliance.

This policy option acknowledges that DSOs across the EU are not sufficiently unbundled, giving rise to a need for specific provisions to ensure the neutrality of the DSO when dealing directly with consumers and with potential competitors of its bundled supplier-arm.

The policy option entails clarification on the DSOs roles with respect to specific tasks:

1) Data management,
2) Ownership of local storage, and

3) Ownership of electric vehicle charging infrastructure.

A common feature-for these tasks is that they transcend the typical core DSO tasks. In particular, the ownership of storage and electric vehicle charging infrastructure are candidates for commercial entities as well.

Defining whether or not DSOs can own e.g. storage facilities is an important challenge. Arguments for DSO ownership typically revolves around its position to choose a size (there may be economics of scale) and location (location is important for dealing with local bottlenecks) optimal for the entire grid. Conversely, commercially owned facilities will respond to price signals and maybe choose sub-optimal locations and/or size.[68] One example is that customer-sited storage may even imply more grid investments such as reverse flow upgrades similar to that of rooftop solar PV. To a large extent, this will depend on whether commercial investors in storage will receive correct signals from the market. If a DSO could signal its specific need for flexibility in a particular part of the network, the market would respond to such a signal. If on the other hand the underlying fee structure is not incentivising efficient planning, it is likely to lead to inefficient decisions. The exact pricing of such flexibility needs is complicated as it is not likely that there will be a large and liquid market for such providers. In the provision of ancillary services at TSO level, this is often solved by procuring a more long-term service of a particular kind. The premise that DSOs would invest in optimal storage facilities is contingent on the quite strong assumption that it has the proper incentives to do so. This requires proper design of remuneration schemes. The discussion has parallels to the debate about liberalising the wholesale market, where power generation traditionally was owned by the network operator. The rationale for liberalising ownership was that under market-based price signals, commercial entities were better at choosing the optimal investment decisions unlike regulated entities which had a history of building too much generation capacity and at an excessive cost (gold plating).

By allowing DSOs to own storage facilities, this is likely to adversely affect market based competition and innovation. Beside from eroding the value of commercially owned storages, DSOs also have an advantage in terms of branding and customer access – particularly when not fully unbundled.[69] Consequently, the DSOs use of such facilities should be substantially regulated and monitored.

The benefits of having a common EU approach is likely to be significant. The degree of DSO involvement will determine the business conditions of commercial operators. A level playing field across Member States is likely to enhance business conditions and innovation in the market. If instead, there is uncertainty as to whether a DSO can establish its own storage facility – thereby eroding the commercial business case of e.g. an existing facility – this will create significant risk to investors.

The policy option entails closer information exchange and collaboration between the TSO and DSOs. This is increasingly important in order to exploit the full potential of flexibility services. When the TSO activates flexibility for system balancing purposes or transmission constraints management, and the flexibility resources are located in the DSO network, this

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[68] *See e.g. http://www.greentechmedia.com/articles/read/should-utilities-own-distributed-battery-storage*

[69] *See e.g. http://www.greentechmedia.com/articles/read/should-utilities-own-distributed-battery-storage*

may lead to undesired constraints in the DSO network. It is important to define a clear set of rules and cooperation mechanisms to address this issue.

The policy option is expected to imply administration cost at EU level in order to specify the specific conditions for the use and procurement of data management, ownership of local storage, EV infrastructure for the DSOs and will thereafter entail costs of monitoring compliance.

5.6.3 Evaluation of policy option 2

Policy option 2 entails more comprehensive possibilities for procurement and use of flexibility services while addressing the key issues and risk of engaging in “grey-areas” for non-bundled DSOs by applying stricter unbundling rules.

Both ACER and CEER have pointed out that when a DSO is carrying out activities identified as “grey areas“, it should be subject to strict unbundling requirements regardless of whether or not it is subject to the de-minimis rule. This policy option is addressing that point.

By enforcing the unbundling rules, the risk of distortions of competition will be reduced. Stricter unbundling rules could be implemented by lowering the threshold for number of customers from 100,000 to for example 50,000. Such unbundling would help to establish the neutrality of the DSO when new activities such as ownership of local storage, data management and EV’s charging infrastructure is undertaken. However, this unbundling should of course be seen in light of the substantial cost and resources that unbundling implies.

Unbundling has the potential of preventing conflicts of interest between regulated and competitive activities, which will be even more important in the future when DSOs will be facilitating new market and thereby undertaking activities that potentially could be supplied by a competitive market. Distribution unbundling is therefore a means to ensure fair retail competition by guaranteeing a non-discriminatory behaviour of the DSO and this objective must be kept in mind. Such benefits should of course be seen in light of the associated costs for small DSOs.

The more DSOs engage in flexibility services, the more robust separation is needed, especially if the DSOs also have a role in data management. When DSOs takes on new roles, sufficient controls are needed to ensure that DSOs do not use access to data to gain commercial advantage or create market distortions.

Policy option 2 is expected to have the highest administrative costs because unbundling of DSOs has historically shown to be a rigorous process with respect to time and resources.

5.7 Qualitative evaluation of the specific policy options – distribution tariffs

The purpose of tariff *structures* is to ensure non-discrimination between grid users such that they pay a ‘fair share’, and to incentivise cost reflective behaviour. The tariff structure should therefore be evaluated against to what degree it promotes cost reflectiveness, economic efficiency, non-discrimination, transparency, stability and is easy for consumers to understand.

5.7.1 Policy option 0: Status quo

The tariff structure in most Member States does not sufficiently achieve the economic purpose of network tariffs. The tariffs do not reflect the costs imposed on the grid from a particular type of behaviour, e.g. additional consumption during peak load. This implies that DSOs will have to incur costs in terms of grid reinforcements or more frequent maintenance, cost that could have been reduced through behavioural changes.

In several Member States different generation sources face different tariffs – typically because renewable energy sources are treated differently than conventional sources, which may be a breach of the non-discrimination principle. In a recent case from Denmark, tariff exemptions for distributed renewable energy were revoked, as it was considered discriminatory. These prosumers still utilised the grid in periods when their own generation was insufficient, and this cost will now be covered by the prosumer itself.[70]

Additionally, another issue with the distribution tariffs is the lack of transparency across the Member States. Consumers' knowledge of the true cost drivers of grid costs is a prerequisite for cost-efficient consumer behaviour. Transparency is the tool to provide this knowledge.

In case of no further EU action, it is up to the individual Member States to design the tariff structures. While this option preserves full flexibility for Member States, it could potentially lead to rules and solutions of varying character, which might not be sufficient in dealing with the issues of discrimination among grid users and lack of cost reflective use of the grid. Full flexibility for the Member States does imply that distribution tariffs can be specifically tailored to fit local needs.

5.7.2 Policy option 1

This policy option aims primarily to increase transparency on distribution grid tariffs through a number of measures:

1) Clarify the framework for NRAs to authorise and calculate tariffs
2) Impose obligations on more detailed transparency requirements
3) Introduce common EU performance indicators to be made publicly available
4) Introduce new requirements on DSO development plans

By increasing transparency of grid tariffs several benefits are likely to occur:

- Induce more cost reflective behaviour, due to the fact that consumers become better aware of the costs associated with their behaviour. The importance of cost reflective behaviour is likely to grow as tariffs become more reflective of underlying costs. As long as tariffs are primarily volumetric, this effect is likely to remain small

70 *Dansk Energi* http://www.danskenergi.dk/Aktuelt/Arkiv/2015/Maj/15_05_13B.aspx

- DSOs and NRAs will to a larger extent adopt cost-reflective and non-discriminatory tariffs, as they can be measured upon this.
- It is possible that increased transparency might also have spill-over effects to the internal market. The choice of location of an electricity intensive industrial consumer will to a large extent be influenced by its electricity costs, and transparent tariffs may increase the efficiency of such a decision. It is difficult to assess the magnitude of this, but it does not seem to be a large issue.

Increased transparency of distribution tariffs both within and between Member States would provide valuable information to the consumers regarding the true tariff cost drivers. When consumers are able to compare tariffs among Member States they would be able to challenge grid costs that seem unreasonably high compared to other Member States. For the comparison to be meaningful tariffs have to be calculated by using a methodology independent of country specific costs and also net of taxes etc. Given the differences Member States across and also different distribution localities, this seems like an almost impossible task.

Consumers' knowledge of the true grid cost drivers is a prerequisite for cost-efficient consumer behaviour. Transparency is the tool to provide this knowledge, implying that it also includes a transparent methodology used of calculating the tariffs and underlying cost set by the NRAs.

Transparency might also incentivise best practise behaviour. When NRAs and DSOs easily can compare tariff structures between Member States, this may stimulate a move towards best practice tariff setting.

Full transparency over tariff structures and levels in the EU would also potentially benefit the internal market. For instance, electricity intensive industrial consumers could take more informed decisions on where e.g. to place their production.

This policy option is likely to have medium administrative costs for both administrators (NRAs and the Commission) and the DSOs and therefore the consumers. Costs will primarily be related to meeting new information and transparency requirements e.g. in terms of performance indicators.

5.7.3 Policy option 2

This policy option goes beyond option 1 and includes harmonisation of tariffs for distributed energy resources and self-consumption across Member States.

The harmonisation could imply standardised approach to exposing distributed energy resources and self-consumption to tariffs that fully reflect underlying costs to the grid, taking into account all costs and potential benefits. Achieving this harmonisation would prevent distortions to competition and would send economic signals to renewable generators informing them of the actual costs (or benefits) they cause to the system.

This option reduces flexibility for Member States, as specific elements are harmonised at the EU level. This is also the benefit of the option, as non-discrimination and cost-reflective tariffs can be ensured more effectively. At the same time this policy option runs the risk that there is “no size fits all” with regards to tariffs structure for distributed energy resources.

If the harmonised approach entails that distributed generation faces full costs to the grid (no hidden subsidies) this will imply that renewable energy sources might need a higher level of support through ‘regular support sources’ in order to achieve deployment ambitions. This support structure is preferred in order to incentivise deployment that is cost efficient, e.g. also including cost to the grid (RE deployment that gives rise to high grid costs will be relatively less attractive compared to RE deployment that gives rise to fewer grid costs).

Tariff components for distributed energy resources differs among the Member States. In several Member States, distributed energy resources are directly subsidised or indirectly by exemption from use of system charges.

A potential risk of this policy option is that Member States cannot fully design distribution tariff tailored to local needs, as they would be bound the principles in the EU tariff framework. Another issue with harmonisation is that a “one-size fit all” framework for distribution tariffs might not exists and this would give rise to some inefficiencies. A harmonised framework also risks being less innovative because you cannot try out different models across the EU and learn from the best examples along the way.

5.7.4 Policy option 3

Policy option 3 includes a full harmonisation of the tariff structures across the EU which will align tariffs with best practice, if best practice can be determined. The option depends upon to what extent a best practice for distribution tariffs is truly universal across the Member States or dependent on local circumstances. One methodology may work well in one specific local area but cannot easily be adapted to fit other locations with different characteristics.

This policy option is associated with the lowest risk of discrimination because the EU potentially could impose a tariff framework specifically targeted at securing non-discrimination.

This harmonisation could take many forms. The aim should be to develop a common framework that fully addresses the future challenges for distribution tariffs and at the same time is flexible enough for the Member States to adjust for local conditions. A common framework for distribution tariffs could consider the following elements:

1) Capacity based tariffs
2) Introduction of time element
3) Cost reflective tariffs for different system users (e.g. distributed energy resources, prosumers etc.)

Including a mandatory capacity element in the distribution tariffs could help to achieve cost recovery as an increasing amount of distributed energy resources is injected in the grid. However, capacity tariffs do not encourage energy efficiency because the capacity tariff is unchanged even if consumers lower their consumption. This is one of the drawbacks of capacity tariffs. However, distribution tariffs are only part of the final bill consumers receive for electricity use. The consumer bill includes payments for electricity used, taxes and network charges. Therefore, consumers still have an incentive to save energy even in the case distribution tariff are 100 per cent capacity based.

Energy efficiency needs to be seen in a broader perspective. Higher electricity consumption does not necessarily mean inefficiency. It could very well be the case that electricity is preferred over less-efficient and more carbon-incentive energy. Many electric appliances are more efficient than those using other types of fuel.[71]

Introducing a mandatory time element in the distribution tariffs across all Member States would aim at incentivising demand response and it would be up to the individual Member States to decide on the detailed implementation of time in the distribution tariffs.

Harmonisation of the distribution tariffs would also imply a common framework for the treatment of distributed energy resources and self-consumption in the tariff scheme. Based on a suitable assessment, the aim would be to establish distribution tariffs where distributed energy resources and self-consumption is neither subsidised nor discriminated against.

This policy option is viewed as the most beneficial as it would ensure that distribution tariffs moves most towards best practice in all Member States. However, it depends upon to what extent a best practice for distribution tariffs is truly universal across the Member States or dependent on local circumstances. The policy option also has low risk of discrimination because non-discrimination principles would be enforced. This policy option also has a high risk mitigation potential as potential risk would be eliminated by introducing a best practice framework and still allowing the Member States sufficient flexibility to implement the framework in a way that addresses local needs.

5.7.5 Policy option 4

This policy option can be viewed as a lighter version of option 3 where it is only the time-element that is harmonised. It entails that Member States must differentiate tariffs according to time of use.

The specific implementation will be up to the Member States discretion, and could involve the following:

- Time of use tariffs (ToU)
- Critical peak pricing (variation of time-of-use)
- Dynamic pricing

Time of use tariffs are already prevalent in several Member States typically by different day/night tariffs or seasonal tariff rates. They could also be more detailed e.g. vary according to specific hours of the day. The different tariff rates are set well in advance and the higher rate is intended to coincide with pressure on the grid. ToU tariffs aims at incentivising peak shaving and congestion mitigation. As ToU tariffs can unintendedly create new peaks when consumers increase their demand as soon as the lower rate applies, it is important to properly design the steps of the ToU.

[71] *Mercados (2015), Study on Tariff Design for Distribution Systems*

Critical peak pricing tries to solve the issue of new peaks by applying high distribution charges when there is expected congestion issues. The difference between ToU tariffs and critical peak pricing is that the higher prices during critical hours is set closer to real time by notifying the consumers typically 1-2 days in advance. The critical period can last several hours. If the scarcity conditions happen to be a structural feature of a distribution system, charging structures set in advance of real time are less effective than dynamic pricing schemes.

Dynamic pricing implies a tariff that can change in real time as response to a sudden stress to the system in terms of a supply outage. This type of pricing will to a large extent be able to induce cost efficient use of the grid, but requires significant smart meter roll out and also smart consumption devices capable of responding to real time price signals.

This policy option does not by itself address the problem of discrimination among grid users. However, it could be complementary to other options.

This policy option is associated with low-to-medium administration cost. As such it would be relatively easy to implement and enforce the option, but is contingent on a sufficiently transparent system to allow monitoring.

5.8 Qualitative evaluation of the specific policy options – data handling

5.8.1 Policy option 0: Status quo

Choosing this policy option would mean no further action on EU level; national approaches towards data handling could then develop without EU legislative guidance. As already witnessed, this will mean a range of different data handling models as well as different choices within the models (see also task 1). For the most part, diversity in approaches is, according to our assessment, not problematic per se. There is a number of key choices that have to be made to prevent market inefficiencies and distortions. Those key choices relate to non-discrimination, interoperability, DSO-access to technical data, transparency and cybersecurity.

Worth noting is that in the baseline there is a risk of discrimination, as unbundled suppliers might be disadvantaged compared to suppliers bundled to a DSO. In situations where DSOs are collecting the relevant data and distributing it to energy suppliers, the DSO could essentially discriminate against unbundled suppliers by being less timely and adequate in its distribution of information (as explained in the status quo section of task 1). The DSO could potentially provide an advantage to its bundled supplier by offering better grid services (e.g. maintenance or repair) in areas dominated by the bundled energy supplier. In both cases, the bundled supplier would have an advantage compared to the unbundled supplier.

Besides non-discrimination, there might be potential for improvement in the baseline regarding the other key choices (interoperability, DSO-access to technical data, transparency and cybersecurity). With no further EU involvement, it is likely that at least some Member States take inferior decisions, or continue to follow the inferior choices they made already. However, the overall consequences for the market will be less severe than for non-discrimination.

5.8.2 Policy option 1: Update and strengthen EU rules

Policy option 1 is to update and strengthen EU rules. Based on our assessment, there are a number of key areas, which could be candidates for strengthening, such as: non-discrimination, interoperability, DSO-access to technical data, transparency and cybersecurity. Each of those policy option elements will be assessed individually.

a) Non-discrimination

The objective of strengthening EU rules on non-discrimination would be to create a level playing field for all commercial market players, especially with the aim of ensuring non-discrimination against unbundled suppliers compared to bundled suppliers. In many of the prevailing data handling models in Member States, ensuring non-discrimination has been an important part of the design. An example is the centralised data hub model, where all suppliers extract data from the hub instead of directly from DSO. This reduces the possibilities for bundled DSOs to discriminate. However, this does not need be the case in all data handling models (e.g. the 'DSO as a facilitator model'), and strengthened EU rules on this topic may prove effective in ensuring the objective.

The main benefit from this policy would be improved competition in the market for energy supply, which is an important part of EU retail energy objectives. This is particularly important in the absence of full unbundling.

A drawback of such policy is that is can be difficult to monitor and enforce in some data handling models, e.g. the DSO as a facilitator. This would require monitoring systems between DSOs and energy suppliers documenting timeliness and comprehension of the data streams, which may be both costly and administratively difficult to implement. In a model such as the data hub, it will be less difficult to administer as it only requires one monitoring system within the data hub linked to the existing data flows.

b) Interoperability

A main benefit of ensuring interoperability between different data systems is easy access to new markets for commercial actors such as energy suppliers or aggregators. Ensuring e.g. similar data formats for consumption data reduces entry barriers for commercial actors seeking to establish in other Member States. This could enhance competition in the supplier and aggregator market. Potentially increasing the overall business case of aggregators, interoperability could contribute to a more flexible demand side. However, the positive effects on aggregators would probably be minor. For the British aggregator Kiwi Power, different data formats and data handling systems are an inconvenience when entering a new market, but not a problem.[72] Much more important to them is that consumption data is available at high granularity, and that there is a market (i.e. overall interest and demand) for their business.

Ensuring interoperability would imply agreeing to an international standard, which would induce costs: both administrative costs related to defining and concurring on the new format, but especially to data administrators (DSOs or data hubs) who will have to adapt their system to a new common format. Such costs are likely to be significant, as a vast

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72 *Interview with Mitchell Curtis, Kiwi Power*

share of existing data handling systems and the involved entities would have to adjust to the new standards (suppliers, DSOs, 3rd parties, data administrators).

c) DSO-access to technical data

Smart meters also convey 'technical information' about the grid such as over and under voltage. An objective would be to make sure that DSOs have timely and comprehensive access to this data in order to maintain and operate the grid efficiently. So far, EU-level legislation does not specifically address technical data. However, the access to technical data would enable DSOs to fulfil their core task of planning and operating its grid in a cost efficient manner. In many Member States, DSOs have – or are expecting to get – timely and comprehensive access to technical data, but this is not given. Some data handling models have the feature that smart meter data can be routed around DSOs, consequently introducing at least a time lag in access to technical data. While it has not been possible to quantify the benefit to DSOs of getting timely and comprehensive access to this technical data, DSO stakeholders have expressed that this is of high value in terms of more focused and cost efficient grid reinforcements.

While there are no – or very limited – obvious costs to strengthening this rule, it may face a trade-off with strict privacy considerations and non-discrimination. One reason to re-route data away from the DSO in the first place is to ensure full privacy of consumers and non-discrimination of unbundled suppliers. This trade-off will mainly be a part of some data handling models, where e.g. a data hub model can overcome at least the discrimination issue and to some extent the privacy issue.

d) Transparency

The objective of strengthening and updating EU rules on transparency would be to make the consumers' rights to access to the own data more clear and the consumption data itself more transparent and understandable. The benefits of increased transparency include the consumers' increased awareness of their energy consumption, which would make them more active participants in the market, proactively seeking to optimise and reduce their consumption.

There is no need to further strengthen consumer access itself on EU level, since several provisions exist already (Electricity Directive, Annex I(1)(h), Energy Efficiency Directive, Article 9(2)(d) and 10(2), (3)(a)). Those rules cover consumer access sufficiently. One of the provisions, namely Article 9(2)(d) on Metering in the Energy Efficiency Directive also touches upon transparency, stating that *"if final customers request it, metering data on their electricity input and off-take is made available to them […] in an easily understandable format that they can use to compare deals on a like-for-like basis"*. Further rules, e.g. on related processes, could support this existing provision and help to step up transparency. However, voluntary national initiatives could also be sufficient; there is no strong indication that action has to be taken on EU level.

The benefits of more aware consumers are twofold. Firstly, substantial energy savings could be achieved. Studies suggest that creating better awareness of one's own energy consumption is a main driver of energy efficiency. Experiments conducted in Washington State, USA, in 2008 for instance showed that sending well-designed energy bills can nudge consumers towards considerable energy savings. Instead of the quarterly, classic energy bills, well-conceptualised bills were sent every month, visualising the household's energy consumption in comparison to other households. This form of feedback leads to energy savings of 1.2 per cent, and 99 per cent of the 84,000 participating households preferred the new, transparent and illustrative billing system over the prior one.[73] Combined direct feedback, for example on real time consumption and energy prices, energy savings will be more substantial: evidence from Ireland and England shows that energy savings can reach 2.5 per cent, and 8.8 per cent in peak hours.[74]

Secondly, a positive effect on the energy market can be expected. Active and well-aware consumers are more likely to make informed decisions; for example regarding their energy supplier. More consumers might switch their supplier, which will foster competition among energy suppliers. Active consumers might also consider 3rd party services such as apps to reduce or optimise their energy consumption, which would amplify the market for 3rd party activities. Initiatives like the *Green Button* initiative started in the US in 2012 could simplify the interaction between consumers and third parties, and therewith further increase the market potential of 3rd party services. The Green Button Initiative means that consumers can give 3rd parties access to their consumption data with one click (on a green button online); the 3rd parties then automatically receive a standardised data-package for that consumer. The initiative positively affected the overall business case of third parties. [75]

The disadvantage of strengthening rules on transparency are the – however limited – induced administrative costs which will incur to the entity responsible for making the data accessible to the consumer.

e) Cybersecurity

The objective of strengthening rules on cybersecurity would be to ensure that the data handling system is safe and secure against cyberattacks. The European Parliament and Commission have already agreed on a directive with the same objectives in December 2015, namely on the Network and Information Security (NIS) Directive. The provisions in the NIS directive aim at improving cybersecurity capabilities in Member States as well as improving the Member States' cooperation on cybersecurity. To our assessment, the NIS is comprehensive in its scope to also sufficiently guide data handling in the electricity sector. It is consequently unlikely that additional EU electricity-specific will improve the situation. One could choose an alternative approach, for example by defining very tangible, standard-like rules for cybersecurity instead of overall guidelines like in the NIS directive. However, as both the threats and the defence systems in cyberspace change and develop rapidly, such rules would be outdated soon and no longer contribute to achieving the objective. Additional rules on cybersecurity are consequently likely to not be sufficiently effective, and

[73] *Copenhagen Economics (2013) based on Energy Saving Trust (2009): The smart way to display A summary report on consumer preferences for energy display designs; Raseman, S. (2009): Evidence from Two Large Field Experiments that Peer Comparison Feedback Can Reduce Residential Energy Usage.*

[74] *Copenhagen Economics (2013) based on Intelligent Energy Europe (2012): European Smart Metering Landscape Report 2012; Ofgem (2011): Energy Demand Research Project: Final Analysis (study conducted by AECOM for Ofgem).*

[75] *Innovation, Electricity, Efficiency - The Edison Foundation (2012): Green Button: One Year Later.*

if formulated generally to not be outdated soon, monitoring compliance will be challenging.[76]

5.8.3 Policy option 2: Mandatory data handling model

Policy option 2 is to introduce a mandatory data handling model in all Member States. The objectives are the same overall objectives as identified above, namely non-discrimination, interoperability, DSO-access to technical data, transparency and cybersecurity. Introducing a mandatory data handling model would be the most effective way of meeting the objectives. Interoperability will be ensured by design, as all Member States would use the same approach model and format. Non-discrimination against unbundled suppliers could be achieved effectively e.g. by choosing a central data hub, thereby removing the direct DSO-supplier data flow. In order to also effectively deliver on transparency, DSO-access to technical data and cybersecurity, the mandatory model should be designed in such a way. By stipulating a common model design, monitoring and enforcement become simpler and less costly.

The main disadvantage of policy option 2 is its high administrative costs. Determining a mandatory data handling model will imply administrative costs of defining and designing such a model, and more importantly large costs of scrapping an existing data model and rebuilding a new, both in terms of personnel costs and IT infrastructure. Designing and building a new data handling model is a complex procedure and may well take several years of planning and implementation. In Denmark, the central data hub took more than 4 years to design and develop in its simple form, and 7 years in its enhanced form, and is estimated to cost app. €165 million, where app. €65 million accrued to the data hub administer (the TSO), and app. €100 million accrued to DSOs and energy suppliers.[77] Redesigning already implemented data handling models across the EU are therefore likely to be substantial.

The large costs associated with policy option 2 is a significant drawback, questioning the overall attractiveness of the option, despite its effectiveness in achieving interoperability and non-discrimination.

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[76] *Interview with Olivier Chatillon, Florian Gonzalez and Jean Francois Montagne from the French DSO ERDF, data handling experts for France, as well as with Franz Fischer, Energie AG Oberösterreich Customer Services GmbH and Head of ARGE EDA, data handling expert for Austria.*

[77] *Danish Government (2016), [EFK alm. del – svar på spm. 101-104,]. The costs to DSOs and energy suppliers also include a limited share of costs not directly associated with the hub but with related regulatory changes.*

6. TASK 4: COMPARING THE OPTIONS

The comparison of alternative policy options identifies the policy that in the short or long run will reach the intended objectives, such as: increased efficiency in distribution tariffs, flexibility in distribution networks, enhanced cost-effectiveness and value-added services through data handling.

We perform a scorecard analysis according to the results in task 3, by looking at effectiveness, efficiency and cost issues. The scan serves as a picture of the extent to which the options under consideration comply with the principles of subsidiary and proportionality, while providing an assessment of whether some possible interventions have unacceptably high/low impacts for certain effects.

6.1 Explanation of the scoring methodology

In the following tables, we present the expected impact of the policy options based on the objectives in a matrix form to allow for easy comparison (policy options versus impacts). In this multi-criteria analysis, the "business as usual" scenario is used as the reference scenario.

Sign	Level of impact	Sign	Type of action
(0)	**No significant impact**	**(0)**	**No significant impact**
+	**Light positive impact**	**-**	**Light negative impact**
++	**Medium positive impact**	**- -**	**Medium negative impact**
+++	**Large positive impact**	**- - -**	**Large negative impact**

Our assessment is based on the following principles/objectives:

- Effectiveness: How effective is the policy option in reaching the objectives?
- Governance/compliance: - What is the level of public intervention?
- Risk of discrimination/distortions to competition: Is the policy option likely to reduce discrimination or distort competition?
- Costs: Administration costs, enforcement cost etc.
- Distribution of cost: Are costs unevenly distributed on some actors, e.g. small household consumers or SMVs?

From the point of view of governance and level of intervention:

- no impact means no further EU involvement;
- light impact translates into the provision of guidance, best practice, expert meetings with Member States;
- medium impact entails the development of standard or practices or guides at EU level (binding or non-binding);

- large impact translates into the enforcement of new rules, with compliance monitoring.

6.2 Section 1: Cost efficient grid operation

Table 18: Summary of policy options for cost efficient grid operation

	Policy options (down) to be evaluated on core indicators (right)	**Effectiveness** regarding defined objectives	**Governance / Compliance** (how easily can the option be enforced?)	**Risk of discrimination** (distortions to competition)	**Risk mitigation potential**	**Costs (net)** (admin., compliance /enforcement cost etc.)	**Distribution of costs:** public or private – if private, who? (Consumers / Producers / DSOs / data handling entity)
0	Status quo	+	(0)	---	+	(0)	DSO
1	Allow and incentivise DSOs to procure flexibility services from DER and establish mandatory cooperation between DSOs and TSOs	++	+++	-	++	--	DSO
2	Allow and incentivise DSOs to procure flexibility services from DER but without any constraints or cooperation between DSOs and TSOs	+++	+++	--	+	-	DSO

Policy option 1 is considered to be the most effective in terms of incentivising DSOs to acquire flexibility services and at the same time reducing the risk of distortions to competition compared both to the status quo scenario and policy option 2.

Policy option 1 would entail the development of rules and guidance at EU level, with the involvement of the Commission and ACER at European level, and of the NRA and DSOs at national level. In terms of subsidiarity, public intervention at EU level in terms of coordination, roles setting and monitoring would create a level playing field and favour the creation of a European DSO body (similar to ENTSO-E). However, policy option 1 is expected to be costlier to implement because of all the rules that have to be defined for DSOs engaging in data handling, electric vehicles charging infrastructure and ownership of local storage facilities, as well as for the new monitoring requirements at EU and national level, compared to policy option 2. The status quo scenario does not incur any net costs because there is no policy change.

The advantage of status quo is that the Member States have full flexibility to design the regulation of the DSOs within the framework of the third energy package. No further public intervention or monitoring procedures would be required. In reality this means that some - NRAs might be able to design local regulatory approaches that are better at incentivising DSOs to procure flexibility services than the EU harmonised approach implied by policy option 1 and 2. The disadvantage of the status quo scenario is that some Member States might not select sufficient solutions in order to incentivise DSOs to procure flexibility services.

Policy option 2 goes significantly further than policy option 1 in providing DSOs with more comprehensive possibilities for acquisition and use of flexibility services thereby giving DSOs the most flexibility to ensure efficient grid operation. The expected impact in terms of governance is similar to option 1 but option 2 goes further and would require increased monitoring of the market development at EU level. In addition, the risk of market distortions is likely to increase as DSOs actions will overlap more with commercial activities (e.g. a DSO would be able to resell surplus flexible demand originally acquired for congestion purposes to the market), also increasing the risk of discrimination against not-bundled energy suppliers. In addition, the option stipulates stricter unbundling requirements, thereby alleviating issues related to neutrality and non-discrimination towards commercial actors.

6.3 Section 2: Distribution tariffs

Table 19: Summary of policy options for distribution tariffs

	Policy options (down) to be evaluated on core indicators (right)	**Effectiveness** regarding defined objectives	**Governance / Compliance** (how easily can the option be enforced?)	**Risk of discrimination** (distortions to competition)	**Risk mitigation potential**	**Costs (net)** (admin., compliance /enforcement cost etc.)	**Distribution of costs:** public or private – if private, who? (Consumers / Producers / DSOs / data handling entity)
0	Status quo	+?		--	+	(0)	Consumers
1	Clarify the framework	+		-	+	--	Consumers
2	Harmonise DER	++		(0)	++	--	Consumers
3	Fully harmonise tariffs	+++		(0)	+	--	Consumers
4	Time element	+		-	+	--	Consumers

All of the policy options for distribution tariffs except for status quo imply that Member States will lose some degree of flexibility because they would have to comply with extended EU-legislation compared to currently requirements in the TEP and EED provisions.

The restrictions on Member States flexibility in setting distribution tariffs will potentially be most significant if policy option 3 is implemented as this policy option implies a fully harmonised framework for distribution tariffs across the EU with common calculation methodologies for all tariff elements. The Commission would lead and monitor the framework for harmonizing distribution tariffs with the support of ACER and the consultation of appointed Ministries and DSOs. Despite the constraint of losing the flexibility to adapt national schemes to local conditions, - policy option 3 is considered the most effective in terms of implementing a best practice framework for distribution tariffs.

Policy option 1 would clarify the framework for NRA authorisation and calculation of tariffs through guiding principles developed at EU level. This option would introduce common EU performance indicators and requirements for transparency and for DSO development plans. Policy option 1 would be developed by the Commission with the support of ACER and the consultation of appointed Ministries and DSOs. Enforcement and monitoring would take place with the NRA at national level and with the Commission and ACER at EU level.

Policy option 1 allows for learning by doing effects among the Member States and also easy information exchange. Implementing policy option 1 means that the EU can help the DSOs to increase their knowledge sharing and that Member States still have full flexibility with regards to tariff structures.

Further to policy option 1, policy option 2 would harmonize distribution tariff elements regarding distributed energy resources and self-consumption in order to ensure that discrimination among grid users or distortion of competition does not happen. An example would be to follow the THINK report's[78] recommendation of exposing distributed energy resources to full tariffs (no hidden subsidies) in order to send efficient signals (distributed energy resources could be supported through other channels if deemed appropriate). The Commission would lead and monitor the framework for harmonizing distribution tariffs with the support of ACER and the consultation of appointed Ministries and DSOs. Policy option 2 would however result costlier than option 1 in terms of compliance with a new framework to be enforced in all Member States.

Policy option 4 introduces a time element in distribution tariffs and is the easiest option to implement. Guidelines would be developed at EU level by the Commission and implemented at national level by NRAs and DSOs. The implementation of policy option 4 still leaves a high degree of flexibility for the Member States as it only implies that the DSOs adopts minimum two different tariff rates during the day, for example day/night tariffs but there is no requirements on the actual price difference between those two tariffs. While policy option 4 will increase cost reflectiveness and to some extent discrimination, it will not affect discrimination among grid users in the wholesale market from the treatment of distributed energy resources in several Member States.

[78] *THINK (2013) From Distribution Networks to Smart Distribution Systems: Rethinking the Regulation of European Electricity DSOs*

6.4 Section 3: Data handling

Table 20: Summary of policy options for data handling

Policy options (down) to be evaluated on core indicators (right)	**Effectiveness** regarding defined objectives	**Governance / Compliance** (how easily can the option be enforced?)	**Risk of discrimination** (distortions to competition)	**Risk mitigation potential**	**Costs (net)** (admin., compliance /enforcement cost etc.)	**Distribution of costs**: public or private – if private, who? (Consumers / Producers / DSOs / data handling entity)
0 **Status quo**	0	0	n/a	n/a	0	0
1 **Update and strengthen EU rules on...**						
... non-discrimination	++	+	n/a	n/a	-	Data handling entity
... interoperability	+	++	n/a	n/a	- -	Data handling entity, DSO, supplier
... DSO-access to technical data	++	+	n/a	n/a	-	Data handling entity
... transparency	+	+	n/a	n/a	-	Data handling entity, DSO, supplier
... cybersecurity	+	-	n/a	n/a	- -	Data handling entity
2 **Mandatory data handling model**	+++	+	n/a	n/a	- - -	DSOs, data handling entity

Policy option 0, the status quo, is by definition the cheapest option among the three, but also means that if there exist market distortions and inefficiencies, they cannot be addressed by EU legislation.

Important areas within data handling are covered in current EU legislation for example consumer protection and access. Today we have more types and larger amounts of smart meter data, as well as more market actors involved. In the optimal case, the collected data should be provided to those market actors to which it is of most value. The business case of aggregators for example is built on access to (real time) consumption data access and DSOs can operate the distribution grid more efficiently if they have quick access to technical data.

If policy option 0 was to be chosen, each Member State would still develop its own data handling model at national level and the currently existing risk of discrimination against unbundled suppliers will remain unaddressed. DSO-access to technical data does not have a strong legal basis in EU legislation at the moment. According to the DSOs interviewed, this is not a problem as of now, since the DSOs are typically given access to technical data, but without legislation, there is no guarantee that there won't be challenges in the future. In the presence of those risks, we assess that taking action at EU level should be considered.

Existing risks could be addressed effectively if policy option 2, a mandatory data handling model, was to be chosen. But this option also means substantial costs. Compared to business-as-usual, a mandatory data handling model lies at the other end of the range of EU intervention. Not only particular objectives, but the approach to achieving them would be specified in EU legislation. A specific data handling model and responsible entity (-ies) in each Member State, with uniform processes and access rules to the data, would be defined at EU level by the Commission with the support of ACER and the consultation of appointed Ministries and DSOs. The Commission would monitor the transposition and compliance of these rules at EU level while national data protection authority would monitor data privacy. If well-designed, a mandatory data handling model will be able to solve current challenges effectively, and also monitoring compliance is feasible. But there are two significant disadvantages of policy option 2:

- Firstly, such a "one-fits-all" solution is likely to be inefficient in some Member States, since it is inflexible and cannot be adapted to the national context. Each data handling model has pros and cons (see earlier chapters), which depend on the national context and power market structures that the model is applied to.[79]
- Secondly, the costs of building a new data handling model from scratch are substantial.

Policy option 2 is more expensive than policy option 0 and 1. It is Important to keep in mind is that most Member States already have a data handling model in place. The expenses for having built that data handling model are so-called *sunk costs*, i.e. expenses that cannot be recovered if that existing data handling model is disestablished. Moreover, Member States will incur new, additional costs of setting up a new data handling model. The high costs of this policy option put a question mark to the overall efficiency of this option. The important question is whether the objectives like non-discrimination can be met at lower costs, for example by addressing them individually as in policy option 1.

The strengthening of single EU rules (policy option 1) offers the advantage of flexibility. Objectives that are currently insufficiently met can be addressed individually, which means that the Member States only incur the minimum costs necessary for meeting the objectives. This policy option lies in between the two "extremes" status quo and mandatory data handling model. It allows for targeted EU intervention where necessary. By updating and strengthening EU rules, for access to consumer data and related processes to guarantee transparency, objectivity, non-discrimination, and interoperability the Commission provides a legal framework that ensures that overall objectives are met, but within that framework, Member States can still move freely. The exact design of the data handling model for example resides with each individual Member States as it does currently. The Commission

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[79] *An example: A benefit of the central data hub compared to the DSO as facilitator is the centralised storage and handling of the data, which allows for the realisation of economies of scale. That benefit weighs more in a decentralised power market than in a power market that is naturally rather centralised. The power markets of Germany (869 DSOs), Spain (351 DSOs), Sweden (173 DSOs), France (148 DSOs), Italy (144 DSOs) and Austria (128 DSOs) are highly decentralised regarding the distribution grid (Think 2013); moving from the DSO as a facilitator to the central data hub would mean enormous efficiency gains through economies of scale and simplification for suppliers here. The power markets of Bulgaria, the Czech Republic, Hungary, Lithuania, Luxembourg, Malta, Slovakia, Slovenia and the Netherlands on the other hand are all characterised by only a single-digit number of DSOs (Think 2013), which means that the data handling model "DSO as a facilitator" would already mean a high level of centralisation and a high realisation of economies of scale.*

would monitor the implementation of these principles at EU level and national data protection authorities would monitor the respect of data privacy.

When considering updating rules, we recommend considering in particular non-discrimination of unbundled suppliers. New rules that ensure that DSOs cannot give an advantage to their bundled supplier or a disadvantage to an unbundled supplier would effectively remove all grounds for discrimination in that area at reasonable costs. When revising the legislation on data handling, it should moreover be kept in mind that access to technical data is important to DSOs to operate, maintain and plan the distribution grid effectively and efficiently.

Increased transparency might harbour positive effects like energy savings and a positive effect on the energy market. However, we did not find strong indication to argue that intervention on EU level is necessary here. Voluntary, national initiatives could potentially be a better and more efficient approach to unlock those potentials. Similar argumentation holds for interoperability and cybersecurity. There might be room for improvement in some Member States, but we do not see the necessity to take action on EU level.

7. TASK 5: CONCRETE POLICY RECOMMENDATIONS

7.1 Cost efficient operation of DSO grids

The current state of national regulation of DSOs in most Member States is not sufficiently able to incentivise cost efficient grid planning and operation. This is both the case with respect to;

- clarifying the increasing size of new roles and activities which is in a grey area on whether it should be conducted on purely commercial terms or with a more active DSO involvement and
- income regulation incentivising DSOs to utilise new technologies instead of the traditional grid expansions.

With new technologies such as smart meters and increasingly economically viable storage solutions, a number of new roles and activities are emerging.

In the absence of a common approach to clarifying the role and activities of DSOs, there is a risk that different Member States will opt for different definitions. This may have implications at EU level as DSO activities in terms of balancing and congestion management have spill-over on the wholesale power market. Different national conditions for local DSO use of flexibility services may hamper an efficient wholesale market across Member States particularly in balancing markets. Moreover, the internal market for demand aggregators and other third party actors will be hampered by potentially different market conditions and degrees of allowed DSO activity in commercial activities.

Based on this, we assess that EU-level action is warranted. Specifically, we assess that policy option 1 appears to be the most attractive option. Allowing DSOs to acquire flexibility services is appropriate if specific conditions are established under which the DSO can use this flexibility while ensuring neutrality of the DSOs and non-discrimination of third parties.

An important part of policy option 1 is to clarify the role of the DSOs in specific tasks such as ownership of local storage and electric vehicle charging infrastructure. It is important to define these roles in order to clarify the conditions both for DSOs and for commercial actors in the market. It may be less obvious, however, that such clarification need to be common across Member States. Whether DSOs should be able to own local storage solutions, for example, remains an open question, and the right answer may depend on local circumstances.

Policy option 1 also includes mandatory cooperation between DSOs and TSOs on specific areas. While this may strictly not be necessary for all TSO/DSO relationships,[80] active DSO engagement in acquiring flexibility resources warrants enhanced cooperation with TSOs. Especially the possible situation where the wholesale market price signals to a distributed energy resource is opposite from what the local distribution grid situation would dictate warrants cooperation between DSOs and TSOs in defining a solution. More frequent exchange of data or other cooperation structures may also be useful. It is relevant to

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[80] *Not all DSOs will have strong deployment of distributed energy resources and/or be in a situation where local grid congestion is likely.*

discuss whether small DSOs should be forced to engage, as it may be relatively burdensome without adding high value to overall system balancing objectives.

Policy option 2 goes significantly further than policy option 1 in providing DSOs with more comprehensive possibilities for acquisition and use of flexibility services. While this gives DSOs the most flexibility to ensure efficient grid operation, it also runs the highest risk of disrupting activities, which are also suited for commercial operation. In addition, the risk of discrimination against commercial parties is also the highest, but may be mitigated by stricter unbundling rules if these are effective.

7.2 Distribution tariffs

Currently NRAs have full and exclusive rights for setting and approving tariffs and methodologies are very different across Member States. Based on our analysis, we do not see strong evidence that this is a problem that warrants major intervention. One argument for adopting a common tariff framework could be that it might affect the internal market for products. If the decision to establish an electricity intensive consumer depends on arbitrarily set grid tariffs, this would distort placement from its most efficient location. However, this argument does not seem to muster much support. Instead, different tariffs methodologies may be appropriate due to very different underlying characteristics of local distribution grids. Where for instance a time based tariff can be useful in changing demand patterns in some grids, it may be an unnecessary burden in others.

Another argument for not fully harmonising tariffs is that there is currently no well-established best practice to harmonise on. On the contrary, due to the changing conditions of distribution grids it may be beneficial to ensure that there is ample room for testing new tariff designs and exchange practices across different DSOs. This could be related to electric vehicle charging tariffs which is inherently difficult to design.[81]

It has been highlighted that the current tariff practices across DSO are not transparent both in terms of the tariff level for specific consumers and for the overall methodology for calculating tariffs. Policy option 1 addresses this issue by imposing more detailed transparency requirements and requiring performance indicators to be made available, which seems appropriate. Defining several relevant and meaningful performance indicators for DSO will likely turn out to be difficult, as DSOs to a large extent are responding to factors which are external to them such as distributed energy deployment, local network topology and the distance between consumers in the network etc. While difficult to conclusively assess, based on the analysis, policy option 1 seem broadly appropriate.

Policy option 2, where tariff elements for distributed energy resources are harmonised, has merit in particular for setting guidelines on how to address distributed renewable energy sources and prosumers. Similarly, to other generation facilities, renewable energy sources make use of grid services and non-similar treatment of generators may be discrimination. This falls under EU interest, as generation in the distribution grid affects the cross-border wholesale market and consequently the EU internal market for electricity. It provides an

[81] So far, no convincing model has been designed for a cost reflective tariff which is also transparent and relatively stable, when the marginal cost of connecting and charging an addition electric vehicle may be substantially higher than the prior vehicles.

argument for clarifying tariff methodologies in terms of for example cost reflectiveness and non-discrimination. Guidelines could include good practice in tariff setting such as including capacity and time elements into the tariff methodology, while still preserving flexibility to design tariffs according to the underlying grid characteristics. Such guidelines could also include best practice principles on e.g. DSO remuneration schemes, as discussed in Section 1.

7.3 Data handling

Member States are increasingly adopting new models for handling data related to electricity consumption. In some Member States this is driven or accelerated by the prospect of smart meter roll out and increased data availability, while other Member States have chosen to develop data handling models for other reasons such as for facilitating market processes (e.g. switching, settlements etc.). So far, several different data handling models are in place or being developed. The difference is both in terms of overarching model design (e.g. data hub vs. DSO as a facilitator) and in terms of specific design choices within e.g. a data hub.

Based on our analysis, the current developments to a quite large extent seem compatible with EU objectives in spite of the differences between Member States. However, in light of the changing nature of data collection and new and sometimes novel data handling models being developed, it will be appropriate to update and strengthen current EU provision in line with policy option 1. We assess that particularly a few elements are important to address specifically. An important element is whether to stipulate that DSOs should have access to technical data from smart meters about grid conditions. This would improve DSOs ability to operate and maintain the grid cost-efficiently. In some models it has been seen however, that smart meter data has been routed from DSO-owned smart meters directly to third party data handlers, thereby not allowing DSOs full and timely access to the technical data. There may be reasons for this – in particular for ensuring non-discrimination towards unbundled suppliers and consumer privacy concerns – and the extent to which strong provisions should be taken on this issue given such trade-offs should be assessed. Our initial assessment is that most existing models would be capable of ensuring sufficient use of the technical data for DSOs without compromising other objectives.

With the increasing amount of data from smart meters, it becomes even more important to ensure that non-discrimination is sustained. It must be ensured that DSOs provide timely access to data of sufficient quality to all energy suppliers and relevant third parties (given consumer acceptance), also if DSOs have ownership interests with competing entities. In all models currently being developed and implemented, ensuring non-discrimination is a priority, but it remains a priority to ensure that new models in other Member States also live up to this objective.

We have also explored the value of ensuring interoperability between different data handling models, e.g. reducing barriers for establishing third party aggregation services or energy supply services in the internal market. While beneficial, it does not seem to be a sufficiently large problem for these actors to warrant costly measures in coordinating and redesigning models to ensure interoperability. Some regions are looking into ensuring interoperability between data models e.g. in the Nordic region, and it would be interesting to follow this development.

Adopting a standardised data handling model across the EU – as suggested in policy option 2 – does not seem appropriate in terms of costs and benefits. Based on our analysis, we assess that there would be quite limited benefits from adopting a standardised data handling model across the EU. The objectives of the EU in terms of especially protecting consumer privacy, ensuring access to data for consumers, and especially timely and non-discriminatory access to data for commercial energy suppliers can be met also when the data handling model differs across the EU. Conversely, the costs of harmonising a data handling model are likely to be significant. This is mainly because several models have already been devised and implemented often resulting in substantial cost for developing and investments in e.g. IT infrastructure. Scrapping these models would imply substantial costs.

8. LIST OF APPENDIX

8.1 Appendix A - Abbreviations

Abbreviation	Full name
ACER	Agency for the Cooperation of Energy Regulators
CAPEX	Capital Expenditure
CEER	Council of European Energy Regulators
CDH	Central Data Hub
DAM	Data Access-Point Manager
DDIM	Dynamic Distribution Investment Model
DE	Distributed Energy
DG ENER	Directorate General for Energy
DPIA	Data Protection Impact Assessment
DSO	Distribution System Operator
EU	European Union
EV	Electric Vehicle
GDPR	General Data Protection Regulation
GDS	Generic Distribution System
IA	Impact Assessment
MiFiD 2.0	Markets in Financial Instruments Directive
NIS	Network and Information Security Directive
NRA	National Regulatory Authority
OPEX	Operational Expenditure
RES	Renewable Energy Systems
TOTEC	Total Expenditure

ToR	Terms of Reference
TSO	Transmission System Operator
VRES	Variable Renewable Energy Resources
WACC	Weighted Average Cost of Capital

8.2 Appendix B – Bibliography

Author	Title	Year
DSO regulation		
CEER	Status Review of Regulatory Aspects of Smart Metering	2013
CEER	The Future Role of DSOs	2014
Copenhagen Economics	Use of nudging to increase energy efficiency (Brug af nudging til at øge energieffektivisering)	2013
ECN & Ecorys*	The Role of DSOs in a Smart Grid Environment	2014
ERGEG	Position Paper on Smart Grids	2010
Eurelectric	Regulation for Smart Grid	2011
Eurelectric	Flexibility and Aggregation – Requirements for their interaction in the market	2014
EvolvDSO	D1.4 – Assessment of future market architectures and regulatory frameworks	2016
DNV-GL	Integration of Renewable Energy in Europe	2014
Tractebel, Ecofys, Sweco, PWC*	Study on the Effective Integration of Distributed Energy Resources for Providing Flexibility to the Electricity System	2015
Smart Grids Task Force (EG3)*	EG3 Report: Regulatory Recommendations for the Deployment of Flexibility	2015
Think*	From Distribution Networks to Smart Distribution Systems: Rethinking the Regulation of European Electricity DSOs	2013
Tractebel, Ecofys	Identifying energy efficiency improvements and saving potential in energy networks, including analysis of the value of demand response	2015
Ruester, Schwenen, Batle, Perez-Arriaga	From distribution networks to smart distribution systems: Rethinking the regulation of European electricity DSOs	2014

E-Bridge, IAEW, OFFIS	Moderne Verteilernetze für Deutschland"(Verteilernetzstudie)	2014
Joint Research Centre	Smart Grids project outlook	2014
Tractebel, Ecofys	"Identifying energy efficiency improvements and saving potential in energy networks and demand response, in support of the implementation of article 15 of the energy efficiency directive (2012/27/EU)"	2015
Scelectra	D4.1 Policy scenarios to sustain EV deployment	2015
DSO network tariff structure		
CEDEC	Distribution Grid Tariff Structures for Smart Grids and Smart Markets	2014
Eurelectric	Network Tariff Structure for a Smart Energy Eystem	2013
GEODE Working Group Tariffs	GEODE Position Paper on the Development of DSO's Tariff Structure	2013
refe, mercados & indra	Study on Tariff Design for Distribution Systems	2015
Similä et al.	Network Tariff Structures in Smart Grid Environment	2011
Data Handling		
Butts & Shenoi (Eds.)	Infrastructure Protection VII Chapter 2. Data Handling in the Smart Grid: Do we know enough?	2013
Copenhagen Economics	Use of nudging to increase energy efficiency (Brug af nudging til at øge energieffektivisering)	2013
Smart Grids Task Force (EG2)	EG2 Report: Regulatory Recommendations for Data Safety, Data Handling and Data Protection	2011
Smart Grids Task Force (EG3)*	EG3 First Year Report: Options on Handling Smart Grids Data	2013

EDSO	Data Management: The role of Distribution System Operators in managing data	2014

8.3 Appendix C – List of stakeholders

Stakeholder	Description	Consultation method
National government		
Czech Government		Review of "New Energy Market Design - 2015" public consultation[82]
Danish Government		Review of "New Energy Market Design - 2015" public consultation[82]
Dutch Government		Review of "New Energy Market Design - 2015" public consultation[82]
Estonian Government		Review of "New Energy Market Design - 2015" public consultation[82]
Finnish Government		Review of "New Energy Market Design - 2015" public consultation[82]
French Government		Review of "New Energy Market Design - 2015" public consultation[82]
German Government		Review of "New Energy Market Design - 2015" public consultation[82]
Hungarian Government		Review of "New Energy Market Design - 2015" public consultation[82]
Norwegian Government		Review of "New Energy Market Design - 2015" public consultation[82]
Polish Government		Review of "New Energy Market Design - 2015" public consultation[82]
Swedish Government		Review of "New Energy Market Design - 2015" public consultation[82]
Slovak Government		Review of "New Energy Market Design - 2015" public consultation[82]

UK Government		Review of “New Energy Market Design - 2015” public consultation[82]
Electricity consumers		
IFIEC Europe	Industrial energy users in Europe	Review of “New Energy Market Design - 2015” public consultation[82]
BEUC	European Consumers Organization	Review of “New Energy Market Design - 2015” public consultation[82]
EUROBAT	European manufacturers automotive, industrial and energy storage batteries	Review of “New Energy Market Design - 2015” public consultation[82]
CEPI	European Paper Industry	Review of “New Energy Market Design - 2015” public consultation[82]
European Aluminium		Review of “New Energy Market Design - 2015” public consultation[82]
European Copper Institute		Review of “New Energy Market Design - 2015” public consultation[82]
Cefic	The European Chemical Industry Council	Review of “New Energy Market Design - 2015” public consultation[82]
EuroACE	European Alliance of Companies for Energy Efficiency in Buildings	Review of “New Energy Market Design - 2015” public consultation[82]
BusinessEurope		Review of “New Energy Market Design - 2015” public consultation[82]
EUROCHAMBERS		Review of “New Energy Market Design - 2015” public consultation[82]

[82] *Telephonic or face-to-face interview may follow (if necessary)*

EUROFER	The European Steel Association	Review of "New Energy Market Design - 2015" public consultation[82]
EURACOAL	European Association for Coal and Lignite	Review of "New Energy Market Design - 2015" public consultation[82]
Eurometaux	European Association of Metals	Review of "New Energy Market Design - 2015" public consultation[82]
Electricity Industry		
EASE	European Association for Storage of Energy	Review of "New Energy Market Design - 2015" public consultation[82]
Energy Community		Review of "New Energy Market Design - 2015" public consultation[82]
Eureletric	The association of the electricity industry in Europe	Review of "New Energy Market Design - 2015" public consultation[82] & face-to-face Interview
GEODE	European Voice of local Energy Distributors	Review of "New Energy Market Design - 2015" public consultation[82] & face-to-face Interview
CEDEC	European Federation of Local Energy Companies	Review of "New Energy Market Design - 2015" public consultation[82] & face-to-face Interview
EDSO	European Distribution System Operators' Association for Smart Grids	Review of "New Energy Market Design - 2015" public consultation[82]
ENTSO-E	European Network of Transmission System Operators	Review of "New Energy Market Design - 2015" public consultation[82]
ESMIG	European Smart Energy Solution Providers	Review of "New Energy Market Design - 2015" public consultation[82]

ETP	European Technology Platform for Electricity Networks of the Future (ETP SmartGrids)	Review of "New Energy Market Design - 2015" public consultation[82]
EWEA	European Wind Energy Association	Review of "New Energy Market Design - 2015" public consultation[82]
Friends of the Supergrid		Review of "New Energy Market Design - 2015" public consultation[82]
RGI	Renewables Grid Initiative	Review of "New Energy Market Design - 2015" public consultation[82]
SEDC	Smart Energy Demand Coalition	Review of "New Energy Market Design - 2015" public consultation[82]
University of Cyprus	CY	Questionnaire
Dansk Energi	DK	Questionnaire
Energia	FI	Questionnaire
ERDF	FR	Questionnaire & Telephonic Interview
RWE	DE	Questionnaire & Telephonic Interview
DEDDIE	EL	Questionnaire & face-to-face Interview
EDP	PT	Questionnaire & face-to-face Interview
GKPGE	PL	Questionnaire & Telephonic Interview
Enexis	NL	Questionnaire & Telephonic Interview
Energi Norge	NO	Questionnaire & Telephonic Interview
Iberdola	ES	Questionnaire & Telephonic Interview
Energy Networks	UK	Questionnaire & Telephonic Interview

Regulators		
ACER	Agency for the Cooperation of European Regulators	Review of “New Energy Market Design - 2015” public consultation[82]
CEER	Council of European Regulators	Review of “New Energy Market Design - 2015” public consultation[82]
Aggregators		
Kiwi Ltd	UK	Review of “New Energy Market Design - 2015” public consultation[82] & Telephonic Interview
Next Kraftwerke	DE	Review of “New Energy Market Design - 2015” public consultation[82]
Swisscom Energy Solutions	CH	Review of “New Energy Market Design - 2015” public consultation[82]

8.4 Appendix D – Interview guide

This is a general list of questions. Specific questionnaires are developed for each category of stakeholder and consultation method (telephonic interview, face to face interview and written survey):

- Section 1: What types of remuneration schemes are best suited for future challenges and which Member States have implemented these?
  - *Are European DSOs more inclined to an active network management or a passive network management in relation to connect more low-carbon electricity generators?*
  - *Which cost items related to new smart grid solutions usually fall outside the different national regulated cost base?*
  - *Which new activities should be included in the cost base of the DSOs to incentivise new smart grid investments?*
  - *If the remuneration scheme for DSOs focus more on capital expenditure (CAPEX) investments would it provide more incentives to invest in infrastructure (and why)?*
  - *Would it be useful to create reference models for remuneration schemes?*
  - *To what extent do the costs for energy losses within the distribution network impact the DSOs operational expenditure (OPEX)?*

- Section 2: Identify the different models for tariff structures across the Member States and the ability to incentivise consumer demand in a peak situation
  - *What is the role of tariff-structures to drive new grid investments?*
  - To what extent do current tariff structures reflect the costs borne by the DSOs for service provision?
  - *To what extent do current tariff structures encourage customers to optimize their load profiles, so that the utilization rate of the distribution network capacity is as high as possible?*
  - *To what extent do current tariff structures take into account consumers who also generate their own electricity?*
  - *Should Member State tariff schemes be more coordinated?*
  - *Should there be a European approach to distribution tariffs?*

- Section 3: Map the existing data handling approaches, and assess if they are in accordance with the general principles of e.g. non-discrimination?
  - *Are Member States adopting data handling models in accordance with the objectives stipulated in the Electricity Directive 2009/72/EC and the Energy Efficiency Directive 2012/27/EU?*
  - *Is the adoption of different models in different Member States likely to give rise to distortions?*
  - *Should the EU consider legal means to align the data handling models?*

8.5 Appendix E - Review of the 2015 public consultation "New Energy Market Design"

8.5.1 Public consultation 2015

This section provides a summary of the responses to the European Commission's public consultation on "*New Energy Market Design*" launched from 15 July 2015 to 9 October 2015.

The objective of the public consultation was to seek stakeholder's views on the issues that may need to be addressed in redesigning the European electricity market. These issues include:

(vii) Improvements to market functioning and investment signals;
(viii) Market integration of renewables;
(ix) Linking retail and wholesale markets;
(x) Reinforcing regional coordination of policy making, between system operators and of infrastructure investments;
(xi) The governance of the internal electricity market;
(xii) A European dimension to security of supply.

The present study supports the impact assessment concerning the new role and tasks of distribution system operators (DSOs), in a context of increased variety of electricity sources such as renewable energy systems (RES) and the deployment of new smart technologies. Therefore, we specifically focused on the questions from the open consultation addressing demand-side response measures (DSR), the distribution tariff framework and data handling models, namely:

- Question 10*: "where do you see the main obstacles that should be tackled to kick-start demand-response (e.g. insufficient flexible prices, (regulatory) barriers for aggregators / customers, lack of access to smart home technologies, no obligation to offer the possibility for end customers to participate in the balancing market through a demand response scheme, etc.)?"*
- Question 14: "h*ow should governance rules for distribution system operators and access to metering data be adapted (data handling and ensuring data privacy etc.) in light of market and technological developments? Are additional provisions on management of and access by the relevant parties (end-customers, distribution system operators, transmission system operators, suppliers, third party service providers and regulators) to the metering data required?*"
- Question 15: "s*hall there be a European approach to distribution tariffs? If yes, what aspects should be covered; for example, framework, tariff components (fixed, capacity vs. energy, timely or locational differentiation) and treatment of own generation?*"

Our findings are also compared with the main conclusions of the 2014 public consultation on "Retail Energy Market".

Given the open nature of the questionnaire accompanying the consultation document this summary report is of a qualitative nature and structured as follows:

- "**Stakeholder assessment**": overview and selection of respondents;
- "**Outcome of public consultation**": a summary of respondents' views to each selected question from the consultation questionnaire.

8.5.2 Stakeholder assessment

The Commission received in total 320 replies to the public consultation. Approximately 50 per cent of these answers came from national or EU-wide industry associations, 26 per cent of the answers stem from undertakings active in the energy sector (suppliers, intermediaries, customers) and 9 per cent from network operators. The remaining answers from national governments and several national regulatory authorities and a significant number of individual citizens and academic institutes participated as well.

The selected answers were chosen from the approved list of stakeholders (Annex C – inception report) and additional interested parties forming a sample of 43 stakeholders grouped in five main categories:

- **National Governments:** Czech Government, Danish Government, Dutch Government, Estonian Government, Finnish Government, French Government, German Government, Hungarian Government, Norwegian Government, Polish Government, Swedish Government, Slovak Government, UK Government.
- **Regulators**: ACER and CEER (joint answer);
- **Aggregators:** KiwiPower, Next Kraftwerke and Swisscom Energy Solutions (joint answer);
- **Electricity consumers:** BEUC – European Consumer Association, BusinessEurope, EUROCHAMBERS, CEFIC - European Chemical Industry Council, CEPI - European Paper Industry, EUROFER - the European Steel Association, EURACOAL - European Association for Coal and Lignite, Eurometaux - European Association of Metals, European Aluminium, European Copper Institute and IFIEC Europe - Industrial energy users in Europe;
- **Electricity industry:** EASE - European Association for Storage of Energy, Energy Community, Eureletric - the association of the electricity industry in Europe, ,, EUROBAT - European manufacturers automotive, industrial and energy storage batteries, GEODE - European voice of local energy Distributors, CEDEC - European federation of local energy companies, EDSO - European distribution system operators' association for smart grids, ENTSO - European network of transmission system operators, ESMIG - European Smart Energy Solution Providers, ETP - European Technology Platform for Electricity Networks of the Future (ETP

SmartGrids), EWEA – European Wind Energy Association, RGI - Renewables Grid Initiative, Friends of the Supergrid, SEDC - Smart energy demand coalition.

Members of the categories "National Governments", "Regulators", "Electricity consumer" and "Electricity industry" provided exhaustive answers to all the questions. However, the members of the category "Aggregators" expressed their opinion only to the question related to demand-side response.

8.5.3 Outcome of 2015 public consultation ""New Energy Market Design"

The outcome of the public consultation is presented for each of the three selected questions in the form of a summary of respondents' views followed by more detailed comments by each group of correspondence.

- Flexibility and demand response
- Distribution tariffs
- Governance rules for data handling

8.5.4 *Flexibility and Demand-Response*

Question 10: where do you see the main obstacles that should be tackled to kick-start demand-response (e.g. insufficient flexible prices, (regulatory) barriers for aggregators / customers, lack of access to smart home technologies, no obligation to offer the possibility for end customers to participate in the balancing market through a demand response scheme, etc.)?

Summary of findings:

National governments consider that the lack of incentives for consumers to engage in demand side response should be tackled by dynamic prices and the deployment of smart meter technology.

Smart energy management systems are indeed believed as precondition to make the field of demand response accessible to a broad range of consumers by ca 60 per cent of the "Retail Energy Market" respondent.

Some stakeholders from the energy industry believe that only when consumers know that demand-response will work smoothly and fully guarantee the protection and privacy of their data, they will be willing to engage. In addition, they believe that regulated prices, lack of price volatility and market restrictions to the integration of aggregators (the latter shared with electricity consumers and aggregators), are the main obstacles to the development of flexibility services.

Regulators and some energy consumers think that consumers' awareness should be increased providing transparent information. This finding is also highlighted by the fact that in "Retail Energy Market" consultation ca. 68 per cent respondents agree that a large number of consumers would engage in demand response programmes if they were offered simple services and hassle-free technical solutions.

Most of members of the energy industry and some national governments believe that there is no European-wide solution that will provide benefits to all Member States and recommend that any future legislation should take into account the different realities throughout Europe.

National governments

The national governments point out that electricity prices in the market are currently not sufficiently divergent to induce consumers to participate in demand-side response. The use of dynamic tariffs, varying for instance between peak load time and low peak time, could incentivise all consumers, including households, to engage in demand-side response on a voluntary basis. Such price signals and the deployment of technologies such as smart meters are crucial to increase awareness of consumers and empower them to use flexibility and demand side response.

Member States state that it is important to ensure open and unbiased competition of technologies providing flexibility services and remove discriminatory barriers hampering the integration of aggregators on the energy market. The competition between suppliers and aggregators to use demand side response and the investor uncertainty to engage in such new technologies are the current obstacles.

Some governments (Hungary, Netherlands, Norway, Sweden, Slovakia) also consider that consumers (mostly large industrial consumers, but also households or aggregators) should be involved in the balancing market and that regulatory and technical barriers should be removed so consumers can provide demand side response to support TSOs in ensuring the balance between supply and demand.

A few Member States (Denmark, Finland, Sweden, UK) consider that the current energy regulations designed around a traditional electricity system do not fit technologies like demand side response and storage and that there are cultural barriers from regulated monopolies (e.g. Distribution Network Operators) who could potentially use demand side response and storage as an alternative to network reinforcement.

The Swedish government however states that there is no "one fits all" solution to take down the obstacles to demand side response and the Hungarian government is reluctant to further EU action in this regard in the name of subsidiarity. The United Kingdom and Netherlands support the promotion of open standards for smart appliances, which will be key means to unlock the significant potential for demand-response.

Regulators:

Regulators identify numerous obstacles in the participation of DSR in the market:

- *Limited price incentives* seem to be the main cause of low participation of DSR;
- *Cultural barriers:* t*hese include a lack of understanding of the value of flexibility, or a lack of willingness to provide or use flexibility due to, e.g. institutional biases, lack of confidence in the flexibility programmes, lack of trust in market*

actors. In this respect, identifying "business models" for the development of DSR might address some of these barriers.;

- *Regulatory barriers*: these include a lack of clarity regarding the roles and responsibilities of parties in using and providing flexibility and gaps in the regulatory framework. Data management can also be a barrier to entry in a regulatory context;
- *Structural barriers*: these may include costs relating to investment, R&D and economies of scale which may make procuring or providing flexibility costly in relation to the economic benefits. Insufficient unbundling may be a structural entry barrier for new suppliers.
- *Metering barriers*: the expansion of DSR beyond large industrial consumers requires that end-user consumers have appropriate metering in place (smart metering systems).

Aggregators:

The aggregators joint answer advocates that a level playing field should be guaranteed such that independent aggregators can be integrated and provide demand response solutions (e.g. load management and load modulation). The current obstacles to their development are highlighted in their answer:

- *Coordination processes with suppliers and aggregators should be substituted by ones with the TSO*: aggregators perceive discrimination against other providers of ancillary services because of the coordination processes. A conventional power plant owner producing balancing power has only to pass a contract with the TSO. In most of the Member States, the independent aggregator has, in addition to the contract with the TSO, to sign a contract with each Balancing Group Responsible and get the permission of the DSO. Often conflicts of Interest between Aggregators and the Balance Area supplier which prevent them working together. Aggregator and the Balance Area supplier are competing for the same customer;
- *Coordination processes with the DSO should not become a barrier to entry.* Aggregators understand the fact that the DSO may intervene on network security grounds is understandable, however this raise the issue on data protection. The demand response aggregator should not be obliged to pass the names and data of the customers participating in the pool to the DSO. Otherwise, data do not stay with the network part of the utility but are passed on to the energy delivering part (supplier) who is a competitor to the aggregator (they may try to discourage the costumer from joining the pool of the aggregator);
- *The application of the unbundling rules in practice has to be monitored.* The fact that in most of the Member States the aggregator has to pass a contract with the balancing group responsible and another with the DSO in which the different pool participants are located, is perceived to represent a barrier to entry from the aggregators point of view. If unbundling rules are ineffective and the aggregator has pass on information to the balancing group responsible and the DSO (with the permission of the costumer), this leads to the fact that the DSO passes on the information to the supplier, which in turn may try to discourage the costumer from joining the pool of the aggregator. In addition, the

information flows between aggregators and BRPs/suppliers is not considered necessary for aggregators of households;
- *Grid charges:* the “electricity-intensive final consumers” are rather incentivized for constant electricity consumption than doing load management or providing balancing energy. Therefore, the profits of flexibility on the demand side are very often cannibalized by increasing grid-charges;
- *Participation of demand response in all markets of the balancing energy markets.* Control reserve markets includes: primary control, secondary and tertiary control. In some Member States, only secondary and tertiary control energy markets are opened for demand response aggregators.

The aggregators believe that demand-response should not be dealt with in the energy efficiency directive but in the electricity directive.

Electricity consumers:

All the stakeholders considered agree that demand-side response together with the implementation of new technologies, such as smart meters, can be important tool the future electricity grid.

Industry consumers’ representatives (CEPI, CEFIC, European Aluminium) highlight that the potentials of demand-response from industry are also considered way bigger than the residential sector (CEPI). However, it is also highlighted that not all energy intensive industries possess the flexibility for demand-side response requirements due to technical, operational and market constraints. Thus, DSR should be market-driven and voluntary.

Recommendations for stimulating the development of voluntary demand response include:

- Stable regulatory framework guaranteeing: a) fair remuneration for DSR, b) aggregators to participate in the market;
- Remove commercial/legal constraints (e.g. it is not always clear who is the owner of load flexibility, price spikes should not be regulated);
- System constraints: minimum size (MW) and duration of products are sometimes incompatible with industrial constraints;
- Grid codes and network tariffs must to be appropriate and non-discriminatory;
- All load flexibility must be able to find its way to the market or to TSO products;
- Improve transparency: give end consumers access to essential information. Increase awareness of the opportunities and benefits offered by DSR

Industrial storage system should be stimulated (as technology to reduce volatility) European Alluminium points out that differences between systems in the Member States represent an issue for the lack of progress of DSR. It is believed that under interconnected and harmonized markets and grids, DSR practices could be further developed. Otherwise, national grid services should prevail.

Eurometaux and BusinessEurope advocate that market design for demand response must be developed regionally, in close cooperation with stakeholders, reward must reflect real value of flexibility, and incentivize use of existing capacity which in the long run will give the highest benefit at lowest cost. In addition, it is advocated that no subsidy should be allocated to explicit demand response programs in order to ensure a level playing field between all demand response providers.

Similarly, EUROCHAMBERS believes that no "one size fits all" solution that can provide benefits to all Member states. Any future EU actions should take the different conditions throughout Europe into consideration.

Energy industry:

Some energy industry stakeholders (CEDEC, EASE, ETP) believe that demand side response (DSR) is an essential new option on the energy market. However, it is thought that consumers are currently insufficiently aware of the impact on their energy consumption, possible savings, costs and comfort.

The main obstacles in the development of demand-side response are perceived to be related:

- Infrastructure (meters, data handling systems, etc.) challenges related to lack of efficient price transformation from the wholesale market to the retail market (shared view with ESMIG);
- Market design challenges related to: a) lack of exposure of consumers to the real cost of power in real time, b) enable aggregators' participation (shared view also with Energy Community, EUROBAT and EWEA), c) to ensure customers are free to access all relevant markets;
- Regulatory barriers preventing new entrants, such as independent aggregators and other third-party providers;
- Challenges related to lack of transparency and competition between retailers and other service providers cross-border and cross-regionally;
- Lack of harmonized regulation and support cross borders;
- Regulated prices and lack of price volatility (shared view also with Energy Community, EUROBAT and EWEA).

SEDC published a report conducted a thorough regulatory review of 16 Member States[83] identifying the barriers hindering the demand-side response development (study quoted by RGI in its answer). This reported identifies that the following measures are needed to enable consumer participation in the electricity markets and potentially unlock the benefits of demand side flexibility:

- Open all market segments to demand-response and enable demand-side resources to compete on an equal footing with other technologies;
- Clarify the roles and responsibilities of the BRP and the independent aggregator;
- Create products that allow the participation of a range of resources;
- Develop measurement and verification requirements;
- Ensure fair payment and penalties;
- Network demand charges.

EWEA proposes that the regulatory framework should allow the participation in balancing markets, either directly (mainly large industrials and partially SMEs) or through aggregation of service providers (residential load shedding), ensuring a level playing field between all participants. In this view, characteristics of balancing products should be defined in a proper way. In addition, the association perceives that there is a growing need to further incentivize the digitalization of European distribution networks**.**

8.5.5 *Governance rules for DSOs and Models of data handling*

Question 14: "How should governance rules for distribution system operators and access to metering data be adapted (data handling and ensuring data privacy etc.) in light of market and technological developments? Are additional provisions on management of and access by the relevant parties (end-customers, distribution system operators, transmission system operators, suppliers, third party service providers and regulators) to the metering data required?"

Summary of findings:

In the 2014 "Retail Energy Market" public consultation ca 81 per cent of the respondents agreed with the statement that "*allowing other parties to have access to consumption data in an appropriate and secure manner, subject to the consumer's explicit agreement, is a key enabler for the development of new energy services for consumers.*"

Similarly, in the 2015 "New Energy Market Design" public consultation, all stakeholder groups agree that access to data by consumers and relevant third parties and data privacy must be ensured.

On regards to the data handling models, regulators and some stakeholders from the electricity industry believe that DSO should act as neutral market facilitator. The majority of the respondent of the 2014 "*Retail Energy Market*" public consultation also viewed the DSOs as the most appropriate entities to manage the consumption data flows.

As data management model, some members of the electricity industry suggest that the DSOs as data hub could provide an effective way to govern the data generated by smart meters

However, one member of the electricity industry is in disagreement and it believes that most data should remain in the meter itself and should be stored in and regulated by a public server.

IFIEC does not see favourably the role of DSOs as market facilitator either, the involvement of a third party is perceived to better support neutrality and a level playing field.

National governments are divided on the best suitable model for data access and data handling, but half of them (among the respondents) advocate central data hubs. Most of the Member States consider that the role of DSO and the model for data handling should be best decided at national level.

National governments:

Given the enhanced role of DSO in metering and handling data, the Member States point out the necessity for neutrality and independence of the DSO vis-à-vis other energy stakeholders, even if coordination between DSOs and TSOs should be enhanced. Data needs to be accessible in real time or close to real time to consumers and to relevant third parties but ensuring data security and privacy is one of the most important aspects of the acceptance of smart meters and the success of their roll-out.

Some Member States promote central data hubs to collect and handle data (Denmark, Estonia, Finland, Germany, Slovakia, Sweden).

Some national governments (Czech Republic, France, Netherlands, Norway, Slovakia) believe that due to the diversity of data access and data handling models across Member States with varying technologic and regulatory framework, the national level is the most suitable for further legislation and that there is no added value to new EU legislation on the role of DSO and the responsibilities for data handling. However, for the Danish government, EU regulation should more specifically define a minimum level of privacy, (e.g. consumers should control access to their own data, access to data should be easy and equal to market players etc.) and harmonise the roles of the market players and to which kind of data they have access. The Finnish government also calls for a clarification of the role of DSOs in the operation of storages and questions whether there is a need to revise unbundling rules.

Regulators:

Regulators favour the future role of the DSOs as "neutral market facilitators". To achieve this will require to:

- Set out exactly what a neutral market facilitator entails;
- When a DSO should be involved in an activity and when it should not,
- NRAs to provide careful governance, with a focus on driving a convergent approach across Europe.

Regulators envisage that consumers must be guaranteed the ownership and control of their data. The DSOs, or other data handlers, must ensure the protection of consumers' data.

The regulators also suggest to consider whether DSOs should be encouraged to establish a single body through which they can more efficiently participate in the process of new electricity market design.

Electricity consumers:

Most stakeholders (BEUC, CEFIC, CEPI) agree that consumers should have access to real time information, historical information, accurate billing and easy switch of provider.

Some of them (CEFIC, EURACOAL) believe that the DSOs should play a central role in providing end-users with the necessary information. All electricity consumer stakeholders agree that data protection must be assured.

IFIEC referred its response to the CEER's public consultation on the "*Future Role of the DSO*" and stated:

- Among the three models for data management, the DSOs should not to play the role of market facilitator. The involvement of a third party is perceived to better support neutrality and a level playing field;
- TSO-DSO coordination and potentially extended role of DSOs with respect to congestion management, forecasting, balancing, etc. would require a separate regulatory framework. Concerns that some smaller DSOs might be overstrained by this. Therefore, it is suggested to consider a de-minimis-rule in this respect. Extended roles for DSO should be in the interest of consumers and only be implemented when it is economically efficient;
- Different supply functions should be considered.

EURACOAL considers an institution similar to the current ENTSO-E, should be established. The institution should provide consultancy and expertise to the European Commission.

EUROCHAMBERS believes that due to different regional and local conditions a one size fits all approach for governance rules for distribution system operators is not appropriate. The EU could support Member States by developing guidelines (e.g. on grid infrastructures and incentive systems).

Energy industry:

Most stakeholders (CEDEC, EDSO, ESMIG, ETP, EUROBAT, EWEA, GEODE) believe that the role of Distribution System Operators should be more involved as grid manager and neutral market facilitator. Some respondents state that the current regulatory framework prevents DSOs from taking on some roles, such as procurer of system flexibility services and to procure balancing services from third parties, and such barriers should be eliminated.

All stakeholders agree that the provision of data management services should be carried out in a neutral and non-discriminatory manner with all appropriate protections for data security, data privacy and the right of the customer to control third party access to data. On this regard, GEODE highlights the need to have a clear distinction between personal data (which belongs to the customer) and non-personal data which should be provided to any relevant party who requests it, on a non-discriminatory basis.

According to Eurelectric EWEA, ETP and GEODE, DSOs as data hub could provide an effective way to govern the data generated by smart meters.

Eureletric believes that the need for guaranteeing security of information and preventing cyberattacks could also be better ensured when there is only one entity in charge of managing information flow. DSOs should be responsible for data handling up to the metering.

Mindful of the different unbundling situations in place the EU, DSOs should be responsible for data handling up to the metering point in a fully unbundled context. Regulatory authorities should make sure that data management beyond the meter takes place in a condition that ensures customer privacy and it should be up to the consumers whether to receive their data through an intermediary (a market party) or retrieve it from a web platform linked to the data hub. Costs connected with data management should be recovered via network tariffs.

According to RGI, for privacy reasons, most data should remain in the meter itself. Data should be stored in and regulated by a public server in an aggregated and formatted way only dealing with the strictly necessary information. TSOs should have access to relevant data, reflecting the actual energy portfolio and installed capacity per source at any given time.

SEDC envisages that DSOs should be neutral market facilitators where unbundling is fully implemented. However, in this scenario DSOs should not be active in markets such as Demand Response, as this would undermine their neutrality.

In relation to a possible Commission intervention on the topic, GEODE suggests the Commission to lay down generic principles rather than specific provisions, taking into account that different Member States have different models on the treatment of smart metering data.

EWEA believes that a DSO representation at EU level, if not an increased coordination amongst existing DSOs associations would be advisable and it should be encouraged by the Commission.

8.5.6 *Distribution tariffs*

Question 15: "Shall there be a European approach to distribution tariffs? If yes, what aspects should be covered; for example, framework, tariff components (fixed, capacity vs. energy, timely or locational differentiation) and treatment of own generation?"

Summary of findings:

Stakeholders appear divided regarding a EU approach to distribution tariffs:

Some electricity consumers believe that harmonising the tariff methodology and structure would be beneficial and reduce barriers to cross-border trade.

However, other electricity consumers, the regulators and most Member States do not perceive that a "one fits all" solution is appropriate for distribution tariffs. The electricity industry and some national governments considers that setting out common principles at EU level is more advisable than a harmonised framework for distribution tariffs.

The 2014 "Retail Energy Market" public consultation covered the stakeholders' perception about European wide principles for setting distribution network tariffs. However, the results do not show a strict dominance of one of the options. The same number of stakeholders responded "neutral" or "positive".

All stakeholders agree that future tariffs design should ensure cost efficiency and a fair distribution of network costs among grid users. The electricity industry supports the importance of the capacity, time and location components to enhance the flexibility of network price signals. Time-differentiated are also supported by ca 61 per cent of the respondents of the "Retail Energy Market" consultation.

National governments: National governments agree that distribution tariffs should stimulate efficiency and be cost-reflective, with the possibility to easily adapt to market developments. National decisions on tariff structure and components are currently related to the division of network costs among the different system users and to the national distribution system characteristics (size and structure of the grid, demand profile of consumer, generation mix, extent of smart metering, approach to distributed generation) and to the different regulatory frameworks (number and roles of DSOs, national or regional distribution tariffs). Therefore, a majority of Member States consider that no further harmonisation of distribution tariffs at EU level is needed.

The French government argues indeed that the Third Energy package already sets high level principles for the establishment of distribution tariffs (bearing of the costs, tariff not dependant on distance) and that the Commission has also developed guidelines for the promotion of self-consumption.

Some national governments are however more open to some common approach at EU level. The Polish government proposes the possibility of continuous exchange of regulation experience between NRAs (e.g. exchange of information on the levels of costs, taxes, amortisation, WACC, support schemes included in tariffs etc.). The Slovak government would consider as beneficial an ACER´s non-binding recommendation on a methodology for distribution tariffs for NRAs, which should incentivize innovation while guaranteeing timely recovery of costs of distribution and efficient allocation of distribution costs. The Danish government suggests that a common framework would increase market transparency from a retail market perspective and would be a first step to harmonisation. All national governments warn that any European harmonisation or framework for distribution tariffs should not preclude the differences in national policies nor prevent experimental tariff structures aiming at fostering demand side response.

Regulators:

Regulators do not perceive that "one size fits all" approach as appropriate for distribution tariffs. According to them, future tariff designs need to meet the following objectives:

- To encourage efficient use of network assets;
- To minimize the cost of network expansion;
- To seek a fair distribution of network costs among network users;
- To enhance the security and resilience of existing networks;
- To work as a coherent structure, consistent with other incentives.

Electricity consumers:

Some electricity consumers (BEUC, CEPI) advocate a dynamic design of distribution grids tariffs to encourage flexibility, reflecting the various profiles of demand response operators (e.g. ranging from industrial production sites to households running their solar PV unit). They argue that a differentiated set of price signals would incentivise demand side flexibility, but that distribution tariffs should comply with EU energy policy and that regulators should have a common understanding of the reward benefits.

On the other hand, other electricity consumers (CEFIC, IFIEC) believe that harmonising the tariff methodology and structure would be beneficial and reduce barriers to cross-border trade. They insist on a fair distribution of grid costs between grid users and on the limitation of incentives to extraordinary performances clearly bringing down the total costs of the electricity system and not leading to cost inefficiencies.

European Aluminium is in favour of a harmonized methodology for grid tariff for the power intensive industry based on the properties and the contribution of the power consumption profile to the transmission system. Such a tariff system must, however, take into account national differences in grid system and market liquidity and maturity.

EURACOAL, EUROCHAMBERS and BusinessEurope instead strongly disagrees with a harmonization approach because it would not take into account the geographic, natural, climate and energy infrastructure differences between Member States.

Energy industry:

Most of the stakeholders agree that an EU *"one size fits all"* harmonization approach to distribution tariffs is not advisable and EU value added should lay in setting out common principles. In particular, EWEA advocates the Commission to encourage NRAs in identifying "best practices" rather than imposing a top down harmonisation of distribution tariffs.

ESMIG, instead, believes that a more uniform approach across the EU would be welcome.

A number of them support the importance of the capacity (CEDEC, ENTSO-E, Eurelectric, ETP, GEODE), time (CEDEC, EASE, ETP, EWEA, GEODE) and location (CEDEC, ETP, EWEA, ENTSO-E) components to enhance the flexibility of network price signals.

The energy industry stakeholder's advocates cost-efficiency and fairness between consumers. They see self-generation as a positive development but believe that prosumers should contribute to the costs of back up generation and grid costs that allow the reception of this back-up supply to avoid that other consumers bear the burden of increased grid cost recovery schemes. In addition, it is believed that system charges and other levies like policy costs should not artificially increase the cost of electricity, acting as a bias penalizing its consumption.

Network charges should provide DSOs with the revenue needed to ensure proper network investments are made and specifically investments in smart grids and in OPEX improvements.

ESMIG advocates for the evaluation of a "performance-based" approach, such that the DSOs remuneration would be based on the performance of the network rather than the volume of electricity.

8.6 Appendix F - Updated stakeholder assessment methodology

This section describes our approach to the updated stakeholders' assessment. This task has the objective to gather relevant information and to find evidences on which policy option would be the most "welcome" in stakeholders' view.

We carried out a primary research programme involving two survey questionnaires and interviews (either face-to-face or telephonic) with selected industry associations and DSOs.

The first step was the identification of relevant stakeholders. The objective of these tasks were to understand the national context, to what extent the proposed policy options already reflect the Member State realities, the drivers and obstacles in relation to market and structural characteristics.

Interviews

Most of the face-to-face and telephonic interviews were carried out in Brussels during the week 12/04 – 19/04 2016. The interviewers asked fixed questions in a consistent format, mainly specific and closed questions, using a standardized questionnaire. The objective of the assessment was the evaluation of the policy options by the stakeholders and to gather relevant feedbacks.

Questionnaire

We developed two questionnaires, one main questionnaire and a follow-up (please see annex), that were distributed among DSOs in different Member States. We obtained most of the contact details thanks to the cooperation of Eureletric.

The questionnaires were finalized considering the data gaps and European Commission 's comments on the first interim report.

The questions are mainly semi-structured questions allowing the respondents to provide perspectives and information. We also designed a target-tailored questionnaire, composed of sections/questions that are common for all respondents.

The structure and the key topics covered:

Questionnaire 1:

I. Policies for DSOs
II. Distribution Tariffs
III. Data Handling
IV. Forecast information

Questionnaire 2:

I. Procuring flexibility services
II. Volume-based tariffs vs. capacity elements and time elements
III. Data handling and cybersecurity

The survey questionnaires were distributed primarily via email. The questionnaires were run for several weeks in order to give respondents an opportunity to respond to the fullest possible extent (including reminder).

As soon as the first survey results came back, we started carrying out an early descriptive analysis of the results.

The key findings were used in the global assessment. The survey report's conclusions focused on the implications and tangible results of the main findings, explaining what those findings actually mean in a policy context.

List of interviewees:

Round 1:

Name	Country
University of Cyprus	Cyprus
Energia	Finland
RWE	Germany
DEDDIE	Greece
Enexis	Netherlands
Energi Norge	Norway
GKPGE	Poland
EDP	Portugal
Iberdola	Spain
Energy Networks	UK

Round 2:

Name	Country
University of Cyprus	Cyprus
Dansk Energi	Denmark
Energia	Finland
ERDF	France

RWE	Germany
DEDDIE	Greece
EDP	Portugal
Enexis	Netherlands
Energi Norge	Norway
Iberdola	Spain
Energy Networks	UK

8.7 Appendix G – Governance and public intervention

This appendix supports the analysis in Chapter 6: Task 4 comparing the options.

Governance & Public intervention

In the following table we present the expected impact on governance and public intervention in impact matrixes for comparison (policy options versus impacts). In this multi-criteria analysis, the "business as usual" scenario is used as the reference scenario.

We look at three main actors: EU level intervention, national actors and companies. For each of them we indicate the following:

Sign	Level of impact	Type of action
-	No involvement, impact	No EU intervention
*	Light impact	Guidance - Providing best practice, carry out studies, expert meetings with Member States
**	Medium impact	Development of standard or practices or guides at EU level (binding or non-binding)
***	Large impact	Enforcement – control implementation and compliance of legislation

Our assessment is based on the following principles:

- The subsidiarity principle underlines the EU level involvement. There should be a clear value added of EU involvement.
- Harmonizing rules could lead to better business environment (DSO not bound to operate nationally)
- Agreeing on standards and sharing best practice ensure interconnectivity between member states and knowledge sharing
- Preparation for internal market for electricity (better use of electricity resources and lower prices)

Actors:

At EU level the main actor is the European Commission (unless stated otherwise), at national level the actors are the respective ministry responsible for energy and the national energy regulators (NRA). ACER is the representative of all Member states NRAs at EU level. In terms of companies we mainly consider DSOs. It is important to recognize that for historical reasons DSOs are very diverse. In some countries there is only one DSO, in others several or thousands. Today, few DSOs are multinational or own DSOs in other Member States. Few DSOs remain state owned. One consideration for the new legislative proposal would be the creation of an EU association representing the interests of DSOs, alongside ENTSO-E.

Section 1: Cost efficient grid operation

Figure 10: Summary Table of Governance - cost efficiency grid operation

Impact type/criteria	Option 0	Option 1	Option 2
Criteria			
Actors involved:	NRAs	European Commission, NRA, ACER, DSO	European Commission, NRA, ACER
Requirement for monitoring:	National level	EU Level and National	EU Level and National
Impact type			
- subsidiarity	-	**	***
- institutional feasibility	***	***	***
- interaction with other Community interventions and other EU Member States	*	***	***
- efficiency & effectiveness (value for money)	*	**	***

Option 0 -Business as usual: no change in EU legislation on tasks of DSOs; Member States are responsible for deciding on a number of non-core tasks as well as on remuneration. NRA's will continue to decide which activities DSO's can engage in.

- Main actors are NRAs
- Monitoring required at national level

This option implies a low level of harmonisation at EU level. Most likely the outcome will be a variety of systems across EU Member States. Monitoring will be a national responsibility. Whereas the option 0 offers flexibility (choosing regimes and national level) the impact and value for money at EU level is limited.

Option 1 - Allow and incentivize DSOs to acquire flexibility services from distributed energy resources. Establish specific conditions for DSOs to use flexibility, and ensure the neutrality of DSOs when interacting with the market or consumers. Clarify the role of DSOs only in specific tasks such as data management, the ownership of local storage and electric vehicle charging infrastructure. Establish mandatory cooperation between DSOs and TSOs on specific areas, alongside the creation of a single European DSO body.

- Actors/roles - European Commission (Definition of 'positive list' of actions/tasks at EU level). ACER, NRAs and appointed Ministry to be involved in EU working groups). DSOs to be consulted via a potential future European DSOs group.
- Monitoring - European Commission to monitor compliance at EU level and NRAs to monitor at national level.

This policy option will give rise to the development of a 'positive list' of actions/tasks at EU level which DSOs can engage in. In terms of subsidiarity creating a level EU playing field on certain areas will benefit from involvement at EU level in terms of coordination, setting the roles and monitoring. Option 1 should be highly feasible; as the EU already has similar working groups and interaction with other Community initiatives and across Member states are ensured with the by involvement of the European Commission and all Member states. The value for money should be high but limited to the intervention (not a full harmonisation). The creation of a European wide DSO association would strengthen the position of DSOs as counterparts to the EU working groups.

Option 2 - Allow DSOs to use flexibility but without any constraints or cooperation with TSOs. Define specific tasks for all DSOs across EU and apply stricter unbundling rules.

- Actors: European Commission (Definition of a broader "'positive list' of actions/tasks at EU level which DSOs can engage in). ACER, NRAs and appointed Ministry to be involved in working group. DSOs to be consulted (via potential future European DSOs group)
- Monitoring: European Commission to monitor compliance at EU level. NRAs to monitor at national level.

This policy option will give rise to the development of a broader 'positive list' of actions/tasks at EU level which DSOs can engage in. Actions will be allowed even if they are not directly linked to congestion management, e.g. also procurement of ancillary services. An example could be that a DSO has obtained surplus flexible demand which was originally acquired for congestion purposes, and that it is now allowed to resell this flexible demand to a market place (e.g. to the TSO or directly in the balancing market). This broader interpretation of allowable tasks will to a larger extent be potentially exposed to competition from other market participants.

The expected impact in terms of governance is similar to option 1 only that option 2 goes further and would require increased monitoring of the market development at EU level. It is expected that the increased opening of markets will increase the value for money as compared to option 1.

Section 2: Distribution tariffs

Figure 11: Summary Table of Governance – Distribution tariffs

Impact type/criteria	Option 0	Option 1	Option 2	Option 3	Option 4
Criteria					
Actors involved:	NRAs (European Commission)	European Commission, NRA, ACER	European Commission, NRA, ACER	European Commission, NRA, ACER	European Commission, NRA, ACER
Requirement for monitoring:	EU Level and National	EU Level and National	EU Level and National	EU Level and National	EU Level and National
Impact type					
- subsidiarity	-	**	***	***	***
- institutional feasibility	***	***	***	***	***
- interaction with other Community interventions and other EU Member States	**	***	***	***	***
- efficiency & effectiveness (value for money)	*	*	**	***	***

Option 0 - ***Business as usual:*** *NRAs competences include full and exclusive powers for* ***setting or approving distribution tariffs*** *or methodologies in the framework of* ***existing TEP and EED provisions***

- Actors: NRAs: *setting or approving distribution tariffs*
- Monitoring: European Commission to monitor compliance with TEP and EED at EU level (businesses usual). NRAs at national level

No minimum requirements imposed at EU level besides in the framework of existing TEP and EED provisions. Institutionally feasible. Interaction with TEP and EED provisions foreseen. Likely to see variation and continued non-transparent tariff setting (value for money low at EU level).

Option 1 - Clarify the framework for NRAs in terms of authorisation and calculation of distribution tariffs, impose obligations on more detailed transparency requirements, and introduce common EU performance indicators to be made publicly available. Introduce new requirements on DSO development plans

- Impose transparency and common performance indicators. This would imply that consumers have more information on the tariff level and structure; a prerequisite for changing behaviour in response to tariffs. Moreover e.g. electricity intensive consumers would be able to use the DSOs 'performance' (cost and quality) as a decision on where to locate production. This information could e.g. be part of new DSO development plans
- The framework for NRA authorisation and calculation of tariffs should be clarified e.g. through guiding principles. An example could be to change the EE-directive Annex from 'network tariffs shall not prevent the shifting of loads from peak to off-peak' to 'network tariffs shall actively seek to shift loads from peak to off-peak'.
- Actors: European Commission/ACER (*clarify the framework for NRAs, introduce common EU performance indicators and new requirements on DSO development plans).* NRAs and appointed Ministry to be involved in EU working group. DSOs to be consulted (via potential future European DSOs group). Potential future (European DSOs group to develop plans at EU level)
- Monitoring: European Commission/ACER to monitor indicators at EU level. NRAs to monitor performance indicators at national level.

Option 2 In addition to option 1, harmonize distribution tariff elements regarding distributed energy resources and self-consumption in order to ensure that discrimination among grid users or distortion of competition does not happen.

- Not just clarifying the NRA framework for authorising and calculating tariffs, but directly stipulating that distributed energy resource and self-consumption should be treated in the same manner across EU; in a way that ensures no discrimination among grid users and of competition. An example of this would be to follow the THINK report's recommendation of exposing distributed energy resources to full tariffs (no hidden subsidies) in order to send efficient signals (distributed energy resource could be supported through other channels if deemed appropriate).
- Actors: European Commission to lead framework for harmonizing distribution tariffs. ACER, NRA and appointed Ministry to be involved in working group. DSOs to be consulted (via potential future European DSOs group).
- Monitoring: European Commission to monitor transposition and compliance with harmonized EU standard

This option may prepare the EU well for changes in future demand such as penetration of electric vehicles.

Option 3. Harmonization of distribution tariffs across EU: fully harmonize distribution tariff methodologies at EU level for all EU DSOs.

Stipulate common calculation methodologies for all tariff elements. Not tariff size but methodology. An example could be to impose a capacity-based element in all tariffs and maybe also a particular (relative) size of the capacity element. Another example, that all Member States adopted the same approach to reverse flows and setting tariffs to owners of electric vehicles (the first three EVs do not impose much cost on the grid, but number, say, 5 impose substantial new costs). We will assess this policy option as the one being able to align current tariffs most towards best practice.

- Actors: European Commission to lead framework for harmonizing distribution tariffs. ACER, NRA and appointed Ministry to be involved in working group. DSOs to be consulted (via potential future European DSOs group).
- Monitoring: European Commission to monitor transposition and compliance with harmonized EU standard

This option explores the full value for money of EU collaboration having a harmonized and transparent approach. The main drawback is the flexibility of having various national or local schemes adapted to national local conditions.

Option 4 Introduce a time-element in the distribution tariffs obliging Member States to differentiate tariffs according to time. Specific calibration up to Member States discretion.

- European Commission to lead framework for harmonizing distribution tariffs. ACER, NRA and appointed Ministry to be involved in working group appointed Ministry to decide on specific calibration. DSOs to be consulted (via potential future European DSOs group)
- Monitoring: European Commission to monitor transposition and compliance with harmonized EU standard

This option can be seen as 'light' version of policy option 3, where tariff methodologies are only harmonised with respect to the inclusion of a time element.

Section 3: Data handling

Figure 12: Summary Table of Governance - Data handling

Impact type/criteria	Option 0	Option 1	Option 2
Criteria			
Actors involved:	NRAs	European Commission, NRA, ACER	European Commission, NRA, ACER
Requirement for monitoring:	National level, EU Level	EU Level and National	EU Level and National
Impact type			
- subsidiarity	-	**	***
- institutional feasibility	***	***	***
- interaction with other Community interventions and other EU Member States	*	***	***
- efficiency & effectiveness (value for money)	*	**	***

Option 0 - Business as usual: each Member State develops its own data handling model in line with rules in the TEP, the EED and upcoming data protection and security legislation.

- Actor/Role DSO and NRA to decide on the data handling model
- Monitoring EC to monitor compliance with TEP and EED and upcoming data protection and security legislation at EU level. NRA and Data Protection Authority to monitor at national level

While maintaining flexibility various data handling models elements and standards are likely to arise.

Option 1 - Update and strengthen EU rules for access to consumer data and related processes to guarantee transparency, objectivity, non-discrimination, and interoperability by any market actor currently responsible for handling data, including DSOs and data hubs.

Maintaining flexibility of main model but guiding/directing on specific elements such as e.g. (there could be more):

- Interoperability (standards on meters or processed data/national, regional or EU level)
- Documentation of non-discriminatory practice regarding data (e.g. reports of timeliness when delivering data to suppliers and third parties) especially in case of bundled DSOs undertaking the data handling (and distribution) task.
- Stipulating that 3rd parties must be granted access to data if consumer consent
- Actor roles: European Commission to lead update of EU rules; ACER, NRA and appointed Ministry to be involved in working group; DSO/TSO/data protection authorities to be consulted
- Monitoring: European Commission to monitor transposition and compliance EU rules.
- National Data protection authority to monitor data privacy

Option 2 - Mandatory data handling model: A specific data handling model and responsible entity (-ies) in each Member State, with uniform processes and access rules to the data. EU rules for access and processes to guarantee transparency, objectivity, non-discrimination and interoperability.

Imposing a particular model e.g. centralised data hub with TSO as administrator.

- *Actors / roles:* European Commission to lead update of EU rules; ACER, NRA and appointed Ministry to be involved in working group; DSO/TSO/data protection authorities to be consulted
- Monitoring: European Commission to monitor transposition and compliance EU rules. National Data protection authority to monitor data privacy

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