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# CBA OF A CHANGE TO THE IMBALANCE SETTLEMENT PERIOD

## A report for ENTSO-E

08 April 2016

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Exhibits

# 1 EXECUTIVE SUMMARY

1.1.1 [●To be completed in the final draft]

# 2 INTRODUCTION

2.1.1 The draft Network Code for Energy Balancing (NC EB) requires all TSOs to develop a proposal to harmonise the main features of imbalance settlement, subject to approval by all NRAs. However, the Imbalance Settlement Period (ISP) duration falls outside this proposal and may be drafted into the final version of the NC EB.

2.1.2 ACER has reviewed the draft NC EB and has proposed that the Imbalance Settlement Period duration be harmonised at 15 minutes. ACER also proposes that its recommendation on the Imbalance Settlement Period be assessed by ENTSO-E using a cost benefit analysis (CBA) to be undertaken before the NC EB enters the Comitology process.

2.1.3 ENTSO-E asked Frontier and Consentec to develop a general methodology for TSOs in relation to the completion of the CBAs envisaged in the NC EB, and a specific methodology for the completion of the CBA for ISP harmonisation. The two reports have been published on ENTSO-E's website:

- Cost Benefit Analysis for Electricity Balancing – general methodology.
- Cost Benefit Analysis for Electricity Balancing – ISP harmonisation methodology.

2.1.4 Following on from the development of these documents, ENTSO-E has asked Frontier to support the process of undertaking a CBA of a change in ISP duration. This document sets out our findings of that analysis.

2.1.5 The remainder of this report is structured as follows:

- In section 3 we set out the overall scope of our analysis and the process followed to undertake the CBA;
- In section 4 we set out our conceptual analysis of the potential effects resulting from a change to the ISP and therefore the analysis potentially required;
- In section 5 we set out details of the data request issued to stakeholders based on this conceptual analysis;
- In section 6 we consider costs, and describe the nature of responses to the questionnaire, the approach taken to estimating costs given the data received, and the results obtained;
- In section 7 we consider benefits, and describe the nature of the responses to the questionnaire, the approach taken to estimating benefits given the data received, and the results obtained;
- In section 8 we present the net CBA findings across the countries studied, and on a country by country basis; and
- In section 9, we summarise our conclusions from the analysis and highlight the key limitations of this analysis from a policymaking perspective.

2.1.6 The Annex provides further details of the analysis of costs associated with a change to ISP duration.

## DISCLAIMER

In the interests of transparent stakeholder engagement, and due to the tight timescales involved, National Grid and RTE (as members of ENTSO-E) have agreed that this version of the CBA ISP report should be shared with stakeholders to allow full consideration by attendees ahead of both the Balancing Stakeholder Group (BSG) on 13th April and the dedicated CBA ISP Stakeholder Workshop on 15th April. However, this is only under the following disclaimer.

National Grid and RTE are not currently in a position to endorse the benefit numbers for GB and France as set out in the ISP CBA report prepared for ENTSO-E by Frontier. We feel strongly that these stated benefits significantly overestimate the likely change in market and TSO balancing activities that would be seen as a result of a shortened ISP. This is based on both internal TSO analysis and also discussions with potentially impacted BSPs and BRPs.

National Grid and RTE appreciate the benefits of a robust CBA report on this topic and are currently working with Frontier to better understand the specific derivation of the numbers presented in sections 7 and 8 of the report. This is because we are concerned that the specific approach applied to derive the benefit numbers within the report may not apply in the same manner or scale to all markets given the differences in operational practices.

For GB specifically, NGET expects limited benefits from the move to a 15 minute ISP and would suggest credible GB benefits to be significantly less than the low case set out in the report. We remain to be convinced that any shortening of ISP duration would give rise to a significant change in the market imbalance volumes based on the proposed effect of transferring balancing volumes to the intraday market. Based on discussions with GB stakeholders, we are aware that similar concerns are shared across other sections of the GB electricity industry.

For France specifically, RTE expects limited to no benefit from the move to a 15 minute ISP with regard to the shift of balancing energy to intraday in terms of overall benefit for the end consumer, when TSO has access to the same set of flexibilities than BRPs. In France, RTE performs proactive unit schedule shifting to cover the anticipated power imbalances. Overall efficiency of centralized vs. decentralized actions can't be approximated by a difference of historical intraday and balancing prices. Based on discussions with French stakeholders, this concern is shared across other aspects of the French electricity industry.

ENTSO-E welcomes stakeholder's feedback on the whole report and also on these specific topics.

# 3 OVERALL SCOPE AND PROCESS FOLLOWED

## 3.1 Introduction

3.1.1 In this section, we describe:

- the scope of the CBA; and
- the process we followed to carry out the CBA, including:
  - our conceptual analysis;
  - the approach taken to collecting data;
  - the approach taken to analysing stakeholder responses; and
  - our approach to developing conclusions.

## 3.2 Scope of the CBA

3.2.1 Although ACER's proposal is to harmonise ISP duration at 15 minutes, the CBA is intended to assess this proposal to understand whether it is the best choice of ISP duration or whether alternative proposals would be better. For this reason multiple factual scenarios were defined and considered, rather than a single scenario of moving to 15 minute ISPs throughout Europe.

3.2.2 Four factual planning cases were defined, which are compared in the CBA. The CBA for each planning case is assessed by comparison to the counterfactual planning case – where ISPs remain as of today. The CBAs for the four planning cases (relative to the status quo) are then compared against each other.

**Exhibit 1. Five alternative planning cases**

| | Description |
|---|---|
| 1 Counterfactual - All ISP remain as of today | ▪ All regions remain with today's ISP (modified by changes *already decided on*) |
| 2 All regions go to 15 min ISP | ▪ Countries with 15 min ISP remain untouched<br>▪ All other countries change to 15 min ISP |
| 3 If change required, move to 15 min | ▪ Countries with 60 min ISP move to 15 min<br>▪ Countries with 30 min ISP remain unchanged |
| 4 If change required, align with neighbours | ▪ Countries with 60 min ISP move to either 15 min or 30 min (depending on largest neighbour) |
| 5 All regions to 5 min ISP | ▪ Full harmonisation to 5 minutes |

*Source: Frontier Economics*

3.2.3 Below, we:

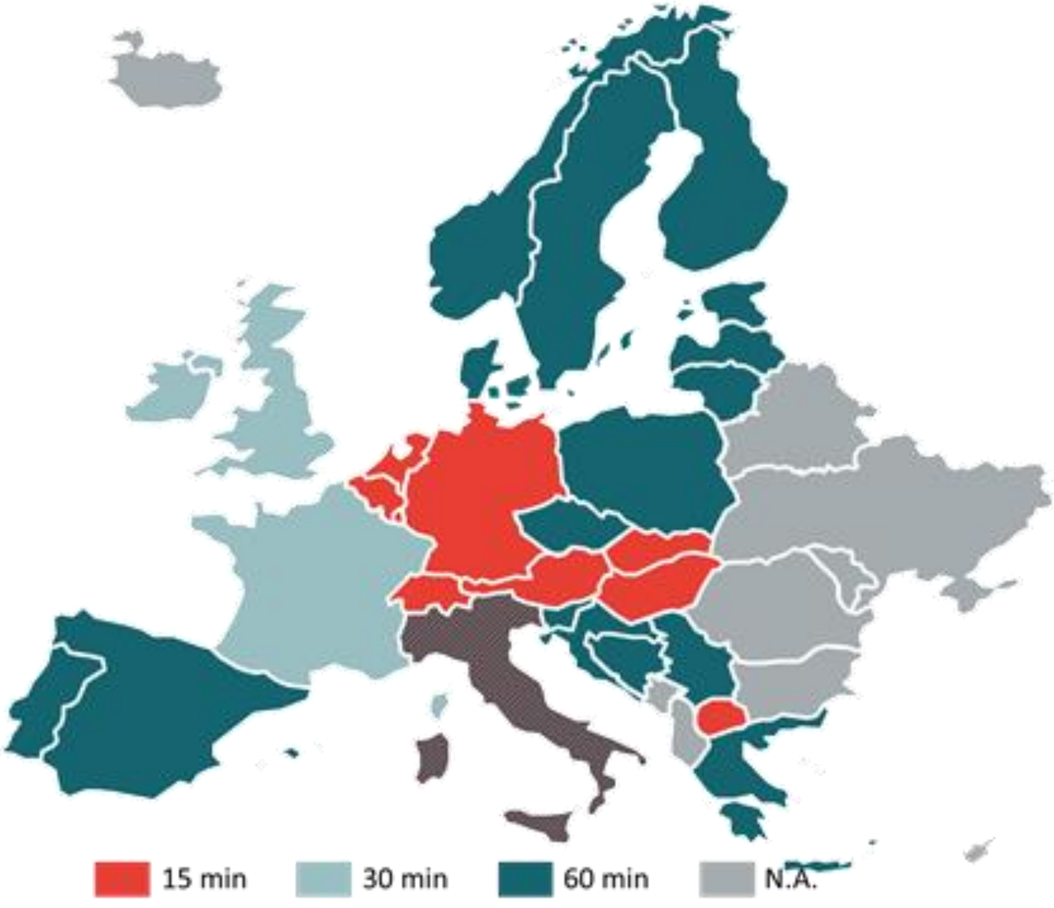
- describe each planning case in more detail;
- set out some further overarching assumptions which form the scope of the CBA; and
- set out the approach taken to defining a geographical and temporal scope for the CBA.

## Status quo – all ISPs remain as today

3.2.4 As a starting point, the CBA requires a thorough understanding of the status quo, that is to say, the state of the world that will prevail absent ISP harmonisation.

3.2.5 In the status quo, ISP durations would be assumed to be equal to those observed as of 2014 for all countries, as depicted in Exhibit 2.

**Exhibit 2. ISP duration in the status quo**




*Source: ENTSO-E WGAS, Survey on Ancillary services procurement, Balancing market design 2014, Jan 2014. Also TSO websites*

*Note: Italy has a 60 minute ISP with the exception of Balancing Service Providers (BSPs) that are required by regulation to have a 15min ISP*

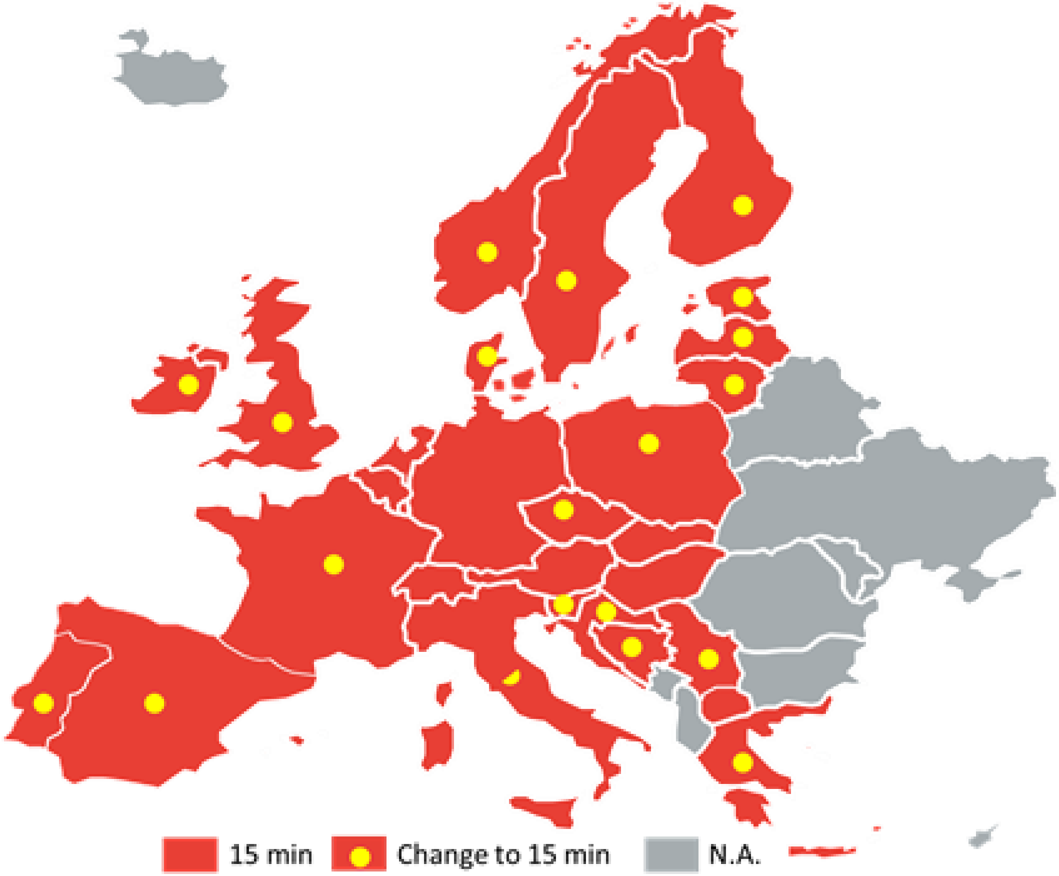
3.2.6 The CBA also considers as part of the status quo any changes decided prior to the CBA being carried out. This includes any changes to ISP duration as well as other changes potentially driving the costs and benefits of changes to ISP durations, such as:

- smart meter roll-out;
- changes to metering rules;
- changes to imbalance price setting rules;
- definition of ancillary services products;
- physical notification rules;
- etc.

## Planning case 1 – full harmonisation to 15 minutes

3.2.7 Under full harmonisation, all ISP durations are aligned to 15 minutes across the EU+3 countries. As Exhibit 3 shows, in this planning case a change of ISP will be required in 20 countries (including Italy).

**Exhibit 3. ISP duration under harmonisation to 15 minutes**




*Source: ENTSO-E WGAS, Survey on Ancillary services procurement, Balancing market design 2014, Jan 2014. Also TSO websites*

*Note: Italy has a 60 minute ISP with the exception of BSPs that are required by regulation to have a 15min ISP. Therefore, Italy would need to change the ISP for non-BSPs to 15 minutes under this case*

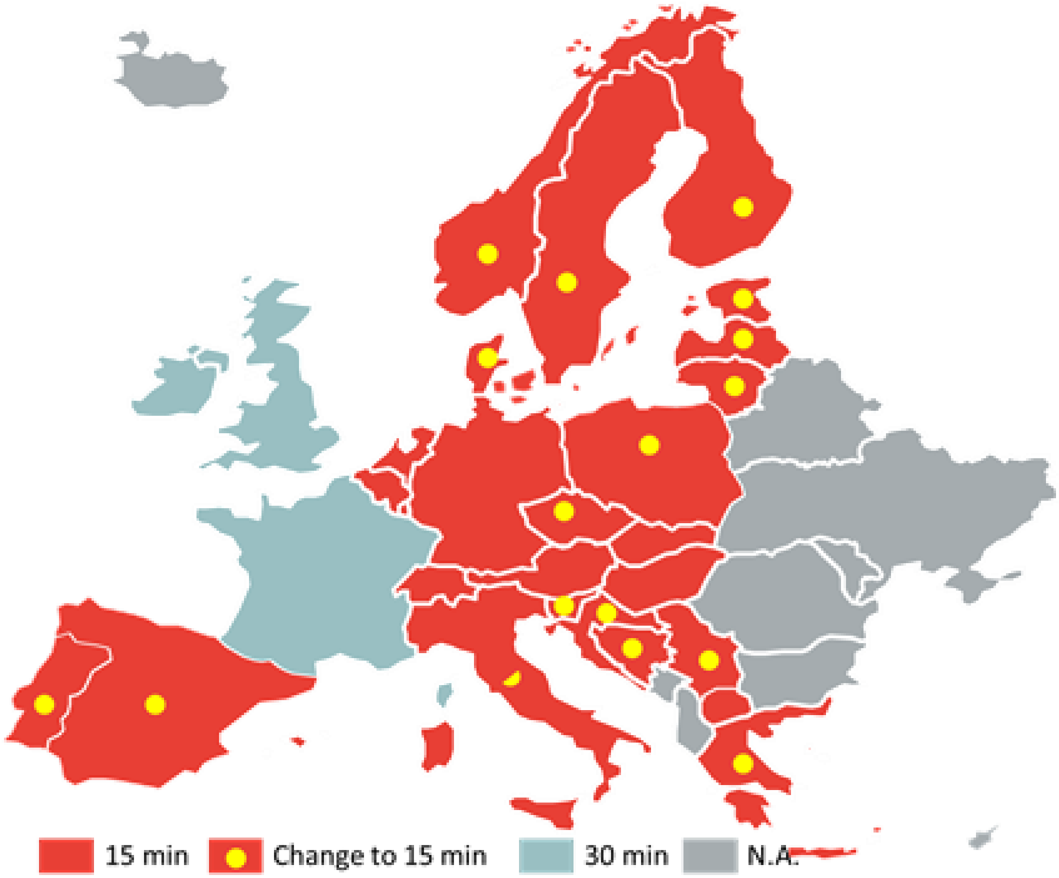
## Planning case 2 – harmonise to 15 minutes only those currently at 60 minutes

3.2.8 In this case, all countries currently with an ISP of 30 minutes or shorter retain their ISP duration, while countries currently with an ISP of more than 30 minutes reduce their ISP duration to 15 minutes.

3.2.9 This planning case has been derived with the potential expectation that it might minimize costs by changing ISP duration for as few countries as possible, while conforming to the framework guideline proposal of a maximum ISP of 30 minutes. This planning case will thereby test whether net benefits in the CBA are maximised by trying to minimise costs. The rationale for this planning case should however not influence stakeholders' views on costs and benefits.

3.2.10 As Exhibit 4 shows, in this planning case the ISP would be changed in 17 countries (including Italy).

**Exhibit 4. ISP duration under harmonisation to 15 minutes of only those currently at 60**




*Source: ENTSO-E WGAS, Survey on Ancillary services procurement, Balancing market design 2014, Jan 2014. Also TSO websites*

*Note: Italy has a 60 minute ISP with the exception of BSPs that are required by regulation to have a 15min ISP. Therefore, Italy would need to change the ISP for non-BSPs to 15 minutes under this case*

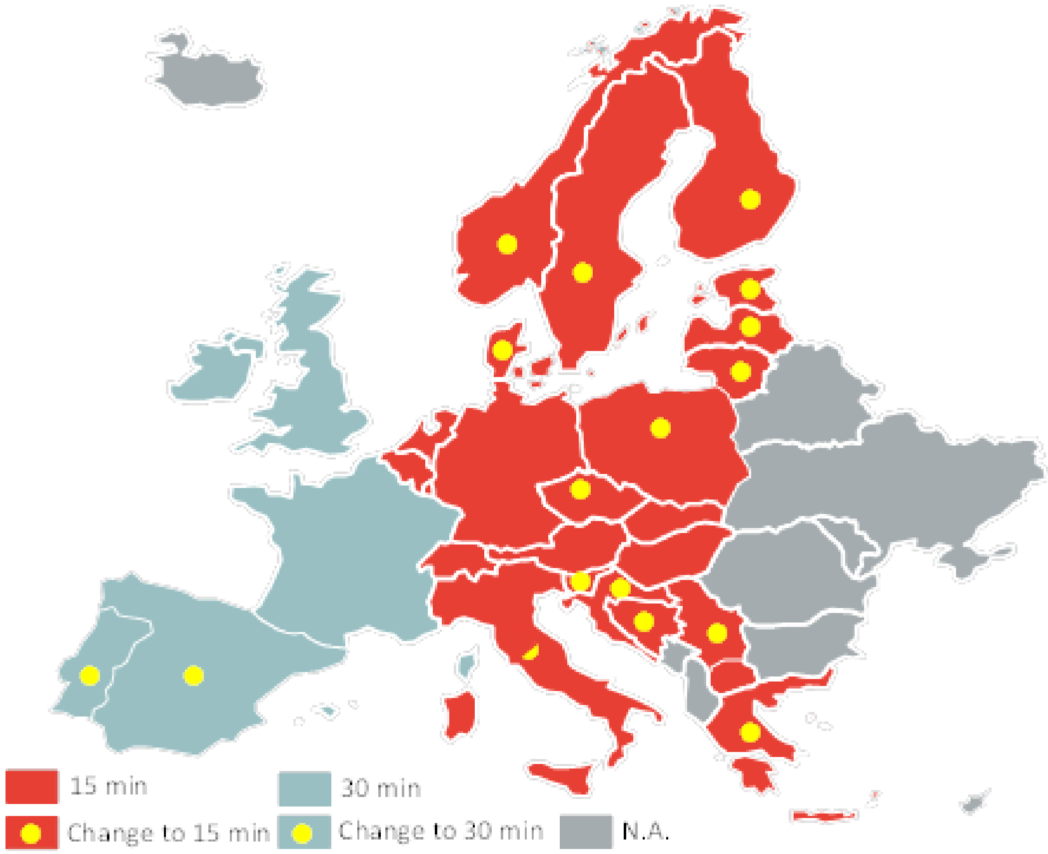
## Planning case 3 – harmonisation by matching ISPs in neighbouring countries

3.2.11 In this planning case, countries that currently have an ISP duration greater than 30 minutes would change ISP. However, they would change to have the same ISP duration as the ISP duration of their largest neighbour, i.e. they do not necessarily all change to a 15 minute ISP as with the previous planning case.

3.2.12 As Exhibit 5 shows, in this planning case the ISP would be changed in 17 countries (including Italy):

- Spain and Portugal would align their ISPs with France, resulting in one harmonised south-western region with 30 minute ISPs;
- All countries in central Europe move to an ISP of 15 minutes, as is already the case in Germany and other countries in the region; and
- The Nordic and Baltic countries would shorten their ISP to 15 minutes.

**Exhibit 5. ISP duration under harmonisation to largest neighbouring country**




*Source: ENTSO-E WGAS, Survey on Ancillary services procurement, Balancing market design 2014, Jan 2014. Also TSO websites*

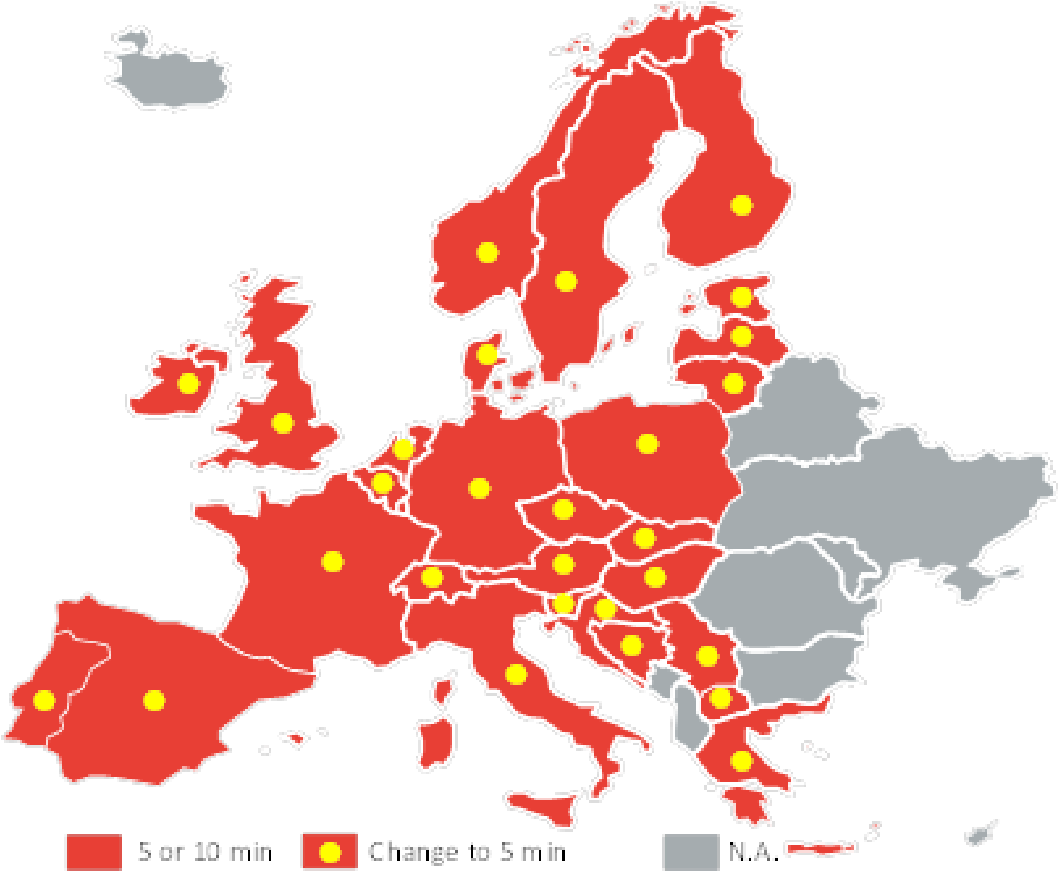
*Note: Italy has a 60 minute ISP with the exception of BSPs that are required by regulation to have a 15min ISP. Therefore, Italy would need to change the ISP for non-BSPs to 15 minutes under this case*

## Planning case 4 – harmonise and all regions reduce to 5 minute-ISP

3.2.13 In this planning case, all ISPs are both harmonised and reduced in duration. The CBA considers the impact of ISPs being reduced to 5 minutes across countries. The reason for including this ISP is to test whether there are benefits to a very short ISP (consistent with the despatch time horizon used in some markets outside Europe) over and above those of complete harmonisation to a 15 minute ISP.

3.2.14 As Exhibit 6 shows, this requires that all 31 countries in the scope of the CBA change their ISP.

**Exhibit 6. ISP duration under harmonisation to 5 minutes**




*Source: ENTSO-E WGAS, Survey on Ancillary services procurement, Balancing market design 2014, Jan 2014. Also TSO websites*

*Note: Italy has a 60 minute ISP with the exception of BSPs that are required by regulation to have a 15min ISP. Therefore, Italy would need to change the ISP for non-BSPs to 15 minutes under this case*

3.2.15 It was also envisaged to consider the costs and benefits of harmonising and reducing ISP duration to 10 minutes across all countries. In order to contain the amount of information asked from stakeholders it was decided that the survey would focus on the 5-minute planning case.

## Overarching assumptions for all planning cases

3.2.16 For each planning case, the only change assessed in the CBA is that of the ISP duration alone. In particular, the CBA assumes:

- No change in the actual imbalance pricing algorithm or more generally in any other part of the imbalance settlement process;
- No change in the balancing mechanism gate closure time;
- No change in Final Physical Notification content, process or timing;
- A fully functional target model with coupled intraday markets;
- The market time unit (MTU) for the intra-day market changes in line with the ISP duration; and
- The MTU for the day-ahead market remains as it is today.

3.2.17 In practice, if we consider the example of the move from a 30-minute to a 15-minute ISP duration, the CBA assumes that:

- A number of trading products become available on the intraday market with delivery windows equal to 15 minutes (e.g. 14.15 to 14.30); and
- The amount of time elapsed between gate closure time and the start of each delivery period does not change – if this was 30-minutes previously, then in the planning case it is still the case that gate closure occurs 30 minutes before the start of delivery. This will require new gate closures to be created across the day (e.g. 13.45 for the delivery period starting at 14.15).

## Geographical scope

3.2.18 The geographic scope of the CBA includes the EU+3 (i.e. the EU + Switzerland, Norway and Lichtenstein).

## Time frame

3.2.19 The analysis of costs and benefits is carried out over a time horizon of c. 10 years after implementation date. ACER's recommendation is that any changes to ISP duration are made by 1 July 2019. For simplicity, the CBA assumes that the necessary actions to implement the change are taken by the end of 2019.

3.2.20 Therefore, we estimate:

- one off capital costs relating to the implementation of a change in ISP, which may be incurred in the years leading up to the change. We assume that the NC EB would have passed through the Comitology process and entered into force at the end of 2016. This would give stakeholders two and a half years from when they knew the requirements of any change imposed by the NC EB to the date by which the change had to be implemented; and
- ongoing costs and benefits for the years 2020 and 2030, and interpolate between the results for these years.

## 3.3 Process followed

### Conceptual analysis

3.3.1 At the outset, we undertook conceptual analysis to identify the areas of possible costs and benefits which we believed it would be worth considering, and the data required from stakeholders in order to assess them.

### Collecting data

3.3.2 The analysis of the costs and benefits of a change to the ISP relies heavily on input from stakeholders representing market participants of various different classes across Europe. This is because:

- The costs incurred as a result of changes to the ISP are likely to depend on the conditions in specific countries and even in specific companies. For example, if a particular country has relatively few meters that measure and record data by the ISP, or if a particular company has installed meters which can be remotely reconfigured, then costs of change may be significantly lower than in other situations.
- The benefits are likely to depend on the behaviour of participants. For example, if participants engage in active trading of shorter energy products to achieve a close balance between physical and contracted positions, a shorter ISP may reduce TSO costs in a way which would not happen if participants were less engaged (e.g. because of a different imbalance settlement regime).

3.3.3 As a result, based on our conceptual analysis, we designed and circulated a questionnaire to a wide range of European stakeholders to understand their views in detail of the likely costs and benefits of changes to the ISP. The survey asked questions in relation to each stakeholder's:

- Role in the market (i.e. aggregator, broker, data provider, DSO, end consumer (metered), generator (metered), imbalance settlement agency (non-TSO), market operator, meter provider, metering service provider, power exchange, retail supplier, trader and TSO);
- Scale, in order to allow responses to be scaled up to allow a view to be formed on costs and benefits for individual countries and for Europe as a whole;
- Views on costs (quantitatively and qualitatively); and
- Views on benefits (quantitatively and qualitatively).

3.3.4 Prior to issuing the data questionnaire, we held discussions with ENTSOE's Working Group and we held a stakeholder workshop setting out our views on cost and benefit categories and outlining our proposed overall approach to the analysis.

3.3.5 The questionnaire was made public by ENTSO-E and was distributed to industry groups in order that they could make their members aware of its existence. As a result of the overall timescale for the project, stakeholders had a relatively short (7 working week) period to respond to the questionnaire. During this period we held two teleconferences with stakeholder representatives to respond to questions about the questionnaire and the overall approach. We responded in writing to questions submitted as part of this process. ENTSO-E also maintained an up to date questions and answers document on its website to help stakeholders to understand the questionnaire.

3.3.6 As part of the questionnaire process, we recognised that we would receive data which was confidential to the companies concerned. We therefore committed that information gathered through the survey could only be published in an aggregated form, e.g. by stakeholder group and by country.

## Analysis of stakeholder responses

3.3.7 In total we received 125 surveys from a variety of stakeholder types and market areas. Surveys differed significantly from one another in terms of the scope of questions answered; we discuss the representativeness and level of documentation of responses separately for costs and benefits below (see sections 6 and 7).

3.3.8 Upon receipt of the stakeholder responses, we undertook a number of activities. In particular, we:

- Collated the quantitative and qualitative information submitted;
- Identified significant "extreme" datapoints and areas where there were ambiguities in relation to responses; and
- Contacted respondents to clarify these points, and in some cases edited the data submitted to address differences in interpretation of questions. We contacted over 70 respondents to clarify aspects of their submissions.

3.3.9 Some responses were received after the deadline for submission. We have tried to take the information from these responses into account in the analysis although in some cases it was not possible in the time available.

3.3.10 It is important to note that we did not undertake a full "due diligence" activity on each data item submitted. This would not have been possible within the time available for the project, and in many cases, we would not have had the necessary insight to assess whether every aspect of costs and benefits being submitted by parties could be fully justified. Neither was the dataset submitted sufficient to allow a process of removal of all but the most clear statistical outliers. Therefore our "data cleansing" process is best understood as one of removing extreme points, and sense checking remaining data against other responses (within country and across Europe).

3.3.11 Even prior to this data cleansing activity, the dataset from respondents had material gaps. In particular:

- Very few respondents provided a complete quantification of individual benefit expectations, though qualitative comments were helpful in understanding the broad scale of the expected impact, and helpful partial quantification (e.g. of the price effect without the volume effect) was provided in some cases;
- A material number of submissions on costs had data gaps, where we needed to understand whether zero costs or benefits were expected or whether

stakeholders expected a non-zero value but were simply unsure of magnitudes;

- The data required to “scale up” estimates of cost to a country-wide and Europe wide level were incomplete.

## Approach to developing conclusions

3.3.12 As a result of the nature of the dataset received, we needed to “fill in” data gaps in a number of areas:

- In relation to costs, the key area in which we had to fill in data related to the scaling up of costs. We relied on public source data for proxies for cost drivers for a number of key cost items to allow us to scale up estimates to individual countries and to the EU+3; and
- In relation to benefits, we had to rely on public source data to develop stylised illustrations of the potential benefits which could be expected in areas where respondents had qualitatively agreed that a benefit could be expected.

3.3.13 We discussed our approaches in these areas with ENTSOE’s WGAS.

3.3.14 We then carried out analysis to fill gaps in the stakeholder dataset. Again, the time available for this activity was constrained by the overall timeline for the project. Having carried out this analysis we discussed our initial findings on costs and benefits with ENTSOE’s WGAS and with stakeholders.

# 4 CONCEPTUAL ANALYSIS OF ISP CHANGE

## 4.1 Introduction

4.1.1 In this chapter, we set out our conceptual analysis of the potential changes to costs and benefits that an ISP change could be considered to have. This analysis formed the framework of our data collection exercise.

4.1.2 We consider separately the potential impact of a change to the ISP on:

- costs; and
- benefits.

4.1.3 We then also consider the distributional issues associated with these costs and benefits, i.e. how the costs and benefits fall to different stakeholders.

4.1.4 For the purposes of considering the size and distribution of costs and benefits we assume that demand for electricity is perfectly inelastic, i.e. the quantity demanded does not change with a change to price. For a small change to price, which would be the likely extent of any average price effect due to a reduction in ISP, we take the view that this is a reasonable assumption.

## 4.2 Impact on costs

4.2.1 A change to the ISP could have a one-off impact on costs (e.g. capital expenditure on IT systems or meters associated with the implementation of change) and ongoing costs (e.g. increased trading costs).

4.2.2 Our analysis relates to *incremental* costs of either type. Conversely, any costs incurred in the status quo should be ignored, including where the costs will be incurred in future under the status quo. In particular, costs of any changes decided prior to the CBA (e.g. changes to metering rules, imbalance setting rules etc.) are not related to a change to ISP duration.

4.2.3 We envisaged seven possible categories of cost resulting from a change to the ISP. These were:

- Trading platforms;
- Metering and notification systems;
- Scheduling and settlement;
- Billing systems;
- BRP forecasting, trading and scheduling;
- Documentation; and
- Network-related costs.

4.2.4 Below we describe each briefly in turn.

## Trading platforms

4.2.5 This cost item corresponds to the cost of modifying systems and processes to support intraday trading. The cost arises because the reduction in ISP duration will mean that platforms used for trading in intra-day timescales will need to be adapted to allow trade of shorter duration products.

4.2.6 This cost item could include costs in relation to:

- The cost of updates to systems and processes to support trading in shorter time windows. For power exchanges, this could include trading support systems, and for participants, this could include trading and risk management systems;
- Development of new trading algorithms: beyond updating existing systems, there could be a need for new algorithms supporting the change in market clearing processes.

## Metering and notification systems

4.2.7 This cost item corresponds to the need to update the software or physically exchange the existing meters, update software related to providing the meter data to the operator of the settlement systems, update software related to the notification of physical plans for generation or consumption to the TSO and / or operator of the settlement systems and update the software related to the notification of contractual quantities to the operator of the settlement systems.

4.2.8 It also relates to the incremental ongoing operating costs of handling additional data from meters, and providing additional data on physical plans and contractual quantities.

4.2.9 These costs arise because a shorter ISP duration means consumption data needs to be read over a shorter period and data required by the TSO and data required for settlement must be provided over a shorter period. We assume here that:

- the meters considered here are only those that are read for the purpose of imbalance settlements; and
- a meter is changed/reconfigured to match the new ISP duration only if prior to the ISP reduction the meter reading period matched ISP duration, and there is a clear ongoing business case for it to remain at the prevailing ISP duration.

4.2.10 In practice, this would typically mean that the meters that are changed/reconfigured are meters for:

- generators connected directly to the transmission network, and larger generators connected to the distribution network;
- larger end-consumers connected directly to the transmission network; and
- meters that can be found at the points of exit from the transmission network to the distribution network.

4.2.11 These meters would be changed / updated only if they were being read on the same periodicity as the imbalance settlement period duration in the status quo (counterfactual). Meters installed on the premises of smaller customers (which are billed based on profiling) would not be expected to be changed because of the change in ISP duration. Even those smaller customers that currently are billed based on metering at ISP frequency need not necessarily have their meters updated with a change to ISP duration unless there was a clear business case for doing so. We also understand that in a number of markets imbalance settlement and other billing actions use non-ISP metered data (e.g. use profiling) despite the fact that it is technically possible for the corresponding meters to be read at ISP granularity. In this type of case, we assume that these meters will not be changed.

4.2.12 This cost item could include:

- the one-off cost of replacing/updating the meters, which could in turn include changing meters, updating meters on site, remotely updating meters, changing meter reading (data collection) systems, and changing meter management systems (validation, storage and processing of data);
- incremental operating costs of managing new meters, including the cost of sending the increased amount of data from the metering responsible party to other market parties including the settlement system, the cost of changes to customer reporting systems etc.
- the cost of incremental change to processes required to provide shorter timeline data relating to contract volume notifications for each ISP to the operator of the settlement system. Where relevant, this notification would normally take place prior to gate closure and could be made by generator and load BRPs and in some cases by power exchanges;
- the cost of incremental change to processes required to provide shorter timeline data relating to notifications of physical generation and consumption plans to the TSO (or other service provider) prior to gate closure. In some cases the shorter ISP duration would require a higher frequency of notifications without changing the granularity of the data provided and in other cases the granularity of the data provided would decrease as the ISP duration is reduced; and
- the cost of changing the systems and processes used to allocate volumes associated with non-ISP based metering to ISPs.

## Scheduling and settlement

4.2.13 This cost item corresponds to the need for TSOs, PXs, BSPs, BRPs, imbalance settlement responsible organisations and other stakeholders to adapt their scheduling and settlement systems to the new ISP duration. This cost will likely relate to developing new IT systems or modifying existing systems.

4.2.14 This could include:

- the incremental cost of changing the systems and processes used to schedule plant over a shorter period of time (e.g. increased frequency in scheduling data);
- the incremental cost of changing the systems and processes to calculate and settle imbalances to deal with the shorter ISP, and the participant systems which interact with these;

- the incremental cost of changing the systems and processes to facilitate the settlement of trades (bilaterally and on exchange) on a shorter ISP basis; and
- incremental costs incurred by the TSOs and imbalance settlement responsible organisations and other relevant parties to adjust the frequency of data publication to the new ISP duration.

## Billing systems

4.2.15 Stakeholders billing their customers according to wholesale price outcomes at the level of the ISP (e.g. for large customers) may need to modify their billing systems. The cost is expected to occur for retail suppliers, the operator of the central imbalance settlement, TSOs and possibly DNOs.

4.2.16 This is likely to include the incremental cost of changing systems and processes to facilitate billing of customers based on the shorter ISP duration.

## BRP forecasting, trading and scheduling

4.2.17 This cost item corresponds to the increased effort made by BRPs to reduce their imbalance position by taking more actions with a finer granularity pre gate closure due to the shorter ISP[1] (Note: it is assumed that Gate Closure Time remains unchanged from the status quo). This encompasses developing new forecasting tools as well as developing new trading and data handling systems.

4.2.18 For BRPs, this includes a one-off cost of developing new forecasting tools or adapting old ones to reduce imbalances. For all stakeholders, there is a one-off cost of developing trading and data handling systems if the reduction in ISP results in increased trading on the intra-day market to manage imbalance positions, and ongoing costs associated with the maintenance of these associated systems and processes.

## Documentation

4.2.19 This cost item corresponds to the one-off cost associated with updating “central” country-specific documentation (balancing codes, network codes, ancillary services codes and agreements, documented procedures underlying codes (e.g. for profiling), transportation charging agreements etc). The incidence of this cost will vary by country: in some jurisdictions this could fall principally on the TSO, in others it may fall to imbalance settlement responsible organisations (as is the case in GB), or on the association of market parties (as is the case in Finland for some parts of the documentation).

4.2.20 The cost should also include the one-off cost associated with decentralised bilateral agreements (e.g. standard contracts for the sale and purchase of power or options to sell or buy power).

[1] See section 4.3 for a detailed description of this impact.

### Network-related costs

4.2.21 This cost item relates to the one-off and ongoing costs incurred by the DNOs and TSOs to adapt their network to the shorter ISP. This might include:

- upfront and ongoing costs associated with adapting the loss procurement system to the new ISP duration; and
- upfront and ongoing costs associated with adapting network optimisation systems to the new ISP duration.

## 4.3 Impact on benefits

4.3.1 We have broken potential benefits down into five separate areas:

- Reduced balancing costs;
- Increased secondary trading volumes;
- Improved investment outcomes;
- Other benefits; and
- Pass/fail criteria.

4.3.2 We discuss each in turn below.

### Reduced balancing costs

4.3.3 The first category of benefits relates to a reduction in the costs of balancing the system as a result of greater activity by participants to manage their own position and, as a result of doing so, to better balance national supply and demand pre gate closure.

#### Shift from balancing energy to intraday energy

4.3.4 In the status quo, Balancing Responsible Parties (BRPs) submit physical notifications and balancing bids and offers to the TSO, leading to balancing actions by the TSO post gate closure. Subsequent to a reduction in the ISP duration, there may be scope for BRPs to use the information on forecast generation at ISP duration granularity and take an increased number of trading actions in the intraday market (pre-gate closure) or physical actions (also pre-gate closure) to reduce their imbalance position in each ISP. This would in turn reduce the need for TSO balancing actions post gate closure. At the same time there could be a shift between manual and automatic reserves leading to a cost reduction (or increase) resulting from the reserve dimensioning methodology.

4.3.5 The existence of a benefit as a result of this change in behaviour rests on there being a difference in the price (or cost) achieved by the BRP when taking actions at a finer granularity on the intraday market relative to the balancing price achieved by the TSO (in EUR or local currency/MWh). This may be because of differences in the resources available in intraday and balancing markets, and could also be because of differences in trading strategy.

4.3.6 The net impact on welfare associated with this benefit would equal the sum of:

- changes in total balancing costs; and
- changes in wholesale costs.

### Lower reserve capacity cost

4.3.7 Similarly, TSOs may hold reserve to be activated post gate closure to manage system balance. Subsequent to a reduction in ISP duration, BRPs may instead withhold more capacity in the relevant market area (i.e. deliberately withhold it from forward markets) in order to allow for it to be sold on the intraday market with finer granularity or to be used for physical actions with finer granularity in the period leading up to gate closure. This may allow TSOs to hold less reserve capacity.

4.3.8 The net impact on total welfare would equal the sum of:

- the change in total balancing costs via the reduction in capacity held in reserve by the TSO for balancing purposes; and
- the change in wholesale costs.

4.3.9 In addition, structural or deterministic imbalances related to BRP ramping at the breakpoint between ISPs may be reduced due to a reduction in ISP duration, potentially reducing the reserve capacity held by the TSO.

### Greater intraday competition from cross border BSPs

4.3.10 Where ISPs are not currently harmonised across a border, it is likely to be difficult for BRPs in one country to sell energy in intraday markets at the lower ISP granularity. This is because this would cause balancing costs for the TSO in the market with the longer ISP which would not be targeted on those gaining from the trade.

4.3.11 Harmonisation of the ISPs across borders would therefore allow greater competition for the provision of intraday energy at a shorter MTU in one of the interconnected markets. This should in turn reduce the cost of serving energy in that market. This could also lead to an increase in the volume of energy sourced from intraday markets.

4.3.12 The welfare effect would equal the difference between the dispatch cost achieved cross-border and that achieved on the local market.

4.3.13 We assume that this benefit is not relevant to trading in balancing timescales. This is because during balancing timescales, TSOs could manage the interconnector flow over time periods significantly shorter than the ISP, and so in theory could exchange blocks of energy with any duration irrespective of the ISP definition.

4.3.14 There could be a further benefit as a result of BRPs withholding reserve capacity across borders rather than in national markets. If this were to exist, the welfare benefit would come from the difference in cost of withholding capacity on a cross-border basis, rather than domestically.

### Greater entry of BSPs to intraday markets

4.3.15 A reduction in the ISP could allow more technologies to participate in intraday markets.

4.3.16 For instance, Demand-Side-Response (DSR) capacity that currently finds it difficult to commit to hourly or half-hourly offers could potentially make quarter-hourly or five minute offers on the intraday market. This might lead to reduced prices in intraday markets from existing demand response capacity.

4.3.17 Similarly, shorter ISPs might make it easier for any particular renewable energy sources to participate as Balancing Service Providers (BSPs) – this might be the case for instance where RES providers are able to commit to volumes on the shorter ISP duration where they might not have been able to for the longer ISP duration.

4.3.18 There could be an impact on competition in balancing markets as well. However, this would depend on their structure. If TSOs were already willing to purchase balancing energy in blocks of time less than the ISP duration, the impact could be negligible. We assume that, if it were felt beneficial, TSOs could encourage greater participation within balancing markets without a general change to the ISP.

4.3.19 The welfare effect of greater competition from new sources of flexible power should be the reduced the cost of serving demand.

## Increased secondary trading volumes

4.3.20 Liquidity is important for a number of reasons, for example, a liquid market is likely to:

- involve lower search costs for participants;
- allow participants to hold less collateral, as price should be less volatile and transacting can take place more quickly; and
- allow participants to take decisions on a firmer basis because the price signal is more reliable.

4.3.21 For all of these benefits, it is liquidity relative to likely physical delivery volumes which is important. The absolute level of secondary trading in a given product is less important than the level of liquidity relative to the demand for that product. In general, there will be lower demand for trading in shorter granularity products. Therefore while the absolute level of liquidity of MTU products may reduce with a shorter ISP, it is likely to be more important to understand whether the level of liquidity increases or decreases *relative to demand for the shorter MTU product*[2].

4.3.22 While aggregate liquidity on products with a shorter MTU may reduce, there are reasons to believe that, using a definition of liquidity relative to demand, a reduction in the ISP could result in an increase in liquidity on intraday markets:

[2] Markets can always aggregate MTU products into longer products if those suit market participants better.

- as we note above, a reduction in ISP duration may be expected to lead BRPs to undertake trading actions with finer granularity on intraday markets in order to be less in imbalance after the gate closure time;
- harmonising ISP and MTUs across markets should lead to trading becoming more uniform, which should in turn reduce transactions costs. This should result in more marginal trades becoming economic and hence greater liquidity; and
- harmonising ISPs and allowing greater cross-border trading should result in liquidity from more liquid markets being translated easily into less liquid markets[3].

4.3.23 The magnitude of benefits will depend on how increases in liquidity translate into system costs and prices. Liquidity translates into a bid-ask spread which market participants have to insure against. The welfare effect should be measured as the impact of a lower bid-ask spread on the cost of collateral that needs to be posted by traders.

## Improved investment outcomes

4.3.24 In the status quo, it is assumed that flexible capacity receives price signals for investment from the combination of reserve, balancing and wholesale prices, subject to the plant's ability to participate in each market.

4.3.25 All else equal, a transfer of revenues from the balancing or reserve markets to the wholesale market could lead to more efficient investment outcomes. This might be, for example, because of a greater transparency and ability to forecast wholesale day ahead and intraday prices compared to balancing and reserve prices.

4.3.26 The welfare effect would be equal to the reduced investment costs arising from better investment decisions meeting a given demand level.

## Other benefits

4.3.27 There are a number of other benefits which may be relevant to considering a change in ISP. These include that:

- it is possible that reducing ISP duration improves frequency quality, by reducing the number and extent of frequency excursions (as a result of a reduction in structural or deterministic imbalances at ISP boundaries);
- it results in an improvement in security of supply as a result of:
  - greater effort on short term balancing by BRPs; and
  - greater availability of flexible sources (e.g. cross-border BSPs, new investment in BSPs) which are available at an earlier point in time.

[3] Joining an illiquid market to a less liquid market is not likely to result in an average level of liquidity across both markets. It is more likely to lead to a bigger market with liquidity levels at (or even beyond) the liquidity levels on the more liquid of the two markets.

### Pass / fail criteria

4.3.28 There are also a number of pass / fail conditions set out in the Energy Balancing Network Code which should be met by a change in ISP. These include:

- Facilitating participation of demand side response;
- Facilitating participation of RES sources;
- Ensuring operational security;
- Fostering non-discrimination and transparency in balancing markets
- Ensuring that the procurement of balancing services is fair, objective, transparent and market based;
- Avoiding undue barriers to entry for new entrants;
- Being technically feasible; and
- Allowing TSOs and BRPs to fulfil their obligations.

4.3.29 From the above conceptual analysis, it appears likely that a change in ISP would pass these criteria.

## 4.4 Distribution among geographies

4.4.1 The above costs and benefits will accrue to different parties and jurisdictions across the EU + 3. It is also relevant to consider the distribution of such costs and benefits.

4.4.2 There will clearly be different distributions of costs among Member States depending on the planning case under consideration. For example, a number of Member States already have a 15 minute ISP, and so the costs for them in a move to a harmonised 15 minute ISP would be negligible.

4.4.3 Benefits may also be unevenly distributed among Member States. For example, while Member States currently with a 15 minute ISP might not have costs, they may secure benefits as a result of greater cross-border trading opportunities from neighbours currently on a longer ISP.

4.4.4 As a result of differences in the geographic distribution of costs and benefits, there may be jurisdictions with net costs or net benefits which are significantly different from the average.

## 4.5 Distribution among stakeholders

### Costs

4.5.1 For each of the cost categories above, it is possible to identify who bears the initial cost. We can make some additional assumptions to form conclusions about where the costs are likely to fall eventually.

4.5.2 These assumptions include:

- Regulation: TSO costs (or imbalance settlement agency costs) can be assumed to be passed through in full to end consumers (possibly after a period of time as existing price controls end);

- Competition:
  - Prices on balancing and wholesale markets are reflective of marginal costs of the marginal installation, and so increases in the marginal cost of the marginal source will be borne by customers;
  - Longer term fixed and investment costs are expected to be borne by generators in the short term and progressively passed on to customers over time, as the wholesale price adjusts to reflect the entry cost. Therefore, any variations in generation fixed costs are assumed to be split 50/50 across generators and customers;
  - Power prices are incurred by retailers and passed on to customers in full.

4.5.3 Based on these assumptions, we have set out in Exhibit 7 the original party bearing costs and where we would expect the cost finally to fall.

**Exhibit 7. Distribution of costs**

| Cost category | Likely channel of cost pass through | Cost ultimately borne by… |
|---|---|---|
| Trading platforms | Trading platforms will recover increased costs through trading fees. A change to trading and internal costs faced by trading parties will be passed on through wholesale and retail prices to end consumers | Consumers |
| Metering and notification systems | Generation meter costs could be assumed to be split 50:50 between generators and consumers via the wholesale price. Network meter costs could be assumed to be passed on through regulated prices to end consumers and costs of end consumer meters are borne by end consumers | Consumers and, to a lesser extent, generators |
| Scheduling and settlement | Increased costs for TSOs, PXs, BSPs, BRPs will be passed on through network charges, the wholesale price (e.g. partial cost pass-through by generator BRPs) and the retail price to end consumers | Consumers and, to a lesser extent, generators |
| Billing systems | Directly borne by large customers or passed on to smaller customer via retail prices | Consumers |
| BRP forecasting and trading | Increased BRP costs will be passed on through the wholesale price (e.g. partial cost pass-through by generator BRPs) and the retail price to end consumers | Consumers and, to a lesser extent, generators |
| Document-ation | Generation documentation costs can be assumed to be split 50:50 between generators and consumers via the wholesale price. Network documentation costs are assumed to be passed on through regulated prices to end consumers and costs of retail documentation are borne by end consumers | Consumers and, to a lesser extent, generators |
| Network related costs | Increase in network charges to network users (load/generators, depending on the national regulation). | Mostly borne by consumers, with a small share borne by infra-marginal generators |

*Source: Frontier Economics*

## Benefits

4.5.4 Similarly, it is possible to consider the distribution of the potential benefits. Below we consider this separately for each of the benefits, based on similar assumptions to those used for costs.

### Reduced balancing costs: reduced TSO energy actions

4.5.5 A reduced volume of TSO actions could result in a number of different distributional impacts:

- TSOs or imbalance settlement parties. TSOs will no longer have to take a number of balancing actions, reducing payments related to bids accepted in the balancing market. We assume that any cost savings are transferred to end consumers (unless incentive mechanisms provide for the TSO to retain some of the cost saving);
- Consumers. Changes in consumer surplus will reflect variations in prices in the wholesale and balancing markets, multiplied by the volumes of energy dispatched in each market (in the status quo and subsequent to the change in ISP duration). The direction of the change in surplus in each market will vary depending on the system status in a given ISP period, as illustrated below. The overall yearly effect on consumer surplus can therefore be considered to be an increase by the average price difference between the price achieved by the BRP when taking actions at a finer granularity on the intraday market relative to the balancing price achieved by the TSO price times the corresponding volume of power shifted from the balancing to the intraday market. This assumes that the difference in prices reflects the difference in underlying costs;

4.5.6 Generators. Producer surplus will decrease with the reduction of trades in the balancing market and this will be offset by the increase in producer surplus from additional actions in the wholesale market. As with consumer surplus, the direction of the change in producer surplus in each market will depend on whether upward or downward balancing actions are being reduced in each period. Similarly with consumer surplus we consider that upward and downward effects net out across the year. The outstanding variation in producer surplus therefore stems from any changes in costs of serving demand.

### Reduced balancing costs: reduced TSO capacity withholding

4.5.7 A reduced volume of TSO reserve capacity procurement could result in a number of different distributional impacts:

- TSOs see a reduction in the cost of reserves held for balancing purposes. This reduction in costs is likely to be passed on to network users, and eventually to end-users;
- Generators. Generators may see reduced revenues from TSO reserve contracts, which we would expect over time to be passed on in part to customers in the form of higher prices. To the extent generators then withheld different volumes of capacity than TSOs, we would also expect a change in wholesale prices which would impact producer surplus. They also

may see a change in production costs which would need to be taken into account. Any such effects on wholesale prices and production costs would be considered as taken into account in the previous sub-benefit item, as the analysis carried out there does not distinguish between different sources for price changes. However, responses to the questionnaire have indicated that they do not think generators would change their behaviour in terms of which market their capacity is made available to. Therefore, a reduction in the capacity procured by TSOs would reduce generator revenues in the short term and in the long run generators could be expected to react by having less capacity on the system (again we assume the resulting price effect is taken into account in the previous sub-benefit item); and

- End-users. We would expect end-users to see reduced network charges, and some changes in wholesale prices as described above.

### Reduced balancing costs: cross-border

4.5.8 A increased use of cross-border resources intraday could result in a number of different distributional impacts:

- Consumers will be impacted on both sides of the border. Consumer surplus will change in line with changes in prices; and
- Generators will also be impacted both sides of the border. Producer surplus will change in line with changes in prices. Generators may also face a change in dispatch costs which will also need to be taken into account, although this would potentially be shared between consumers and generators.

### Reduced balancing costs: new BSPs

4.5.9 Increased entry or activity by new BSPs could result in a number of different distributional impacts:

- Consumer surplus will increase by the product of the average reduction in intraday prices times total demand; and
- Generator surplus will decrease by the average reduction in intraday price times the volume of balancing energy, net of the reduction in the cost of serving demand.

### Increased secondary trading volumes

4.5.10 It is likely that the benefits of any increased liquidity will be passed on to consumers through retail prices.

### Improved investment outcomes

4.5.11 We would assume that changes in investment costs are partly passed onto consumers and partly borne by generators.

# 5 DETAILS OF DATA REQUEST

5.1.1 Based on this conceptual analysis, we circulated a data request to stakeholders across Europe in order to capture data to facilitate a quantified CBA.

5.1.2 This questionnaire was divided into four sections, as described in Exhibit 8.

**Exhibit 8. Structure and content of data request**

| Section | Content |
|---|---|
| Respondent details | Details of the roles(s) undertaken by the respondent, and the relevant jurisdictions in which they operate |
| Current system | Details of the current system within which the stakeholder operates, covering arrangements for imbalance settlement, procurement of balancing and ancillary service products, and arrangements for metering |
| Costs | Estimates of costs to be incurred by the stakeholder for each of 30, 15 and 5 minute ISP duration, split across all of the cost categories identified above, and broken down into capex and opex to be incurred in the run-up to 2020 (capex), and estimated values for 2020 and 2030. The questionnaire allowed for a low, medium and high value for each cost item. |
| Benefits | As for costs, estimates of the benefits relevant to each stakeholder for each of 30, 15 and 5 minute ISP duration, in 2020 and in 2030. |

*Source: Frontier Economics*

5.1.3 Accompanying this data request was a guidebook, setting out the context of the CBA and a description of the data items being requested.

5.1.4 We noted that the questionnaire requested confidential data. We therefore made it clear that ENTSO-E would treat all information provided by individual stakeholders as part of the survey as confidential. We committed that information gathered through the survey would only be published in an aggregated form, e.g. by stakeholder group and by country. Hence, details on individual submissions or data items are not provided in this report.

# 6 ANALYSIS OF COSTS

## 6.1 Introduction

6.1.1 In this section, we set out the quantitative analysis of costs based on the responses from the questionnaire (see section 5) and our approach to deriving cost inputs to the CBA from the responses for the different planning cases (see section 3.2).

6.1.2 We proceed in five steps:

- We first provide an overview of responses to our questionnaire with respect to data coverage and quality of data;
- We then describe the approach used to get from a data set consisting of responses which represent only a proportion of stakeholders and countries to costs that represent EU + 3;
- We define two scenarios for metering costs to reflect two different approaches to adapting smart metering to reflect the change to ISP (profiling or replacement / reconfiguration);
- We provide an overview of the resulting total costs by line item and country; and
- We conclude with remarks as to how these costs can be interpreted.

6.1.3 Throughout this section all costs are presented in real terms and as a net present value (NPV) in 2019. We do not refer to the names of individual respondents to respect confidentiality.

## 6.2 Overview of responses to the questionnaire

6.2.1 Responses to the questionnaire constitute the starting point to determine costs inputs for the CBA. In this section we

- outline data quality and data coverage by country and line item; and
- provide an overview of reported cost estimates.

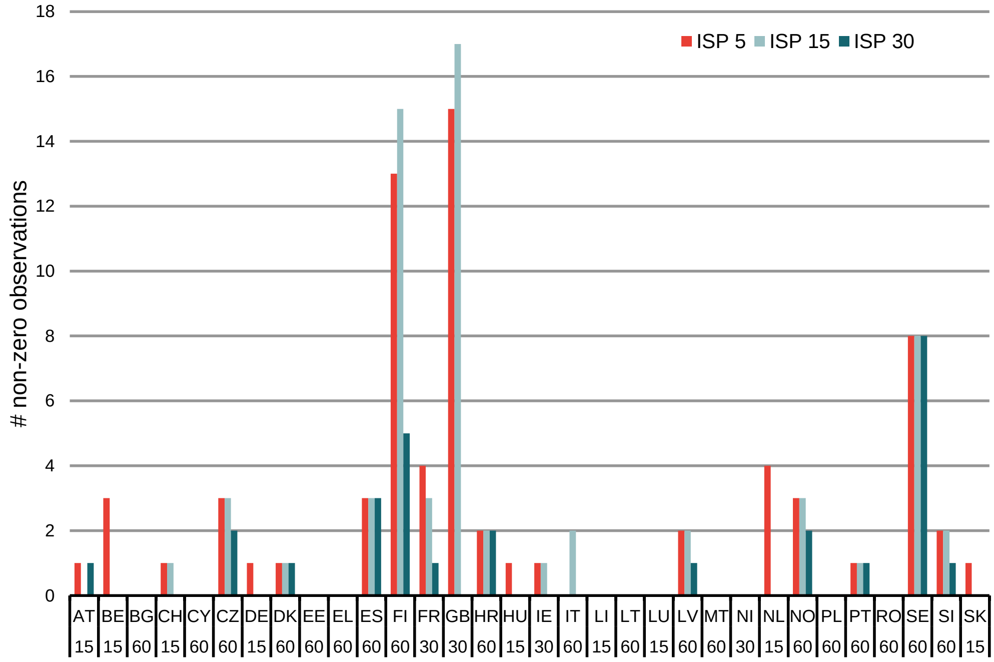
### Data coverage and data quality

6.2.2 We received 125 responses to the questionnaire in total. This includes 21 responses that did not contain any cost information and multiple responses by some stakeholders that submitted a separate response by business activity (e.g. one stakeholder from GB submitted 5 different responses).

6.2.3 The number of non-zero estimates of cost varied significantly by planning case. We received 29 non-zero responses with cost information for a change to a 30 minute ISP, 64 non-zero responses for a 15 minute ISP and 71 non-zero responses for a 5 minute ISP. This reflects the need for more countries to change with the shorter ISP duration.

6.2.4 Exhibit 9 provides an overview of the number of non-zero cost responses by country. Note that a non-zero observation may contain very different degrees of information: it ranges from an almost complete set of cost estimates for relevant line items and for the low/central/ high case (this is the case for 17 responses) to a single central cost estimate for one out of eight line items.

**Exhibit 9. Number of non-zero cost responses by country**




*Source: Frontier*

*Note: Number below country code represents current ISP period (in minutes).*
*Note that a single questionnaire response can account for up to three observations (one for each ISP period). A non-zero observation means that at least one single value is entered.*

6.2.5 The overview by country shows that three countries stand out in terms of data coverage: Great Britain (up to 17 responses), Finland (up to 15 responses) and Sweden (8 responses). These three countries combined account for 63% of all responses for ISP 15. This high response rate is partly due to multiple separate responses being made by a single company, i.e. one response for each of several different business activities (retail, trading, generation, etc.).

6.2.6 There can be several reasons as to why a country has no non-zero responses:

- No response from a country;
- No response for the current ISP period (e.g. BE for ISP 15); and
- No significant cost expected by respondents from that country.

6.2.7 Exhibit 10 provides an overview of the share of responses for a change to an ISP period of 5/15/30 minutes (columns) by the current ISP period of respondents.

**Exhibit 10. Share of non-zero responses by current ISP duration**

| | Change to ISP 5 | Change to ISP 15 | Change to ISP 30 |
|---|---|---|---|
| Current ISP 15 | 17% | 2% | 4% |
| Current ISP 30 | 29% | 33% | 4% |
| Current ISP 60 | 54% | 66% | 93% |

*Source: Frontier*

*Note: There are 2 respondents with positive costs reported for an ISP period equal to the current ISP period – these values have been removed from our analysis. Costs of changing from an ISP of 15 minutes to a longer ISP duration have been reported in some cases but are not relevant for our planning cases.*

6.2.8 The shares of responses show a clear tendency for countries which currently have a longer ISP period of 30 or 60 minutes to have a greater number of non-zero responses. One explanation is that these countries are more likely to be affected by one of the planning cases presented in section 3.2 than a country that currently has a shorter ISP duration.

6.2.9 In summary, we have incomplete geographic coverage with responses received from 22 out of 31 countries in our geographic scope. However, responses cover the largest power markets in Europe and the countries with no non-zero responses are mostly smaller countries. The data coverage is mixed, with only 20% of responses (17 out of 104 responses that provided any cost information) providing an almost complete coverage by line item and ISP case.

## Reported costs by respondents

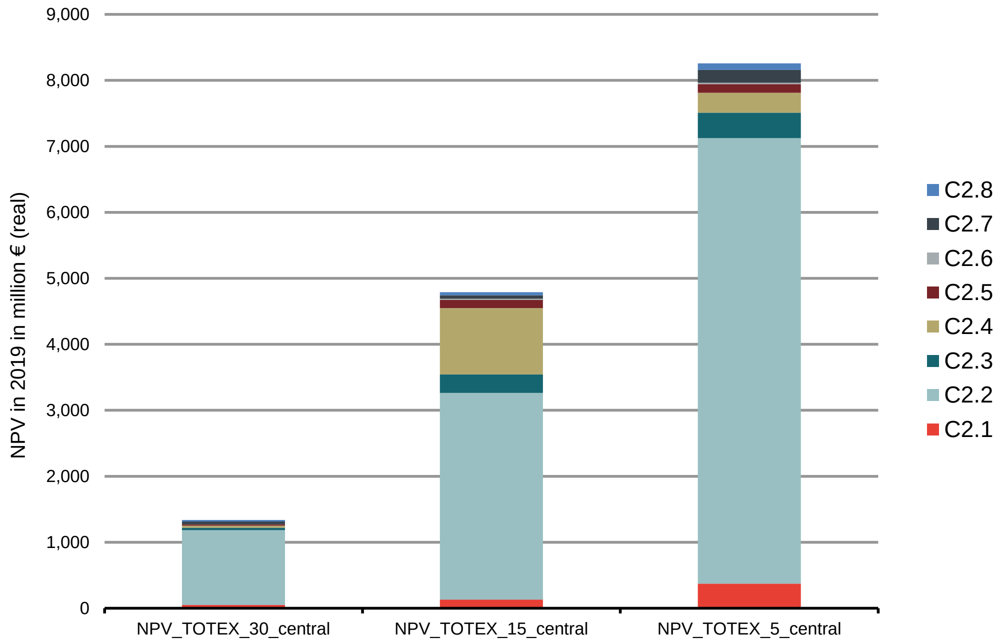
6.2.10 In this section we provide an overview of total expenditure (Totex) reported by respondents for the three different ISP durations. Respondents were asked to provide estimates for three different cases: low case, central case, high case. In this section we provide an overview of responses for the central case due it having the best data coverage.[4]

6.2.11 The values in this section are shown in their raw form. This means they include outliers and data errors (see section 6.3) and all responses for a change to ISP 30, which are apart from Spain and Portugal not relevant for the planning cases we have defined in section 3.2.

6.2.12 Exhibit 11 provides an overview of aggregate reported Totex by cost item for the central case.

[4] Between 16% and 33% of responses (depending on the ISP duration) only submitted cost data for the central case.

**Exhibit 11. Aggregate reported Totex by line item (central case) – all ISP cases**




*Source: Frontier*

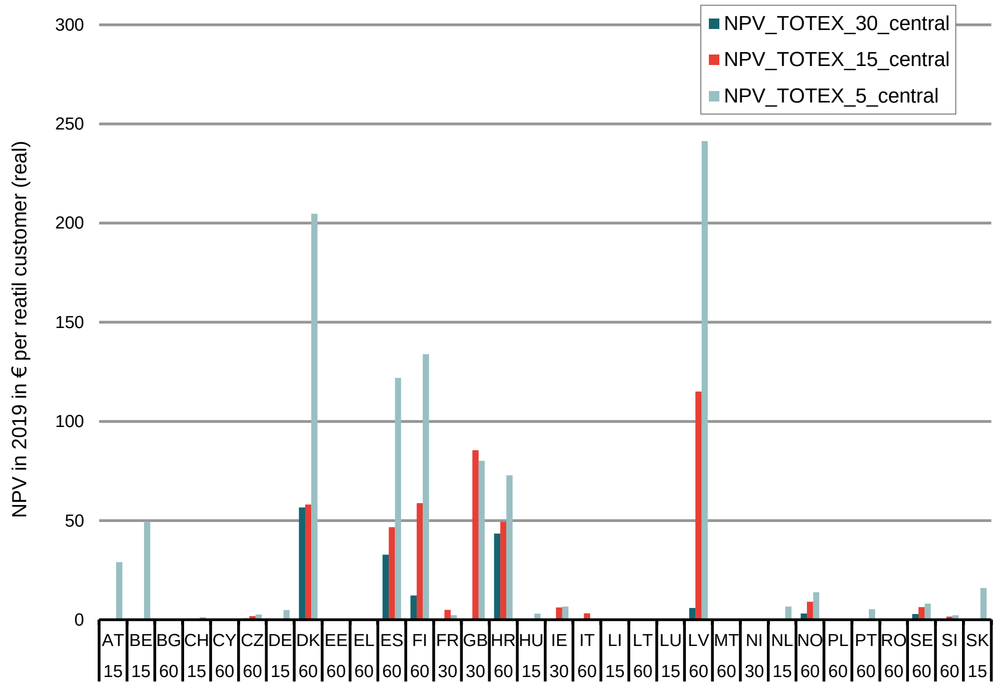
*Note: Values are based on raw data and therefore include outliers.*

6.2.13 The net present value in 2019 (NPV 2019) of reported Totex varies significantly between ISP 30 and ISP 5:

- ISP 5 Totex is more than three times as high as ISP 30 Totex due to
  - (i) higher reported Totex by country and
  - (ii) more countries being affected by a change to ISP 5;
- Metering and notification costs (2.2) are by far the largest cost item, accounting for 72% (ISP 15) and 82% (ISP 5) of aggregate reported Totex.

6.2.14 Exhibit 12 illustrates reported Totex by retail customer.

**Exhibit 12. Total reported Totex per retail customer by costs by country – all ISP cases**




*Source: Frontier*

*Note: Aggregate reported Totex by country is divided by the number of retail customer (see Annex A). Values are based on raw data and include outliers. The numbers below the country codes represent the current ISP period (in minutes).*

6.2.15 The reported Totex per retail customer shows a large variation between the countries in our sample, ranging from, for example for a change to ISP 15, 2 €/customer (Czech Republic, Slovenia) to 115 €/customer (Latvia).

6.2.16 However, when interpreting these values one should keep in mind that they represent total costs for countries to very different degrees. Reported Totex may stem from a response by a stakeholder that only represents a small fraction of the total market and who submitted estimates only for minor cost items. Other respondents may have provided estimates for their entire power system and for several line items (including metering costs which is the line item with the largest costs).

6.2.17 We describe in the next section how we processed the data to deal with imperfections and gaps.

## 6.3 Approach to data processing

6.3.1 The overview of responses has shown, that the data set based on the raw responses to the questionnaire contains two types of data imperfections:

- Incomplete representivity of a country – For the countries where we have responses to the questionnaire, in many cases the responses are not fully representative of the whole country[5].

[5] For example, not all retailers and generators which could be affected by a change to the ISP period have provided a cost estimate.

- Gaps – There are 10 smaller countries for which we have not received any response. Even for countries for which responses were provided, there are some cost items for which no estimates were provided[6].

6.3.2 To derive cost estimates as an input to the CBA, we proceed in three steps, as shown below.

**Exhibit 13. Steps of data processing**

| 1 Compile useable data from questionnaire | 2 Scale up within countries to be fully representative | 3 Close gaps for countries without information |
|---|---|---|
| • Collect useable data from the questionnaire<br>▫ Non-zero observations<br>▫ Removal of outliers and costs reported for ISP durations exceeding current ISP duration | • Scaling up to country-level data<br>▫ Only information from within each country is used for this step<br>▫ Scaling up, also using external info (e.g. retail market shares) | • Closing gaps for countries w/o cost information<br>▫ Average information across countries used<br>▫ Scaling up, also using external info (e.g. retail market shares) |

*Source: Frontier*

6.3.3 Each of the three steps is explained in more details below.

## Compile usable data (step 1)

6.3.4 As a first step, we compile all available responses into a data set. In doing this we have validated the data by: analysing each questionnaire individually to identify ambiguities and data errors, sending more than 60 emails to respondents with queries about their responses, and making more than 40 manual corrections to responses.

6.3.5 Given the limitations of the dataset, a formal statistical outlier analysis is not feasible due to:

- the low number of observations by line item and/or country; and
- the possibility that cost differences between countries relate to fundamental drivers (e.g. a higher share of meters that have to be replaced (C2.1), differences in the need to update software (C2.4)) which could be erroneously identified as outliers.

6.3.6 We have therefore only identified a few "extreme" cost estimates which could not be explained by fundamental differences between countries and which would have a significant influence on the results of the CBA if left in the sample. The data outliers and how we have dealt with them are listed in Exhibit 14.

[6] E.g. for Germany (relevant only for ISP 5), only the four TSOs have submitted a response. Their responses do not include distribution metering costs which would be relevant for retail companies.

**Exhibit 14. Outlier analysis for reported costs**

| No. | Line item | ISP 5 | ISP 15 | ISP 30 |
|---|---|---|---|---|
| C2.1 | Trading platforms | One observation for DE: OPEX moved to benefit side (impact on liquidity) | | |
| C2.2 | Metering and notification systems | One observation for ES: OPEX removed | One observation for ES: OPEX removed | One observation for ES: OPEX removed |
| C2.3 | Scheduling and settlement | | | |
| C2.4 | Billing systems | One observation for GB removed | | |
| C2.5 | BRP forecasting, trading and scheduling | | | |
| C2.6 | Documentation | | | |
| C2.7 | Network related costs | One observation for HR: CAPEX removed | One observation for HR: CAPEX removed | |
| C2.8 | Other costs | | | |

*Source: Frontier*

*Note: Names of respondents and individual values are not listed due to confidentiality requirements. In addition, we have removed reported cost values if the current ISP period is shorter or equal to the new ISP period (i.e. observations from FR and AT on ISP 30 and CH for ISP 15).*

6.3.7 In addition we have removed reported cost values if the current ISP period is shorter or equal to the new ISP period (i.e. observations from France and Austria on moving to ISP 30 and for Switzerland for moving to ISP 15) since we do consider planning cases where countries would have to increase their ISP duration compared to the status quo.

## Scaling up (steps 2 & 3)

6.3.8 The data set based on the questionnaires contains two types of information gaps that have to be filled by assumptions based on information provided:

- Within our sample (incomplete representativity) – Cost estimates which only partially represent costs in a country are scaled up based on information provided by respondents where available (e.g. their market share) and external scaling variables otherwise;
- Outside our sample (gaps) – We have applied a sample average for a certain cost item to close gaps for countries without observations, applying scale variables to control for differences in size of countries.

6.3.9 Exhibit 15 provides an overview of the scale variables used by line item. Further details on the magnitude of scaling by country and cost item are provided in Annex A.

**Exhibit 15. Scale variables used for the cost analysis**

| No. | Line item | Scale variable within sample (full country representativity | Scale variable out-of sample (gaps without observation) |
|---|---|---|---|
| C2.1 | Trading platforms | None | 100% (i.e. apply sample average) |
| C2.2 | Metering and notification systems | Transmission network: None Distribution network: Market share of reported costs where available (proxy: no. of large DNOs divided by no. of observations, source: Eurostat) | No. of retail customers (source: Eurelectric, 2013) |
| C2.3 | Scheduling and settlement | No. of main retailers and generators (source: Eurostat) | No. of main retailers and generators (source: Eurostat) |
| C2.4 | Billing systems | No. of customers with ISP readable meters (0.8.2) (proxy: retail market share) | No. of retail customers (source: Eurelectric, 2013) |
| C2.5 | BRP forecasting, trading and scheduling | No. of main retailers and generators (source: Eurostat) | No. of main retailers and generators (source: Eurostat) |
| C2.6 | Documentation | None | 100% (i.e. apply sample average) |
| C2.7 | Network related costs | None | No. of TSOs |
| C2.8 | Other costs | None | None |

*Source: Frontier*

*Note: Tables with the scale variables are provided in Annex A.*

6.3.10 We have used the following scale variables by line item:

- Trading platforms (C2.1) – This cost item corresponds to the cost of modifying systems and processes to support intraday trading. Costs have mainly been reported by large international energy companies, TSOs and an international power exchange. Responses are treated as representative for the countries within our sample and no scaling is applied. For countries with no observation we have applied the sample average. To ensure consistency across the ISP cases, we have set the costs for a change to ISP 5 at least as high as for ISP 15.

- Metering and notification systems (C2.2) – This cost item corresponds to the need to update the software for metering and notification systems or physically exchange existing meters in the transmission and distribution network. Transmission network costs are provided by TSOs and are treated as representative for the country. Distribution metering costs, mainly provided by DSOs, are scaled up by their respective market share where available. Where this information could not be determined, we scaled up by the number of large DSOs (source. Eurelectric (2013)) divided by the number of observations in our sample. To fill the gap for countries outside our sample, we applied the number of retail customers to the sample average cost per retail customer[7].

- Scheduling and settlement (C2.3) – This cost item corresponds to the need for stakeholders to adapt their scheduling and settlement systems. To scale up costs for countries within our sample, we have applied the ratio between the number of domestic large retailers and generators (source: Eurostat) and the number in our observation. The sample average is scaled by the number of large retailers and generators for countries outside our sample.
- Billing systems (C2.4) – This cost item captures the impact of a shorter ISP on changing systems and processes to facilitate billing of customers. Reported costs are scaled up by the total number of customers with ISP meters (item 0.8.2 of the questionnaire). Where this information was not provided, we rely on retail market shares of respondents. For countries outside the sample, we apply the number of retail customers to the sample average.
- BRP forecasting, trading and scheduling (C2.5) – This item reflects the incremental costs for balancing responsible parties (BRPs) of changing the systems and processes to accommodate a shorter ISP. Since our sample contains a subset of the main retailers and generators, reported costs are scaled up by the ratio of the number of large retailers and generators in a country to the number in our observation for the country. For countries with no observation, the number of large retailers and generators is used to scale the sample average.
- Documentation (C2.6) – This cost item corresponds to the cost of modifying codes and agreements affected by a change to ISP duration. Since there is no obvious scale variable and reported costs are relatively small, no scaling is applied and the sample average is applied uniformly to countries with no observation.
- Network related costs (C2.7) – This cost of adapting networks to a shorter ISP is mainly a TSO-related costs and no scaling variable is applied to responses. The sample average is then applied to the number of TSOs for countries with gaps.[8]
- Other costs (C2.8) – This category is a residual item for any incremental costs that do not fit under any of the categories above. Since it captures specific cost items that may not occur in other countries no scaling is applied.

## 6.4 Definition of two scenarios for metering costs

6.4.1 In this section we describe how and why, based on the comments received from respondents and the interaction with stakeholders, we define two different scenarios for metering costs:

[7] The sample average is adjusted for country-specific high costs per retail customer in the Scandinavian countries and GB, see section 6.4 for details.

[8] This is equivalent to uniform scaling since all countries outside our sample have only a single TSO.

- Scenario "Profiling" – in this scenario we assume that some of the reported costs can be avoided by introducing profiling, instead of reading all smart meters according to the ISP, they are read at a longer time interval (typically the current ISP) and consumption is allocated to ISP periods using an algorithm ("load profile"). In this scenario we have modified the costs for the Scandinavian countries and GB (and Spain for ISP 5) using the sample average while for all other countries we rely on reported costs where available; and
- Scenario "Unadjusted stakeholder data" – this scenario directly relies on the information provided to us by market participants in the questionnaires. The only adjustment is to the sample average used to fill gaps where we have not included the Scandinavian countries and GB (and Spain for ISP 5).

6.4.2 We proceed as follows: we first review the cost concept we require in the CBA, and then review reported costs for distribution metering (line item 2.2) which reveals a large degree of variation. Based on the information revealed by respondents, we then derive cost values for the two scenarios above.

## Review of cost concept: incremental economic cost

6.4.3 Before we get into the details of metering costs it is useful to recall the cost definition set out in section 4.2. Our analysis relates to *incremental economic* costs of changing the current ISP to a shorter period of 30, 15 or 5 minutes, depending on the respective planning case. This means we focus only on costs that are:

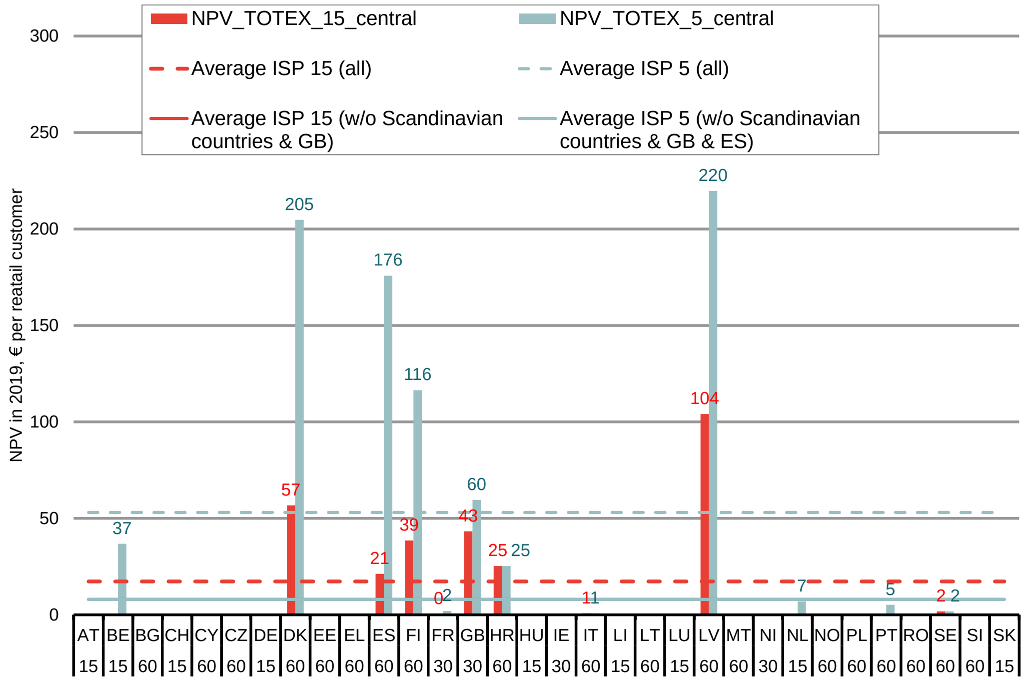
- *Incremental* – This means that any costs incurred in the status quo should not be included, including future costs that will be incurred under the status quo. This means that costs related to any changes decided prior to the CBA are ignored since they are not influenced by the decision to change the ISP. For example, if smart meters were already rolled out, only costs for reconfiguration (or if not possible earlier replacement) should be considered. Therefore, incremental costs can be no greater than the Totex reported for a shorter ISP.
- *Economic* – "Economic" here means that costs should reflect an optimisation when there are different options available to react to a change in the ISP. This is particularly relevant for metering costs: if existing smart meters (which can have a significant cost impact if replaced due to the large number of sites affected) are read at the current ISP period it might not be cost-efficient to replace them instantaneously under a shorter ISP but rely on *profiling* (i.e. allocation of the measured load to the shorter ISP period using an algorithm) until the meters reach the end of their life time.

## Reported metering costs for distribution show high level of variation

6.4.4 We have shown in section 6.2 that metering costs (line item 2.2) account for the vast majority of reported costs in our sample – between 65% (ISP 15) and 82% (ISP 5). This implies that particular attention should be paid to this line item as it has a significant impact on total costs and therefore on the overall result of the CBA.

6.4.5 Exhibit 16 shows metering costs for the distribution network[9] per retail customer. These costs have been determined based on the reported costs (after removal of outliers), scaled up to the full country level. Apart from the scaling variables where we have partly relied on external data (e.g. market shares of distribution network operators in a country, see Annex A for details), these costs are only determined based on the information provided by respondents from the respective countries. A positive cost number indicated that at least one observation for line item 2.2 was available in the data set.

**Exhibit 16. Scaled-up reported metering costs (distribution) per retail customer for ISP 15 and ISP 5**




*Source:* *Frontier*

*Note:* *This graph contains reported metering costs (2.2) for distribution networks, scaled up to be fully representative for the countries with observations and divided by the number of retail customers. Number below country code represents current ISP period (in minutes)*

6.4.6 Exhibit 16 shows a large variation between the countries for which we have reported metering costs. For ISP 15 these range from below 10 € per retail customer for France, Italy, the Netherlands, Portugal and Sweden to 60 € per retail customer in GB and the Scandinavian countries (including Denmark). It is important to note that very high or low values in the sample have a twofold effect: (i) they directly lead to high/low cost inputs for the respective country in the CBA and (ii) they influence the sample average which is used to fill gaps for countries without observations (most notably Germany as the largest country in our sample for ISP 5).

[9] We treat metering costs for the transmission network reported by transmission system operators (TSO) separately.

6.4.7 There are several potential reasons for the large variation:

- Differences in unit costs per meter replaced/reconfigured – respondents might have used different estimates for unit costs to determine overall costs. Due to limited data availability (only a few stakeholders set out assumptions on unit costs) it is not possible to trace back the variation of this cost driver.
- Share of meters that require replacement/remote reconfiguration – the share of meters that have to be replaced (incurring high costs) compared to share of meters that can be reconfigured (remotely) is another key driver for cost differences, for example, in Italy and Portugal smart meters are can be read by 15 minute intervals and in Sweden smart meters can be reconfigured remotely.
- Number of meters affected – Countries with a higher number of meters that are read at ISP scale should lead to higher costs. This is particularly the case for Scandinavian countries which have started the smart meter roll-out and have already achieved either full (Finland, Sweden) or partial roll-out (Denmark at 55%).

6.4.8 In countries with an advanced smart meter roll-out, assumptions on the treatment of smart meters are crucial for the estimate of metering costs. As part of the information gathering and validation process, we engaged in discussions with stakeholders on the interpretation of the results of the questionnaire. These interactions revealed a significant difference as to how metering costs (item 2.2) are determined. Stakeholders from GB and Scandinavian countries (including Denmark) reported high costs per retail customer compared to the sample average because they assume that a large share of the infrastructure (including smart meters themselves) has to be replaced. For example, one stakeholder from Denmark reported that:

> "*1.8 million meters [out of 3.3 million] need to be changed or reconfigured in order to handle 15 min. […] 15 min meters can also handle 30 min, but all 3.3 million meters will have to be changed in order to handle 5 minutes*".

6.4.9 This suggests that irrespective of the benefits from such a replacement, a full change to all existing smart meters would be assumed. However, the same stakeholder acknowledged that profiling would be an alternative:

> "*All the end-user meters, does not necessary have to be on 15 min. resolution in order to go to 15 min. ISP, a profiled solution can still work. Or consumption can be on 60 min. and production on 15 min.*"

## Resulting metering costs for ISP 15

6.4.10 In this section we present the scaled-up costs for the two scenarios for a change to ISP 15. The results for ISP 5 are determined in a similar fashion and are presented subsequently. Metering costs for ISP 30 apply only to Portugal and Spain and are provided in Annex A.

6.4.11 To determine total metering costs we distinguish between:

- Distribution metering costs reported by distribution network operators and – to a lesser extent – other stakeholders[10]; and
- Transmission network costs reported by TSOs[11].

6.4.12 Both cost components are summed to derive total costs.

### Metering cost for distribution networks

6.4.13 For metering costs for the distribution network, which include all costs in relation to smart meters, we mainly rely on responses by DSOs. For Denmark, Latvia and Portugal, TSOs provide system-level cost estimates that include distribution metering costs for the entire network.

6.4.14 As described in section 6.3, scaling up is done in two steps:

- Step 1: Scaling up to full country representativity where we have observations – the light blue bars in Exhibit 18 and Exhibit 17 represent responses from all stakeholders to our questionnaire on line item 2.2 that are in relation to the distribution network. Where responses are not fully representative, we scale up observations according to the share of the distribution network represented by respondents. Fully scaled values are represented by the teal bars.[12]
- Step 2: Gaps for countries were we do not have a response are filled by the sample average per retail customer, scaled by the number of retail customers. To determine the sample average of 8€/retail customer (NPV 2019), we have included all countries other than GB and Scandinavian countries since they are subject to high country-specific costs. Final cost results are represented by the red bars.

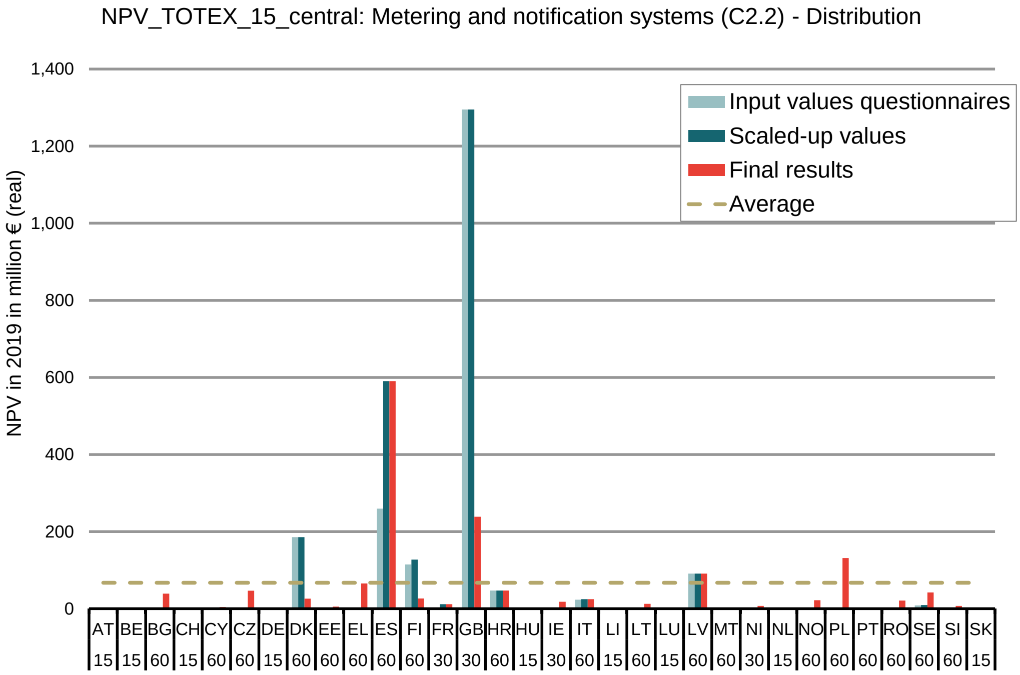
6.4.15 The only difference between the two scenarios below is the treatment of GB and Scandinavian countries. In scenario “Profiling”, the sample average for all other countries is applied while in scenario “Unadjusted stakeholder data” responses for GB and the Scandinavian countries (including Denmark) are used unadjusted.

[10] For some countries (Denmark, Latvia and Portugal) TSOs provide system level cost estimates that include distribution metering costs for the entire network.

[11] Reported costs by stakeholders other than TSOs for ISP meters connected to the transmission grid (e.g. by generators with power plants connected to the extra high voltage grid) are included in distribution metering costs.

[12] Where the teal and the light blue bar are of equal size, responses were considered fully representative, for example, for Denmark and GB.

**Exhibit 17. Total metering costs of the distribution network for ISP 15 – scenario “Profiling”**

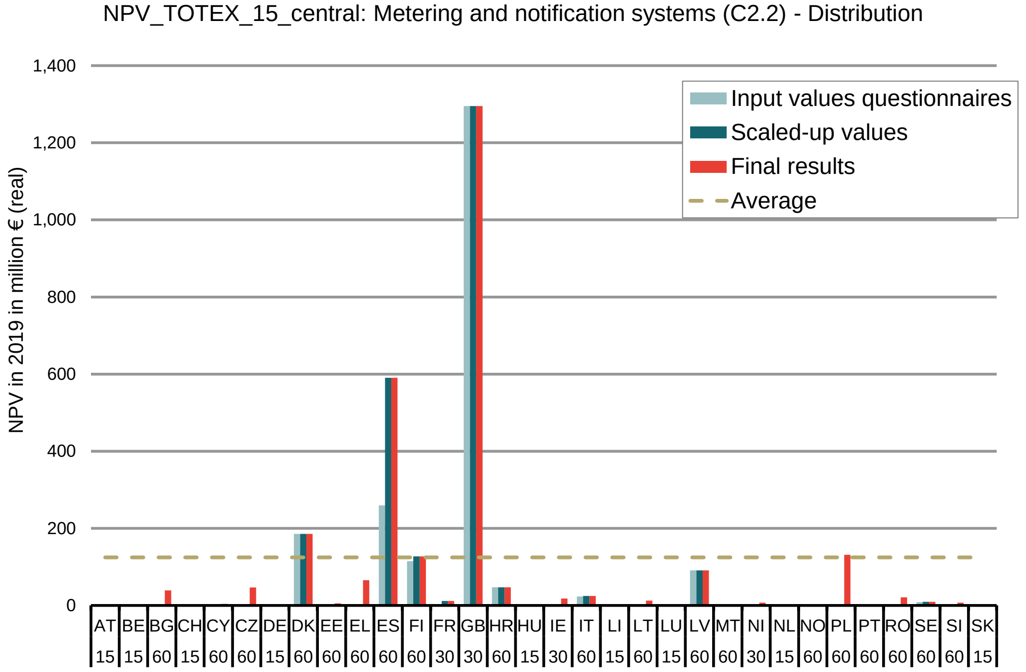



*Source: Frontier*

*Note: See Annex A for further details.*

6.4.16 Scenario “Profiling” leads to total distribution metering costs of € 1.5 billion across all 32 regions. Spain, with € 590 million, accounts for almost half of the total cost, followed by GB with adjusted costs of around € 240 million.

**Exhibit 18. Total metering costs of the distribution network for ISP 15 – scenario "Unadjusted stakeholder data"**




*Source: Frontier*

*Note: See Annex A for further details.*

6.4.17 Total distribution metering costs in scenario "Unadjusted stakeholder data" amount to € 2.7 billion, more than double the costs of scenario "Profiling". This difference is only driven by higher costs for GB and the Scandinavian countries, of which GB accounts for the vast majority of additional costs of more than € 1 billion. Denmark, a country with just 3.3 million customers – a tenth of size of France, has the third highest absolute costs, being € 600 million in NPV 2019 terms.

### Metering costs for the transmission network

6.4.18 Exhibit 19 shows the resulting metering costs for the transmission network for all countries. For transmission metering costs we do not define scenarios since "profiling" is not a viable option for meters connected to the extra high voltage grid. Generators and large customers connected to this voltage level are typically metered in shorter periods than the ISP period, e.g. minute-by-minute.

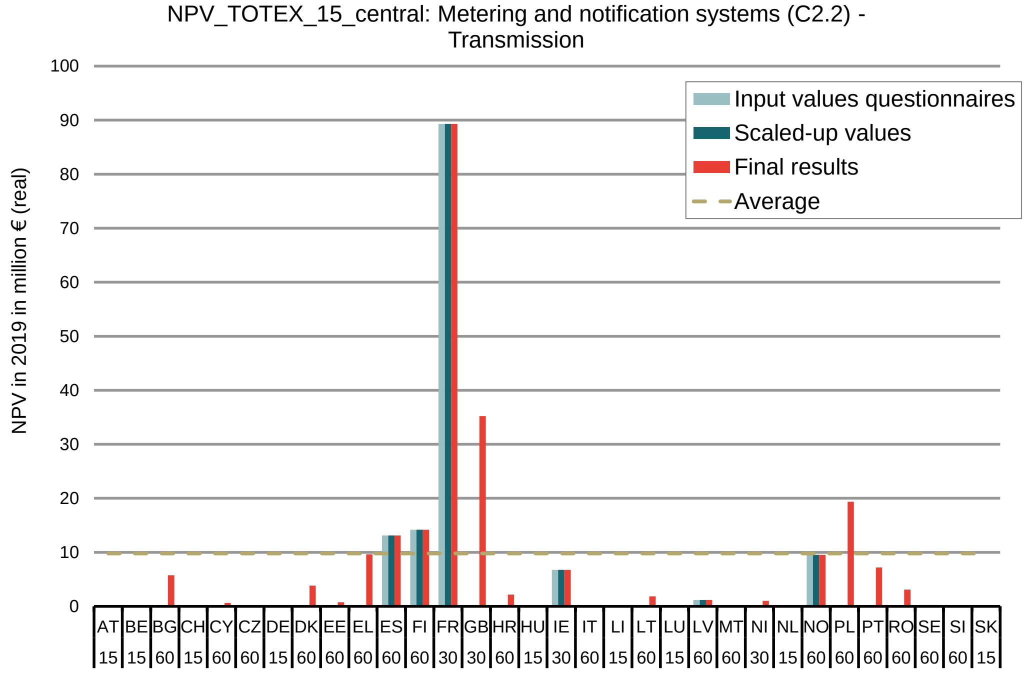
6.4.19 As described in section 6.3, scaling up is done in two steps:

- Scaling up to full country representativity where we have observations – the light blue bars in Exhibit 19 represent responses from TSOs to our questionnaire on line item 2.2. Since TSO responses are fully representative, there is no need to scale up (i.e. a scaling factor of 100% is applied, see Annex A for a complete overview of all scaling factors by line item) and the teal bars which represent the scaled up values are equal to the value of responses.

- Gaps for countries were we do not have a response are filled by the sample average of € 11.4 million, scaled by the number of retail customers (i.e. accounting for differences in the size of respective national power systems). Final cost results are represented by the red bars.

6.4.20 Exhibit 19 shows the results for all countries. On average, metering costs for the transmission network in countries which are affected by a change to an ISP period of 15 minutes amount €9.8 million, slightly below the within-sample average of €11.4 million since on average countries outside our sample are smaller in terms of the number of connected customers. Countries which are currently already at an ISP period of 15 minutes (see values below the country code) would not incur any *incremental* cost.

**Exhibit 19. Total metering costs of the transmission network for ISP 15**




*Source:* *Frontier*

*Note:* *Based on responses by TSOs. Costs reported by other stakeholders for meters in the transmission network (item 2.2.1a) are included in distribution metering costs.*
*Numbers below the country code represent the current ISP duration (in minutes)*

## Resulting metering costs for ISP 5

6.4.21 Incremental metering costs for a change to an ISP of 5 minutes are determined in the same way as for ISP 15. The main difference to ISP 15 is the total cost level for the two scenarios which is significantly higher since:

- respondents reported higher cost estimates for a change to ISP 5 (71 €/customer compared to 32 €/customer for ISP 15[13]), for example because more meters have to be replace instead of reconfigured remotely; and
- a higher number of countries are affected by a change to ISP 5, including 9 countries in our sample that are currently at an ISP of 15 minutes.

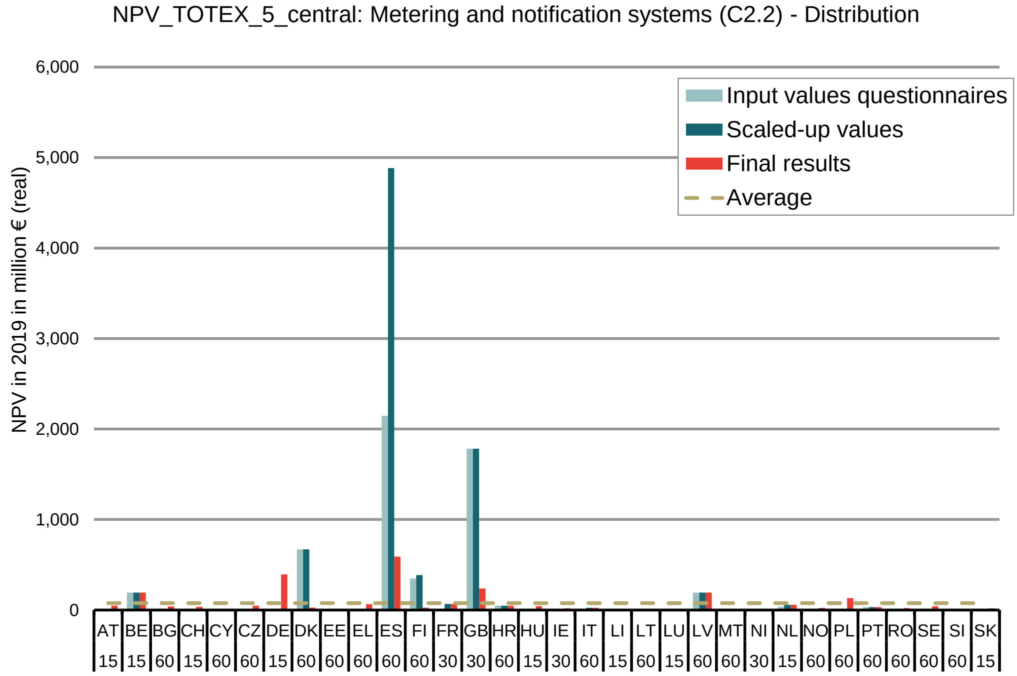
[13] The weighted average across all countries with positive observations, including GB, the Scandinavian countries and Spain.

6.4.22 We proceed in the same way as for ISP 15: we first present two scenarios ("Profiling", and "Unadjusted stakeholder data") for distribution metering costs and then estimate incremental metering costs for the transmission network.

### Metering cost for distribution networks

6.4.23 Exhibit 20 provides the fully scaled-up costs for scenario "Profiling" where the sample average of 8 €/retail customer[14] is applied to GB, Spain and the Scandinavian countries.

**Exhibit 20. Total metering costs of the distribution network for ISP 5 – scenario "Profiling"**



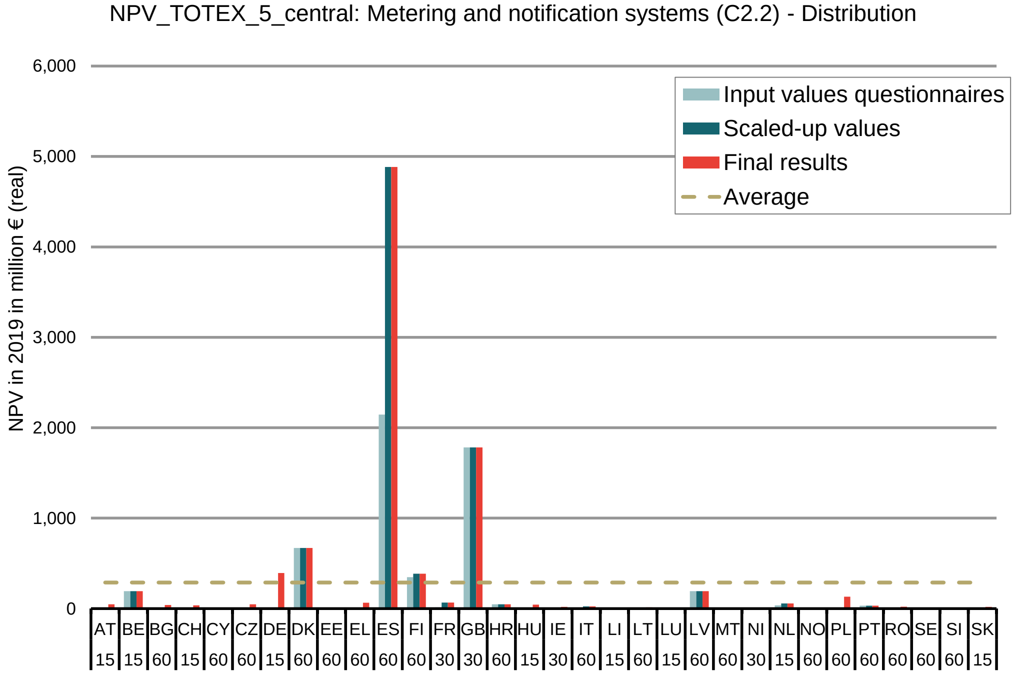

*Source: Frontier*

*Note: See Annex A for further details.*

6.4.24 Total distribution metering costs in scenario "Profiling" are €2.5 billion, an increase by 66% compared ISP 15, which is driven by a larger number of countries being affected by a change to ISP 5. Exhibit 20 shows that reported costs after being scaled up to full country representativity for Spain and GB are significantly lower when the sample average per retail customer is applied to them.

[14] Based on all observations but for GB, Spain and the Scandinavian countries. Countries with a current ISP of 15 minutes which were not included in a change to ISP 15 have reported relatively low costs such that the weighted average decreased slightly from 8 to 7 €/customer. For consistency, we have therefore applied that same average as for ISP 15.

**Exhibit 21. Total metering costs of the distribution network for ISP 5 – scenario "Unadjusted stakeholder data"**




*Source: Frontier*

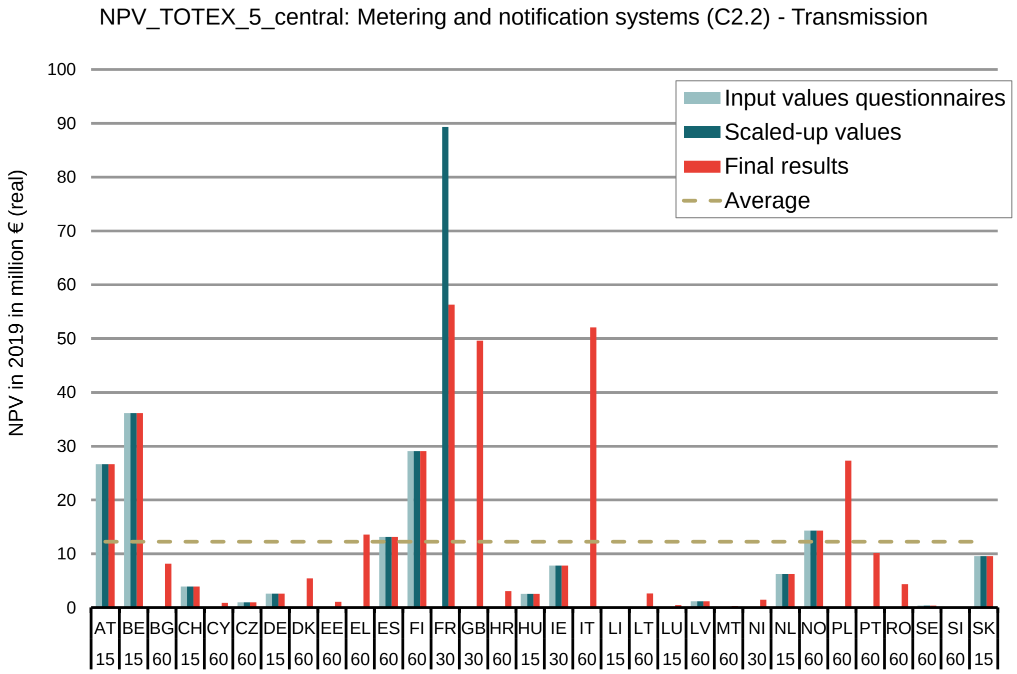
*Note: See Annex A for further details.*

6.4.25 Total distribution metering costs in scenario "Unadjusted stakeholder data" are €9.2 billion, an increase of 237% compared ISP 15, and almost four times the cost of scenario "Profiling". This difference is mainly driven by high costs for Spain, which when scaled up to full country representativity account for more than 50% of total costs across all 31 countries. GB is the country with the second highest costs in our sample, reporting costs of €1.8 billion.

## Metering cost for the transmission network

6.4.26 Exhibit 74 displays the total cost for metering for transmission networks based on TSO cost estimates.

**Exhibit 22. Total metering costs of the transmission network for ISP 15**




*Source: Frontier*

*Note: See Annex A for further details.*

6.4.27 Total costs for all 31 countries are €392 million, an increase of 74% compared to ISP 15 which is mainly driven by additional countries being affected by moving to ISP 5. The sample average of reported costs has gone up only slightly (from €13.5 million to €14.4 million).

## 6.5 Summary of results

6.5.1 In this subsection we provide a summary of total costs by scenario and ISP case used for the CBA. As set out in the previous subsections, to get to fully representative costs, we have first scaled-up reported costs from the questionnaires to full country representativity where we have observations for a line item, and then used information from within-sample countries to fill the gaps for countries where no observation is available for a line item. All detailed calculations by line item are presented in Annex A.

6.5.2 In the remainder of this section we proceed as follows:

- We first present a summary of results for a change to ISP 15 for which we have the best data coverage and which applies only to a subset of countries with a current ISP period longer than 15 minutes;
- We then summarise the results for a change to ISP 5 which would affect all countries in our sample; and
- We then present the results for a change to ISP 30 which is only applicable to Spain and Portugal under the planning case set out in section 3.2.

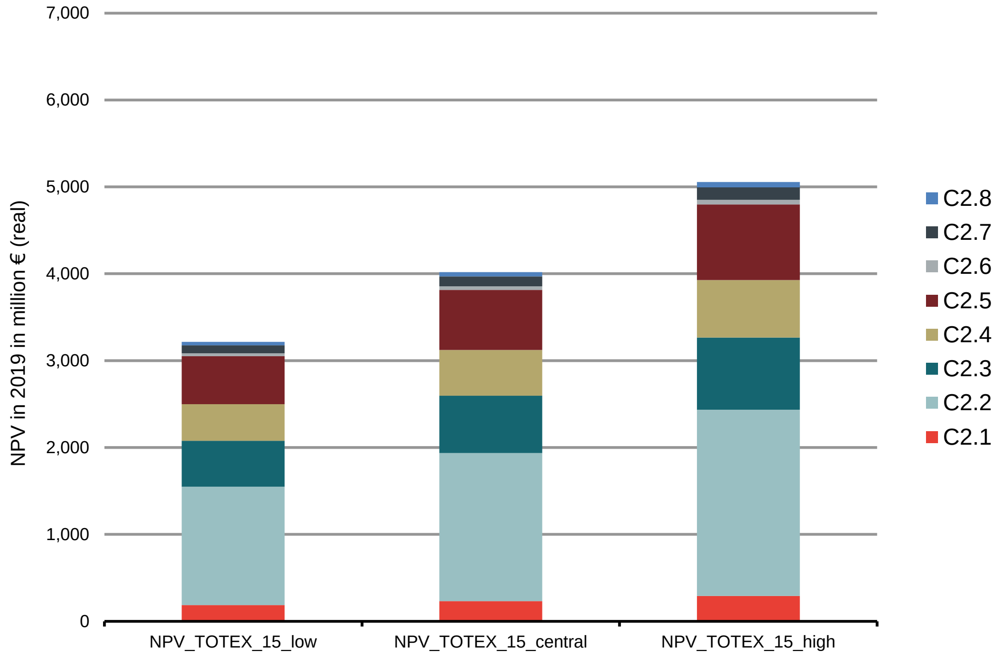
## Change to an ISP period of 15 minutes

6.5.3 We first present total costs by line item, followed by an overview of total costs by country.

### Total costs by line item

6.5.4 Exhibit 23 shows total costs by line item for scenario “Profiling”.

**Exhibit 23. Total costs for ISP 15 by line item – Scenario "Profiling"**




*Source: Frontier*

*Note: The underlying data table can be found in Annex A*

6.5.5 Total costs amount to € 4 billion in total for the central case. The variation to the low and high case is determined based on all responses where all three cases are contained. This leads to

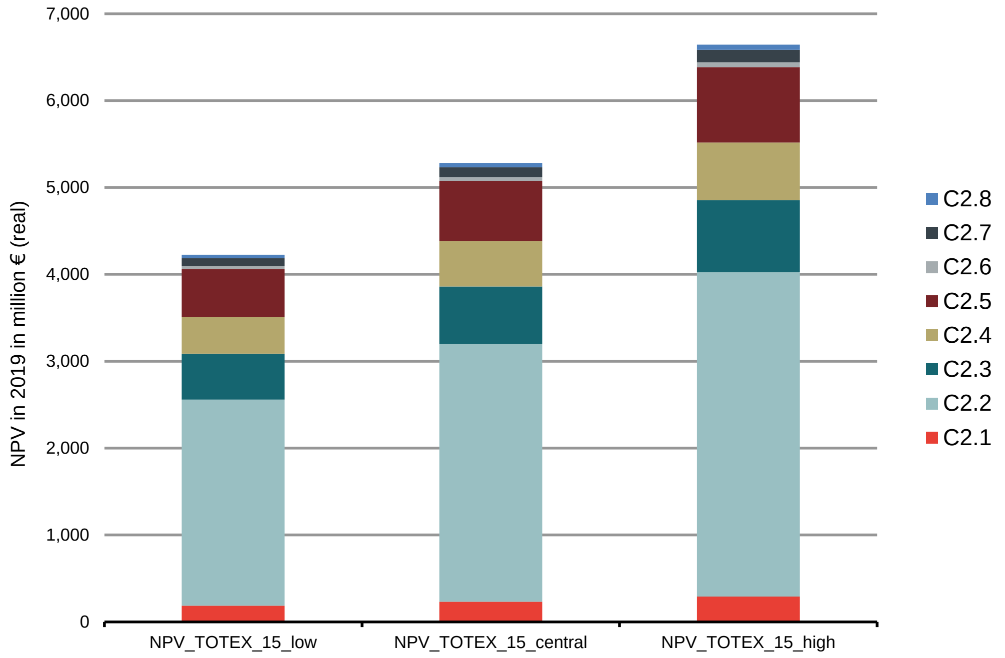
- Low case costs of € 3.2 billion (20% discount on central case); and
- High case costs of € 5.1 billion (26% uplift on central case).

6.5.6 Metering costs (item C2.2) account for 42% of total costs, ranging from € 1.4 billion (low case) to € 2.1 billion (high case). This is below the share in reported costs (see Exhibit 11) where metering costs accounted for 72% due to higher data coverage in the initial data set and adjustments to reported metering costs for GB and the Scandinavian countries.

6.5.7 Line items C2.3 to C2.5 (scheduling and settlement, billing systems and BRP forecasting) combined account for 47% of total costs.

6.5.8 Exhibit 24 presents total costs for scenario “Unadjusted stakeholder data” which differs from scenario “Profiling” only with respect to metering costs (item C2.2).

**Exhibit 24. Total costs for ISP 15 by line item – Scenario "Unadjusted stakeholder data"**




*Source: Frontier*

*Note: The underlying data table can be found in Annex A*

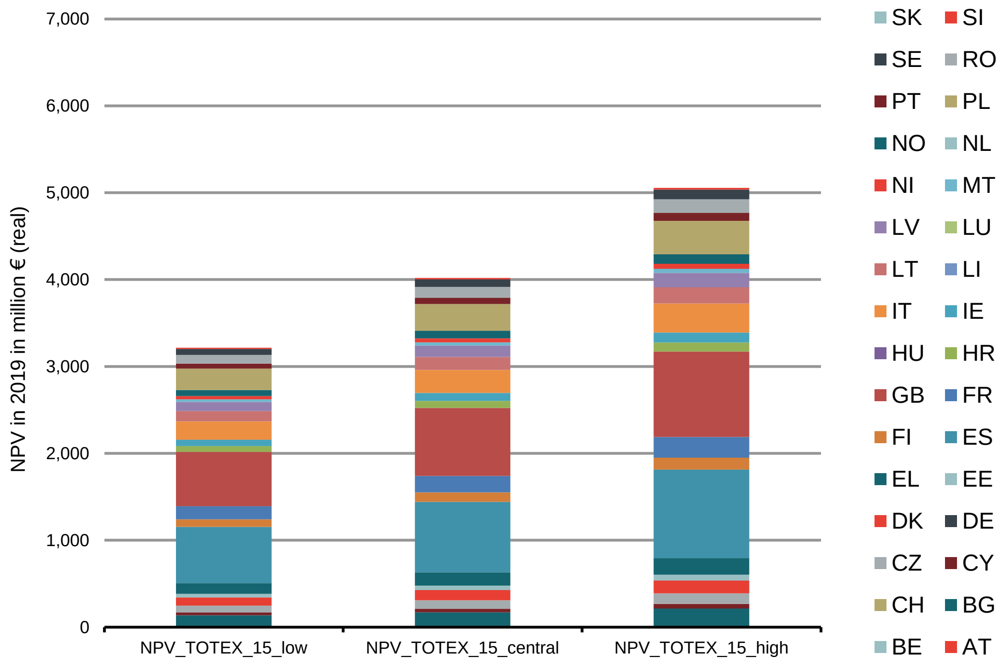
6.5.9 Total costs for the central case are € 5.3 billion, an increase compared to the "Profiling" scenario of almost € 1.3 billion. The variation of the low (-20%) and high case (+26%) remains unchanged in relative terms, based on the variation on responses to the questionnaire.

## Total costs by country

6.5.10 A change to an ISP period of 15 minutes is relevant for Planning Cases 2, 3 and 4 (see section 3.2). In this section we present the costs associated with change to ISP period to 15 minutes for all countries. Whether individual countries are affected by such a change depends on the respective planning case.

6.5.11 Exhibit 25 provides a break-down of total costs for the "Profiling" scenario by country.

**Exhibit 25. Total costs for ISP 15 by country – Scenario "Profiling"**




*Source: Frontier*

*Note: The underlying data can be found in Annex A. Countries in each column are presented in alphabetical order from bottom to top, i.e. starting from Austria and ending with Slovenia.*

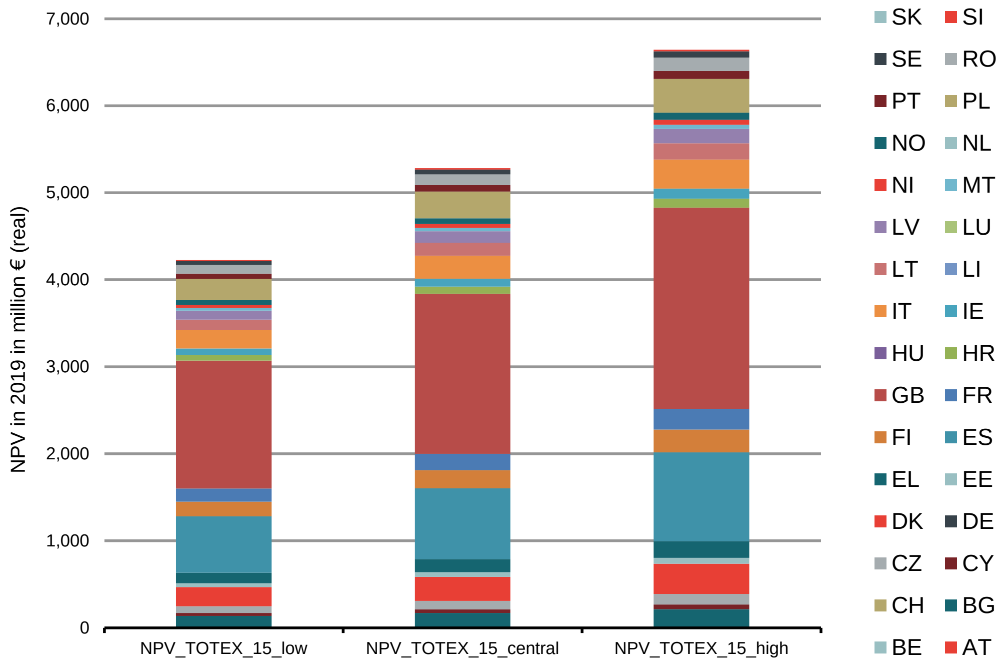
6.5.12 The five countries with highest costs for a change to ISP 15 account for 59% of total costs:

- Spain ranks first, with total costs of € 811 million (central case);
- GB ranks second, with total costs of € 781 million (central);
- Followed by Poland (€ 307 million), Italy (€ 265 million) and France (€ 189 million).

6.5.13 It is worth noting that France, the largest country in terms of the number of connected customers that are affected by a change to ISP 15, accounts only for the fifth largest cost.

6.5.14 Exhibit 26 provides the same cost break-down by country for scenario “Unadjusted stakeholder data”.

**Exhibit 26. Total costs for ISP 15 by country – Scenario "Unadjusted stakeholder data"**




*Source: Frontier*

*Note: The underlying data can be found in Annex A. Countries in each column are presented in alphabetical order from bottom to top, i.e. starting from Austria and ending with Slovenia.*

6.5.15 The five countries with the highest cost account for 66% to total costs, a slight increase by seven percentage points compared to scenario "Profiling".

6.5.16 Directly using reported costs by country (only scaling it up to full representativity) has a significant impact on the order of countries by cost:

- GB, which ranked second in the previous scenario, now ranks first with € 1.8 billion (more than twice the cost as in the "Profiling" scenario);
- Spain moved to second place with unchanged cost of € 811 million, less than half of GB's costs; and
- Denmark with € 277 million is ranked fourth, replacing France in the top five, a country with ten times as many connected customers as Denmark.

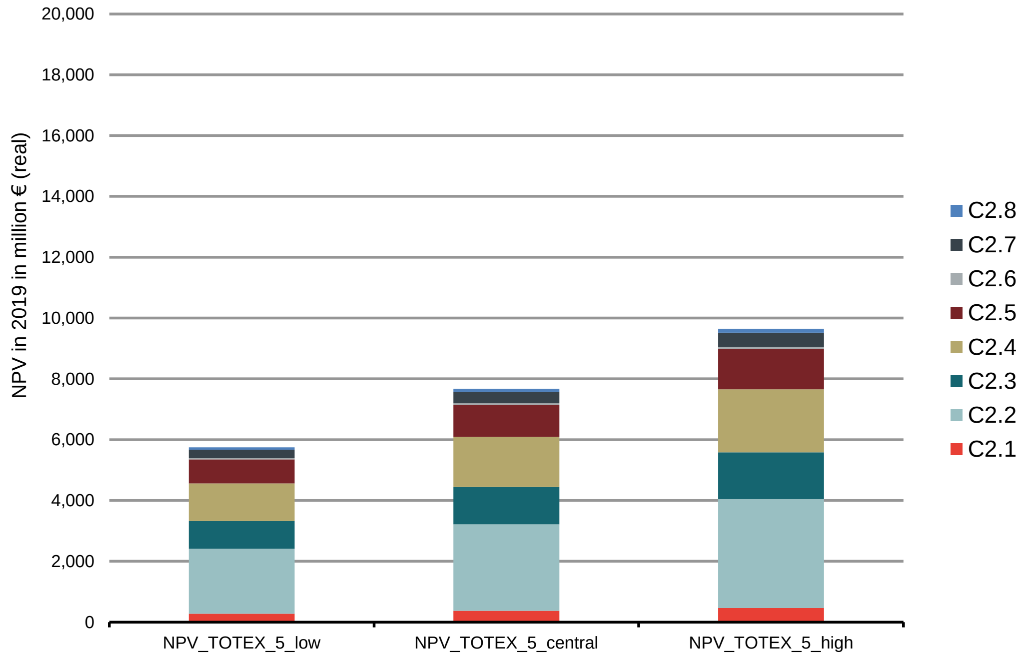
## Change to ISP period of 5 minutes

6.5.17 A change to an ISP period of 15 minutes is relevant for Planning Case 5 (see section 3.2) and would affect all countries in our geographic scope since there is no country in Europe which has implemented an ISP period shorter than 15 minutes.

### Total costs by line item

6.5.18 Exhibit 27 provides a break-down of total costs by line item for scenario "Profiling".

**Exhibit 27. Total costs for ISP 5 by line item – Scenario "Profiling"**




*Source: Frontier*

*Note: The underlying data table can be found in Annex A*

6.5.19 Total costs amount to € 7.7 billion in total for the central case, an increase by more than 90% compared to a change to an ISP of 15 minutes, presented above. The variation to the low and high case is again determined based on all responses where all three cases are available and is in a similar range in percentage terms to the ISP 15 case:

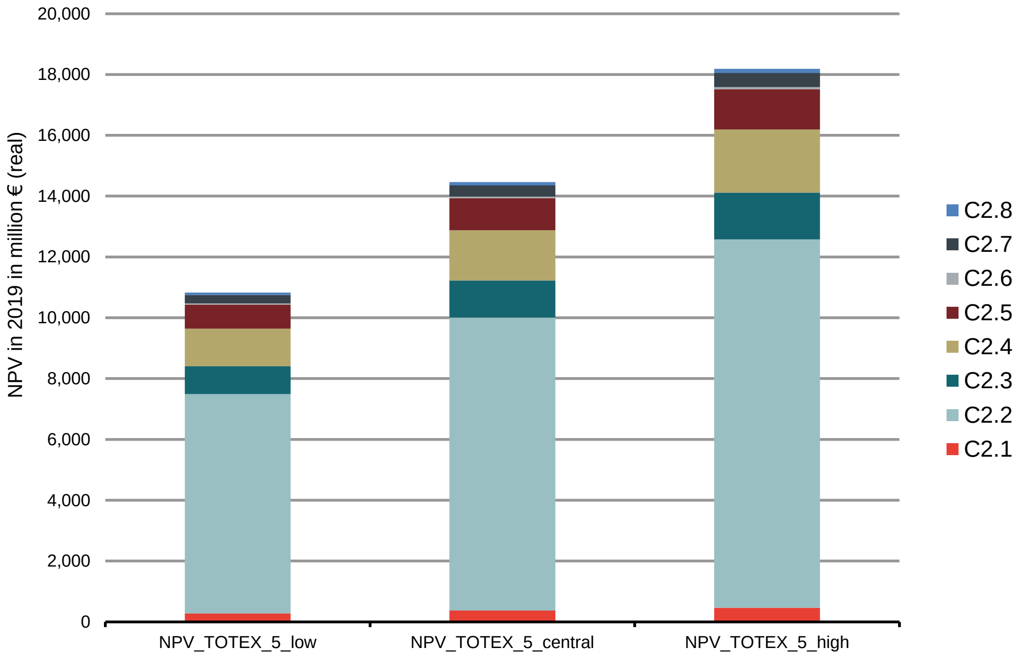
- Low case costs of € 5.7 billion (25% discount on central case); and
- High case costs of € 9.7 billion (26% uplift on central case).

6.5.20 As for ISP 15, metering costs (item C2.2) are by far the largest cost item, accounting for 37% of total costs. This is below the share of reported costs (see Exhibit 11) where metering costs accounted for 82% due to higher data coverage in the initial data set and adjustments to reported metering costs for GB, Spain and the Scandinavian countries.

6.5.21 Line items C2.3 to C2.5 (scheduling and settlement, billing systems and BRP forecasting) combined account for 51% of total costs, a slight increase by 4 percentage points compared to ISP 15.

6.5.22 Exhibit 28 presents total costs for scenario "Unadjusted stakeholder data" which differs from scenario "Profiling" only with respect to metering costs (item C2.2).

**Exhibit 28. Total costs for ISP 5 by line item – Scenario "Unadjusted stakeholder data"**




*Source: Frontier*

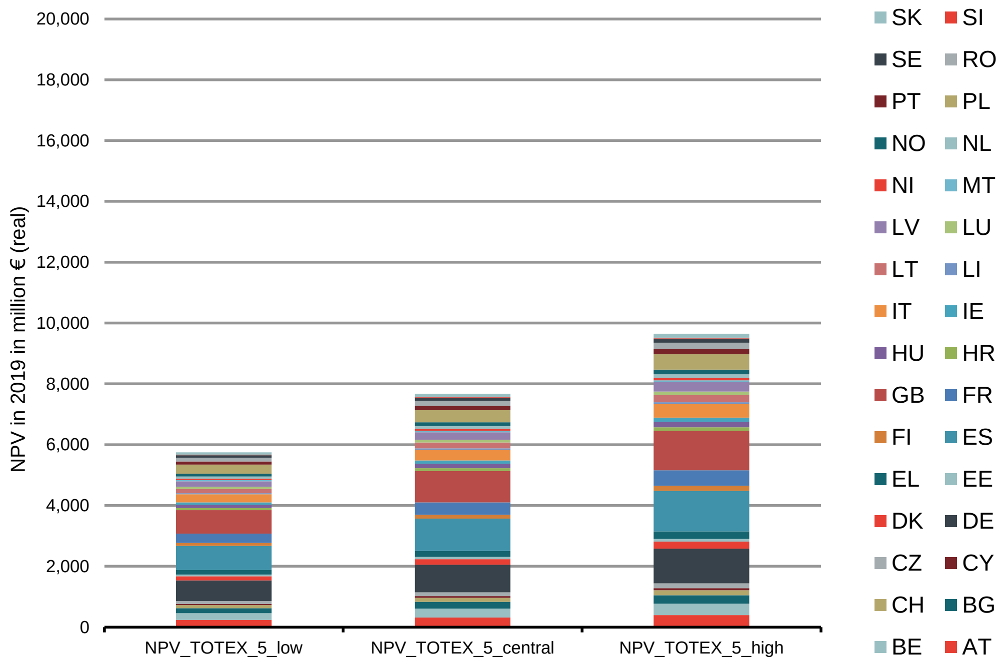
*Note: The underlying data table can be found in Annex A*

6.5.23 Total costs for the central case amount to € 14.5 billion, an increase compared to the "Profiling" scenario of € 6.8 billion. The variation of the low (-20%) and high case (+26%) remains unchanged in relative terms, based on the variation on responses to the questionnaire.

### Total costs by country

6.5.24 A change to an ISP period of 5 minutes is relevant for Planning Case 5 (see section 3.2) and affects all countries. Exhibit 29 provides a cost break-down by country for scenario "Profiling".

**Exhibit 29. Total costs for ISP 5 by country – Scenario "Profiling"**




*Source: Frontier*

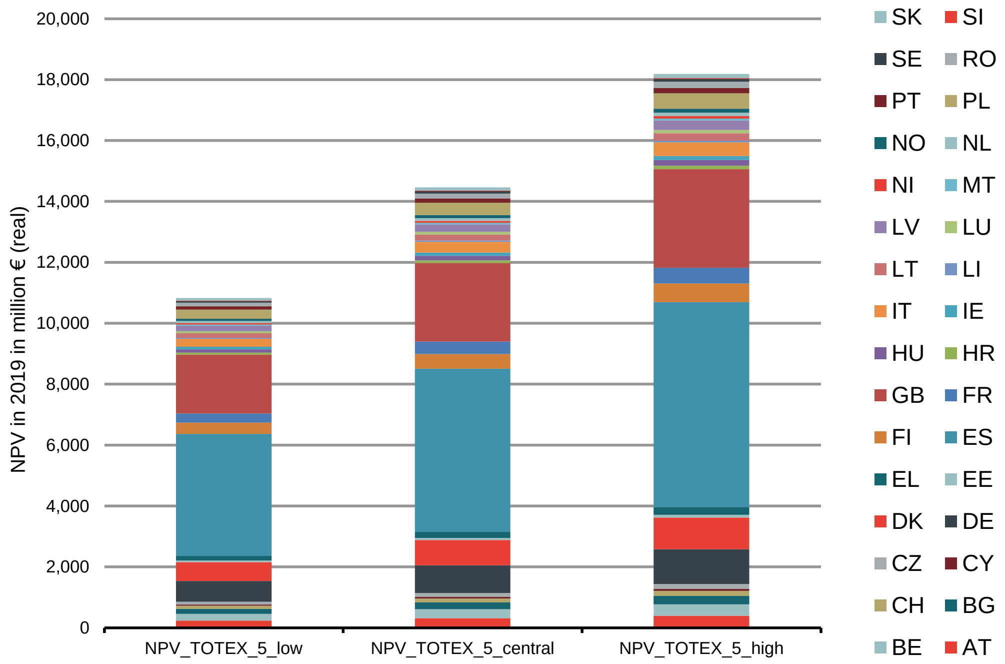
*Note: The underlying data table can be found in Annex A. Countries in each column are presented in alphabetical order, i.e. starting from Austria and ending with Slovenia.*

6.5.25 The five countries with the largest costs for a change to ISP 5 account for 50% of total costs (-9 percentage points compared to ISP 15 since more countries are affected):

- Spain again ranks first, with total costs of € 1.1 billion in the central case (an increase by € 250 mn compared to ISP 15);
- GB ranks second, with total costs of € 1 billion for the central case (an increase by € 250 mn compared to ISP 15);
- Followed by Germany (€ 906 mn), Italy (€ 408 mn) and Poland (€ 401 mn).

6.5.26 Exhibit 30 provides the same cost break-down by country for scenario "Unadjusted stakeholder data".

**Exhibit 30. Total costs for ISP 5 by country – Scenario "Unadjusted stakeholder data"**




*Source: Frontier*

*Note: The underlying data table can be found in Annex A. Countries in each column are presented in alphabetical order, i.e. starting from Austria and ending with Slovenia.*

6.5.27 The five countries with the largest costs account for 70% to total costs, 20 percentage points more than in scenario "Profiling", since two countries (Spain and GB) dominate if metering costs are unadjusted for the possibility of profiling.

6.5.28 Directly using reported costs by country (only scaling costs up to full representativity) has a significant impact on total costs for Spain and GB:

- Spain continues to rank first among all countries at total cost of € 5.4 billion (almost five times the cost in scenario "Profiling");
- GB continues to rank second at total cost of € 2.6 billion (more than twice the cost as in the "Profiling" scenario);

6.5.29 Spain and GB combined account for more than 50% of total costs for all 31 countries, and are more than 8 times as high as costs for Germany which has almost the same number of retail customers as these two countries combined.

## Change to ISP period of 30 minutes

6.5.30 A change to an ISP period of 30 minutes is only applicable to Spain and Portugal under Planning Case 4 (harmonisation by matching ISPs in neighbouring countries) as set out in section 3.2.

6.5.31 For a change to ISP 30 there is no differentiation between different metering costs scenarios since we only analyse two countries.

**Exhibit 31. Total costs for ISP 30 for Portugal and Spain (NPV 2019, million € real)**

| Country | Line item | Low case | Central case | High case |
|---|---|---|---|---|
| ES | C2.1 | 18.5 | 18.5 | 18.5 |
| PT | C2.1 | 0.3 | 0.3 | 0.3 |
| ES | C2.2 (transmission network) | 33.4 | 33.4 | 33.4 |
| ES | C2.2 (distribution network) | 97.7 | 70.3 | 122.9 |
| PT | C2.2 | 0.0 | 0.0 | 0.0 |
| ES | C2.3 | 20.0 | 20.0 | 20.0 |
| PT | C2.3 | 6.7 | 8.4 | 10.6 |
| ES | C2.4 | 61.0 | 76.3 | 96.0 |
| PT | C2.4 | 13.5 | 16.8 | 21.2 |
| ES | C2.5 | 17.8 | 34.8 | 52.3 |
| PT | C2.5 | 29.1 | 36.3 | 45.7 |
| ES | C2.6 | 0.0 | 0.0 | 0.0 |
| PT | C2.6 | 1.5 | 1.9 | 2.4 |
| ES | C2.7 | 3.9 | 4.9 | 6.2 |
| PT | C2.7 | 3.9 | 4.9 | 6.2 |
| ES | C2.8 | 0.7 | 0.8 | 0.9 |
| PT | C2.8 | 0.0 | 0.0 | 0.0 |
| ES | All | 253.1 | 259.1 | 350.3 |
| PT | All | 55.0 | 68.7 | 86.4 |

*Source: Frontier*

*Note: See Annex A for further details.*

6.5.32 The main difference between Portugal and Spain lies in metering costs (C2.2): for Portugal, the TSO REN expects no significant costs since current smart meters can already be read at 15 minutes while for Spain, respondents report costs of up to € 156 million in the high case.

## 6.6 Concluding remarks on interpretation of costs

6.6.1 There are several indications that our final cost results could be interpreted as an upper bound for the incremental costs resulting from a change to ISP duration:

- Non-incremental cost included – Several comments by respondents suggest that what they reported is Totex under a new ISP period, i.e. not netting off costs which they would also occur under the status quo – rather than incremental costs. This is most notably the case for metering costs which is the largest line item where several respondents reported replacement costs based on the price of a new meter, not taking into account that the old meter would have to be replaced also under the status quo, but with a time lag equal to the remaining life time. This is particularly relevant for countries that have started their smart meter roll-out, for example Italy and the Scandinavian countries.
- Respondents with ISPs of 30 minutes or longer are more likely to respond. If their costs are systematically higher, applying the sample average to out-of-sample countries with an ISP duration of 15 minutes (e.g. for a move to ISP 5) would overestimate costs.
- For Germany, we do not have an observation on metering costs for the distribution network (the largest cost item) and we therefore applied the sample average to fill this gap for ISP 5. However, since Germany has not started a significant smart meter roll-out – in contrast to many other countries that are part of the basis for the sample average – this could lead to an overestimation of costs for the largest country within the geographic scope.
- Shared infrastructure – We have analysed each country individually and applied sample averages to fill the information gaps. This is also the case for cost items with a significant share of fixed costs (e.g. 2.4 billing system[15]) that can be shared across different countries by the same stakeholder.[16] It is not clear the degree to which this is reflected by the reported costs for a subset of countries and might lead to overestimated costs, especially for small countries.

6.6.2 For metering costs – by far the largest cost item in our analysis – we have defined two scenarios which differ with respect to the required changes to existing ISP meters of which the majority is installed in private households. Respondents from GB and Scandinavian countries have reported metering costs under the assumption that all smart meters will also under a new ISP period be read at in the same time period (i.e. consumption is read and reported in 15 or 5-minute intervals) as is the case in the status quo. These costs enter scenario "Unadjusted stakeholder data". An alternative to costly replacements or reconfiguration of existing smart meters would be profiling where consumption meters would continue to be metered at the current ISP period (spanning multiple new ISP periods) and the meter readings would be allocated to the new ISP

[15] Changing the software system of billing systems is a one-time fixed costs and largely independent of the number of customers.

[16] In at least one case, a large retailer who is active in Belgium and France (two countries that do even not share the same ISP period) reflected shared infrastructure costs explicitly in reported costs.

period by applying a profile. This effect is captured by lower costs in scenario "Profiling".

# 7 ANALYSIS OF BENEFITS

## 7.1 Introduction

7.1.1 In this section we summarise the views received from respondents with respective to the likelihood of benefits materialising subsequent to changes in ISP durations. Where respondents have provided indicative values for the benefits, we review these as well. In the majority of cases, responses to the survey do not suffice to quantify the scale of potential benefits across the geographical scope for the CBA. We therefore draw on qualitative responses and, if applicable, quantitative estimates, to carry out our own analysis of the potential size of benefits. We describe below the approach used to carry out this analysis and present our estimates for the net present value of potential benefits.

7.1.2 For simplicity, we have considered here the potential benefit associated with a move to 30 minutes, 15 minutes or 5 minutes across Europe. We also show results by planning cases..

7.1.3 The exhibit below provides an overview of the estimated range for the net present value of potential benefits associated with changes in ISP durations. In total, benefits would be expected to range between €1.1bn and €2.7bn in the case of a move to 30 minute ISPs (where the ISP is currently higher), between €2.3bn and €5.6bn in the case of a move to 15 minute ISPs (where the ISP is currently higher), and between €3.0bn and €7.0bn in the case of a move to 5 minute ISPs. The shift from balancing energy to intraday energy is by far the largest driver of this estimate, as we discuss in the remainder of this section. The benefit associated with harmonisation of ISP durations on both sides of a number of borders also accounts for a significant share of the overall benefit value.

**Exhibit 32. Estimated net present value of benefit (€bn)**

| | Low Case | | | High Case | | |
|---|---|---|---|---|---|---|
| | 30 minutes | 15 minutes | 5 minutes | 30 minutes | 15 minutes | 5 minutes |
| Reduced balancing costs – shift from balancing energy to intraday energy | 0.72 | 1.14 | 1.21 | 2.30 | 3.64 | 4.37 |
| Reduced balancing costs – lower reserve capacity cost | 0.04 | 0.04 | 0.07 | 0.04 | 0.04 | 0.07 |
| Reduced balancing costs – greater intraday competition from cross-border BSPs | 0.04 | 0.80 | 0.80 | 0.08 | 1.59 | 1.59 |
| Reduced balancing costs – Further impact on prices | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced balancing costs – Greater entry of BSPs to intraday markets | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 |
| Reduced balancing costs – Further impact on balancing | 0 | 0 | 0 | 0 | 0 | 0 |
| Increased secon0dary trading volumes | 0.26 | 0.34 | 0.91 | 0.26 | 0.34 | 0.91 |
| Improved investment outcomes | 0 | 0 | 0 | 0 | 0 | 0 |
| Other benefits – frequency excursions | na | nz | | na | na | na |
| **TOTAL** | **1.1** | **2.3** | **3.0** | **2.7** | **5.6** | **7.0** |

*Source: Frontier Economics*

7.1.4 The following exhibit breaks down these overall benefits for each of the countries under investigation. The results are presented for each of the four planning cases covered in the analysis. As such, the results shown below can be interpreted as the country-specific net impact of a change in ISP duration associated with each planning case compared to the country-specific status quo ISP duration.

**Exhibit 33. Estimated net present value (2019) of benefit by country and by planning case (in €mn)**

| | Low Case (€mn) | | | | High Case (€mn) | | | |
|---|---|---|---|---|---|---|---|---|
| **Country** | **PC 1** | **PC 2** | **PC3** | **PC4** | **PC 1** | **PC 2** | **PC3** | **PC4** |
| Austria | 47 | 47 | 47 | 128 | 93 | 93 | 93 | 212 |
| Belgium | 22 | 0 | 0 | 58 | 44 | 0 | 0 | 122 |
| Switzerland | 272 | 236 | 236 | 283 | 544 | 472 | 472 | 631 |
| Germany | 185 | 111 | 111 | 655 | 370 | 223 | 223 | 1325 |
| Hungary | 53 | 53 | 53 | 74 | 106 | 106 | 106 | 148 |
| Lichtenstein | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| Luxemburg | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 7 |
| Netherlands | 84 | 0 | 0 | 107 | 167 | 1 | 1 | 250 |
| Slovakia | 93 | 93 | 93 | 107 | 185 | 185 | 185 | 214 |
| France | 245 | 0 | 9 | 283 | 655 | 0 | 18 | 763 |
| Great Britain | 208 | 0 | 0 | 217 | 501 | 0 | 0 | 523 |
| Ireland | 22 | 0 | 0 | 21 | 51 | 0 | 0 | 47 |
| Northern Ireland | 9 | 0 | 0 | 9 | 19 | 0 | 0 | 17 |
| Bulgaria | 43 | 43 | 43 | 40 | 113 | 113 | 113 | 103 |
| Czech Republic | 77 | 77 | 77 | 71 | 203 | 203 | 203 | 184 |
| Denmark | 9 | 9 | 9 | 11 | 47 | 47 | 47 | 47 |
| Estonia | 10 | 10 | 10 | 11 | 26 | 26 | 26 | 25 |
| Greece | 54 | 54 | 54 | 49 | 138 | 138 | 138 | 125 |
| Spain | 289 | 289 | 255 | 267 | 770 | 770 | 669 | 699 |
| Finland | 18 | 18 | 18 | 22 | 60 | 60 | 60 | 62 |
| Croatia | 8 | 8 | 8 | 10 | 55 | 55 | 55 | 38 |
| Italy | 187 | 187 | 187 | 187 | 441 | 441 | 441 | 440 |
| Lithuania | 11 | 11 | 11 | 11 | 26 | 26 | 26 | 23 |
| Latvia | 9 | 9 | 9 | 9 | 21 | 21 | 21 | 19 |
| Norway | 30 | 30 | 30 | 30 | 81 | 81 | 81 | 81 |
| Poland | 168 | 168 | 168 | 154 | 444 | 444 | 444 | 402 |
| Portugal | 56 | 56 | 49 | 51 | 144 | 144 | 125 | 130 |
| Romania | 63 | 63 | 63 | 68 | 163 | 163 | 163 | 180 |
| Sweden | 25 | 25 | 25 | 26 | 89 | 89 | 89 | 89 |
| Slovenia | 25 | 25 | 25 | 16 | 65 | 65 | 65 | 39 |
| Cyprus | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Malta | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| ***Total*** | ***2,328*** | ***1,628*** | ***1,597*** | ***2,986*** | ***5,625*** | ***3,970*** | ***3,868*** | ***6,951*** |

*Source: Frontier Economics*

## 7.2 Reduced balancing costs

### Shift from balancing energy to intraday energy

#### Views of respondents

7.2.1 The vast majority of respondents have not provided an answer to this question. Around 20 stakeholders provided an estimate for the expected annual volume of pre-gate closure trading actions BRPs would themselves undertake on the intraday market or through pre-gate closure physical actions instead of the TSO having to balance post gate-closure. The majority of these stakeholders were TSOs, and others are generators and/or retailers.

7.2.2 Some TSOs flagged that they do not believe this effect can be modelled appropriately, as evidenced by the following selected quotes from responses:

- One respondent stated that "values are available only for actual ISP duration. No forecast can be calculated; too many variables enter in the result to find a suitable result years ahead"; and
- A second respondent stated that "It is difficult to estimate whether there will be a net transfer of volume from the Balancing Mechanism to wholesale markets. The short answer is with limited affect expected in ISP around central scenarios then the increase in trading would be small. […E]ven if wholesale market trading numbers and volumes increased and Net Imbalance Volume (market length) were to get tighter to a balance position, there is no guarantee that wider SO system management costs would go down."

7.2.3 Of the respondents that did provide a quantitative response, the number that consider the effect to be zero and the number that consider a non-zero effect was roughly split evenly.

7.2.4 Among those respondents who provided a MWh value for the expected volume of avoided balancing actions (these respondents were mostly TSOs):

- For the move to a 30-minute ISP, the volume effect ranged between 2% and 6% of the volume of balancing actions in the status quo;
- For the move to a 15-minute ISP the volume effect ranged between 9% and 20% of the volume of balancing actions in the status quo;
- For the move to a 5-minute ISP the volume effect ranged between 14% and 26% of the volume of balancing actions in the status quo[17].

7.2.5 Other respondents suggested a material volume change:

- A vertically integrated player expected a potential reduction of 5-10% of total balancing volumes. They stated that corresponding impact on intraday trading cannot be estimated precisely;
- A retailer expected "5% more trading to better anticipate volume; extreme reduction in imbalance prices compared to current situation. Relative[ly] small price difference";

[17] This is based on central case estimates provided by those respondents.

- A generator stated that "as the products on the intraday trading is assumed to follow the ISP, everything else equal activated volumes will shift from balancing market to intraday market.;"
- A generator stated that "we suspect the overall benefits of a reduction in the existing 30 minute imbalance settlement period in GB would be relatively small, but have no firm evidence or analysis of what they might be."

7.2.6 Some respondents linked the likely reduction in imbalance volumes to ramping:

- One TSO indicated that when only hourly energy blocks can be exchanged and a linear ramp is assumed, the imbalance volume is related to the length of the ISP, with a shorter ISP reducing the imbalance;
- An industry association noted that the Swedish and Norwegian TSO require that BRPs with portfolio changes exceeding 200 MW between two hours to smooth out changes before and after the hour shift. A shift towards for example a 15 minutes settlement period would from this perspective facilitate a more transparent methodology and an also imply an equal treatment of all BRPs.

7.2.7 In contrast, a GB based respondent noted that deterministic frequency deviations are not present in GB and Ireland due to the market design and operating rules, e.g. the use of minute by minute information for final physical notifications in GB.

7.2.8 A number of stakeholders discussed potential implications related to the ability to act on incentives created by a shorter ISP:

- An industry association noted that the higher the level of time aggregation of production schedules, the more deviation on a real time scale. Shortening the ISP (with more real-time date from TSO) would provide BRPs with more time in order to manage unplanned and unpredictable deviations. In this regard, intra-hour would allow the TSO to manage the system balance with an increased accuracy as there is a clear trend towards more dispersed and smaller generation units without real time measurement. To allow for an efficient and practically feasible settlement of these units shorter settlement periods will be necessary. Moreover, it would allow the TSO to better control the delivery of Replacement Reserves and manual Frequency Restoration Reserves by BSPs; and
- A generator noted that "various practical restrictions … suggest the economic benefit of shorter imbalance periods might arise mainly from changes in collective behaviour of smaller participants responding to time-of-use prices, with an assumption they can deliver more efficient supply/demand equilibrium in response to imbalance prices determined at finer resolution than currently. Smaller participants, including individual consumers and small generators, are generally less constrained in their real time activity by industry rules… The larger flexible generators which currently provide most of the balancing services … are instructed by the System Operator at a resolution of minutes, subject to individual physical characteristics. Being subject to pay-at-bid balancing payments at prices and volumes fixed at gate closure, their ability to respond to shorter imbalance periods would be limited. Traded flows across interconnectors could be varied at finer resolution, but restrictions on trading affecting flows after gate closure limits the extent of this… Notification

of wholesale contractual volumes currently ceases at gate closure, limiting the opportunity for trading activity close to real time to respond to expected imbalance prices at finer resolution. These considerations suggest benefits would come mainly from changes in collective behaviour of smaller participants who are less constrained in their real time activity by industry rules, including consumers, with an assumption they can deliver more efficient supply/demand equilibrium in response to imbalance prices determined at finer resolution than currently."

7.2.9 A number of respondents commented on the benefits of a shorter ISP for imbalance pricing and for the incentives on parties to balance:

- One TSO stated that "the time to restore frequency for TSOs is 15 minutes. Therefore, if the ISP is > 15 minutes, no accurate price signals can be given to BRPs to help balancing the system. Therefore, a single marginal pricing system with allowed self-balancing, where BRPs are allowed to help reduce the system imbalance by reacting on price signals on the condition that they are able to restore their balance at any time … is not of use if the ISP is higher than the time to restore frequency." The respondent noted that the benefits of such a mechanism have been observed in the past. They gave the example of Belgium, which switched from a dual pricing mechanism to a single marginal pricing mechanism with self-balancing in 2012. In Belgium, a reduction of 40%, or 500 GWh, of net (to exclude potential counter activations) R2 and R3 balancing actions have been observed between 2012 and 2015. A reduction of 30 % of the SI can be observed and a reduction by 40 % of the ACE after balancing actions;
- A generator provided an example of how the price signal might improve: "for example, an expensive generator which is called to run to balance a residual demand which only lasts 16 minutes might set an imbalance price which is paid by all residual uncontracted demand during the 30 minutes, and paid to all residual uncontracted surpluses during the 30 minutes. That price might be correct for the time for which the expensive generator is required, but could be inefficiently high for other times in the period. Consumers of uncontracted energy at those other times will pay more than they should, and uncontracted generation at those other times will receive more than it should"; and
- An industry association stated that "with long settlement period, the costs incurred by the TSO to balance the system in real time cannot always be properly allocated to the responsible market party because BRPs that have been out of balance within a settlement period (e.g. 15 or 30 min) may be balanced over the whole period. Short settlement periods contribute to a more cost-reflective imbalance settlement. It has been observed that the activation of both upward and downward balancing energy bids increase for longer settlement periods, especially in power systems under high penetration of renewable generation. Under a single imbalance pricing system, that would mean that it is unlikely that balancing energy costs can be fully recovered when upward and downward balancing energy bids are activated within a single settlement period since imbalance prices are determined by the net amount of activated balancing energy)."

7.2.10 Other stakeholders linked the likelihood of achieving benefits to the maturity of their current market design, although we note this is not necessarily consistent with the assumption discussed above of a fully functional target model:

- A Slovenian stakeholder expected that BRPs will not have lower costs for imbalances, rather higher. Already now there is a lack of data on the level of consumption, and on the level of ISP;
- Another respondent stated that “as there is no operating organised intraday market yet, no estimation could be provided”;
- An Irish respondent noted that “the SEM is an ex-post pool market and does not have balancing arrangements currently. As such, it is not possible to quantify the potential impact on the future market”; and
- Another respondent indicated that they did not expect a significant increase in self-balancing performed by the BRPs in the ID markets as a result of the mere reduction of ISP. They stated that “this effect may arise (but it is difficult to estimate) as a result of the gate closure time reduction on the ID markets. The impact in the ID market should consist in the internalization of the dynamic constraint of dispatchable plants within ID markets while today these constraints are solved within ancillary services market (ASM). This shift is not necessarily a benefit because the price of the action performed may be the same in ID market as in the ASM.”

7.2.11 A number of other stakeholders indicated that they did not expect changes in behaviour:

- A supplier reported that they “do not believe that a decrease in ISP duration would result in us undertaking any significant increase in trading volumes.”
- A vertically integrated player expected that the change in ISP would purely lead to a split of current trades over the MTU period into two trades; and
- A generator said that “the extent to which the market(s) can balance itself through the actions of competing participants, rather than rely on the system operator who has significant analytical and operational resources dedicated to achieving a balance in aggregate, is uncertain.”

7.2.12 A TSO commented that the expectation of benefit from a move to a 5 minute ISP would be much lower. They stated that:

- it is expected that a reaction from BRPs towards a 5-min price signal will be operationally and technically infeasible; and
- there is a risk of creating inefficiency in balancing: “since the time to restore frequency for TSOs remains 15 minutes, the TSO would need to make a choice to align the balancing products to an ISP of 5 minutes or not. If the mFRR product would still be activated until the end of the quarter-hour (on a 15 min basis), this could increase the necessary counter-activations by aFRR in the 2nd and 3rd 5 minute time period, if it is assumed that BRPs will react to the 5 min price signal, and could even distort the price signal making it less accurate and potentially worsen the global SI. If the mFRR product would be activated on a 5 minute basis, this would increase the requirements of this product and therefore drastically reduce available volumes and liquidity (for

mFRR from production as well as load) and also increase price (the ramps that create an imbalance will need to be priced in on a smaller time step).

7.2.13 On average those that suggested a non-zero effect considered a reduction in TSO balancing actions of 1,800 GWh for the 5 minute ISP and 1,100 GWh for the 15 and 30 minute ISP duration.

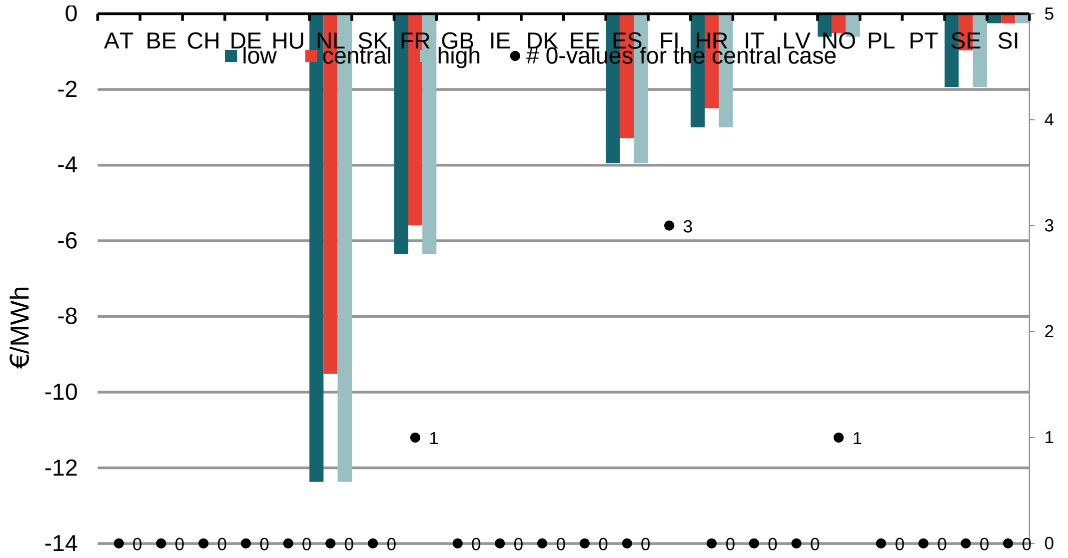
7.2.14 A limited number of stakeholders argue that a reduction in ISP duration would lead to a decrease in average wholesale prices. A larger number of respondents consider that the change in ISP duration would not lead to a significant impact on wholesale prices. A number of respondents, including TSOs, generators and suppliers indicated that they had no basis for estimating a price effect.

7.2.15 A slightly clear picture emerged in relation to balancing prices. A significant number of respondents suggest that balancing prices could decrease following a reduction in ISP duration. However, this view is far from universal:

- A reasonable number of respondents indicated they expected no change in balancing prices (although some suggested that volatility may increase); and
- A smaller number of respondents (including two TSOs) suggested that balancing prices could increase, largely because of reduced liquidity in balancing markets.

7.2.16 The chart below displays the average price difference between the balancing and intraday price as estimated by those stakeholders that provided an answer, in 2020. These estimates range from close to 0 €/MWh up to a discount of over 12 €/MWh in the price achieved on the intraday market by BRPs relative to that achieved by the TSO in the balancing market.

**Exhibit 34. Average price difference, 2020 (€/MWh)**




*Source: Frontier Economics based on survey responses*

## Our analysis

7.2.17 We have carried out stylised analysis to assess the magnitude of a potential benefit resulting from a shift of balancing activities from the balancing to the intraday market. Our aim is to quantify the monetary impact that this reduction in balancing activities will have on social welfare. The size of this impact will depend on two effects that we aim to model in our stylised analysis:

- Volume effect – A shorter ISP duration will allow BRPs to use information on forecast generation and consumption to trade at finer granularity on the intraday market and achieve lower imbalances eventually. As such, the TSO will then need to engage in a lower number of actions on the balancing market compared to the status quo.
- Price effect – The monetary impact associated with shifting volumes away from the balancing market and onto the intraday market will depend on the price differential, all else equal, between the balancing and the intraday market.

### Volume effect

7.2.18 To estimate the potential impact of a reduction in ISP duration on balancing volumes, we have collected the most granular demand and generation profiles available (typically five or fifteen minutes) for a given market area over a full year. Then:

- We derived 15, 30 and 60 minute profiles by averaging the more granular data over the relevant period;
- We calculate balancing actions required in the status quo, assuming BROs are perfectly balanced at ISP granularity and the TSO has to take balancing actions to adjust for imbalances within the ISP period relative to the average load over that period;
- Then, for each potential ISP duration (5, 15, 30), we calculate required balancing actions by the TSO to adjust for within-ISP period deviations from average load;
- We aggregate the volume of all modelled balancing upward and balancing downward actions, and compare this against the volume of actions estimated for the status quo ISP duration.

7.2.19 This analysis was implemented for 11 market areas where data was available. For other countries, we estimate the average volume of avoided balancing actions from those 11 market areas where the analysis has been implemented (depending on status quo and target ISP duration) and we scale this up or down to the rest of other countries depending on the annual volume of demand and generation in each market area (source: ENTSO-E).

7.2.20 We discuss below the impact of the assumptions made in our stylised analysis on how the results should be interpreted:

- We note that the analysis was done at the aggregate demand and generation level in each market area. It could be the case that estimated balancing volumes are lower at this aggregate level than the sum of all balancing actions taken by the TSO to adjust for individual BRP's imbalance positions.

- Equally, the analysis focuses on estimating within-ISP periods imbalances relative to 5-minute periods (or 15-minute when this was not possible). Implicitly this assumes that with a 5-minute ISP no balancing actions would be required from the TSO. This is likely to over-estimate the benefit as data at finer granularity show further deviations in load below 5 minutes.
- The change in balancing actions also relies on BRPs trading at fine granularity on intraday markets in order to reduce their imbalance position as far as possible. A number of respondents have argued that this is not realistic given the current state of intraday markets in certain areas. While the CBA assumes the Target Model will have been implemented in the status quo, we have considered the sensitivity of our estimates to a lack of liquidity preventing the benefit from materialising in certain market areas. For those countries without an intraday market today, we assume a benefit of 0 in 2020 and progressively ramp up the benefit value up to 2030. We find this would reduce the total net benefit across the EU+3 by €0.1bn (in NPV terms, as of 2019, and for all ISP durations).
- Finally, our analysis does not reflect potential future changes in the power sector. For instance, we do not consider demand growth or imports and exports in the benefit quantification. An increase in overall demand or generation volumes in the status quo would lead to a pro-rata increase in volumes that switch from the balancing to the intraday market when the ISP duration is reduced. This could be a potential source of underestimation of the benefit value in our analysis. Similarly, we do not consider potential changes in the power mix at the 2030 horizon and implications for the volume of balancing actions.

7.2.21 Whilst we are not able to quantify the net effect of these potential biases, we would consider that in the round there is no strong reason to believe that there is a consistent bias upwards or downwards in the estimated volume effect.

7.2.22 We also note that the analysis was performed at market area level for 44 countries, based on data availability. As described above, an average volume effect is estimated on this basis and read across to other market areas. We obtain similar orders of magnitude for the volume effect across the eleven countries where it has been estimated. In particular, there is no pattern in the distribution of results according to current ISP duration. This provides confidence in the validity of the estimate.

7.2.23 It could however be the case that the effect is over- or under-estimated for a given country, depending on local drivers of required balancing actions in the status quo and how these would change with a change in ISP. In order to identify those countries where the risk is highest that the stylised analysis yields biased results, we have compared the stylised estimate for the reduction in the volume of balancing actions at the level of the volume of balancing actions in the status quo[18]. We find that the stylised approach estimated a reduction in balancing actions in excess of status quo volumes for six countries. For those countries we cap the volume effect at the level of status quo balancing actions.

[18] This cross-check has been performed for fourteen market zones, based on data availability.

We would note that this results in identical levels for the volume effect across the various planning cases for those countries[19].

7.2.24 Finally, we have compared the stylised estimates of reductions in balancing actions with the volumes indicated by those respondents who provided an answer to the survey. We find that stakeholders' central estimates range between 3% and 39% of stylised estimates. We would emphasise here that the documentation of survey responses does not suffice to disentangle the drivers for the gap between stylised estimates and survey responses. In particular, it is clear that some survey responses factor in hypotheses about BRP behaviour which the stylised analysis does not aim to capture. However, we conservatively use survey responses as a lower bound for the volume effect for those countries where a volume effect has been quantified[20]. This is one of the drivers of the wedge between our estimated low and high range for this benefit.

### Price effect

7.2.25 We have separately estimated the average balancing to intraday price premium by:

- Calculating the difference between either the upwards or downwards balancing price and the intraday price in the same period depending on whether the system as a whole is short or long in every hour of a year; and then by
- Deriving the resulting average premium for upwards or downwards balancing actions over the whole year.

7.2.26 This analysis has been carried out in those market areas where intraday price data availability allowed it[21]. For other countries, we have used the average estimated price differential[22].

7.2.27 The price differential measured between the balancing market and the intraday market in corresponding periods is likely to capture the sum of several effects:

- Supply curve effects, e.g. where the marginal costs of generators are higher when dispatched on the balancing market than on the intraday market (all else equal) due to the shorter lead time for dispatch;
- Merit order effects, e.g. where units called on the balancing markets display higher marginal cost than the marginal plant on the intraday market; and
- Market imperfection effects, e.g. where market structure and arrangements drive the prices in either the wholesale or balancing to include a premium on marginal cost.

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19 Based on data availability this sense-check has been performed for 16 of the countries in the sample. The test found that the estimated volume effect overpassed balancing actions in the status quo in Switzerland, Denmark, Finland, Italy, Norway and Sweden. The fact that the cap imposed on the volume effect int hose countries is identical across all planning case is reflected in the estimated values for the net welfare effect in those countries in the high case in Exhibit 36 below. ,

20 The survey responses retained here concern Switzerland, Germany, Denmark, Finland, Croatia, the Netherlands, Norway, and Sweden.

21 France, Great-Britain, and Romania

22 Subsequent to a request by Nordic TSOs a specific estimate of the price differential was derived in Denmark, Finland, Norway and Sweden based on comparing balancing prices with day-ahead prices.

7.2.28 The supply curve effect is likely to be the main driver of the net welfare effect. As a result an adjustment would seem to be required to be made to the price effect to capture only the net welfare effect associated with this benefit.

7.2.29 The transfers between consumers and producers will be driven by the combination of the supply curve effect and the merit order effect in each period. We note that, as discussed above, the merit order effect would typically lead to an increase (resp. decrease) in consumer surplus and a decrease (resp. increase) in producer surplus in those periods where upward (resp. downward) balancing actions are avoided. It could be the case that over the course of the year the merit order effect is neutral for both consumers and producers.

7.2.30 We have also compared our estimate of the price effect with the estimated average price difference between the balancing and the intraday market indicated by stakeholders in their survey responses. We find that our estimate of the price effect is significantly larger than that indicated by the few stakeholders who provided an answer. This would suggest there is a risk that we have overestimated the price effect.

7.2.31 However, we note that we have not assumed any other change in either wholesale or balancing prices over the CBA period. Should energy prices globally increase at the 2030 horizon then the absolute price premium paid on the balancing market as opposed to the intraday market would also rise. We would therefore be underestimating the benefit value from a change in ISP duration.

7.2.32 In the round, we have reflected the uncertainty around the price effect by taking a more conservative approach when deriving the net welfare effect associated with this benefit. We have assumed that:

- The change in consumer surplus is equal to the product of the estimated delta in price times the volume effect;
- In the low case, the net welfare effect is equal to 25% of the change in consumer surplus;
- In the high case, the net welfare effect is equal to 75% of the change in consumer surplus.

7.2.33 We report below the corresponding value for the benefit associated with shifting volumes from the balancing market to the intraday market.

### Results

7.2.34 We estimate the total benefit would range between €1.4bn and €3.6bn (in NPV 2019 terms) for a harmonised reduction of the ISP duration to 15 minutes across market areas where it is currently longer than 15 minutes. This benefit would increase to €1.2bn to €4.4bn if the ISP duration was to be further reduced to five minutes. We have summarised these results below.

**Exhibit 35. NPV(2019) of the potential benefit from a shift of balancing energy to intraday energy**

| ISP duration | Low (€ mn) | High (€ mn |
|---|---|---|
| ***30 minutes*** | 720 | 2,305 |
| ***15 minutes*** | 1,141 | 3,637 |
| ***5 minutes*** | 1,208 | 4,372 |

*Source: Frontier Economics*

7.2.35 The exhibit below shows how the benefit associated with a reduction in balancing actions is distributed between the countries and ISP durations that we consider in the cost-benefit analysis.

**Exhibit 36. NPV of the potential benefit from a shift of balancing energy to intraday energy by country (in €mn)**

| Country | Benefit 3.1.1 low case (€mn) | | | Benefit 3.1.1 high case (€mn) | | |
|---|---|---|---|---|---|---|
| | 30 min | 15 min | 5 min | 30 min | 15 min | 5 min |
| Austria | 0.0 | 0.0 | 18.6 | 0.0 | 0.0 | 55.7 |
| Belgium | 0.0 | 0.0 | 20.5 | 0.0 | 0.0 | 61.5 |
| Switzerland | 0.0 | 0.0 | 3.6 | 0.0 | 0.0 | 79.0 |
| Germany | 0.0 | 0.0 | 21.4 | 0.0 | 0.0 | 505.1 |
| Hungary | 0.0 | 0.0 | 10.9 | 0.0 | 0.0 | 32.6 |
| Lichtenstein | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Luxemburg | 0.0 | 0.0 | 1.2 | 0.0 | 0.0 | 3.7 |
| Netherlands | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 | 59.2 |
| Slovakia | 0.0 | 0.0 | 7.1 | 0.0 | 0.0 | 21.3 |
| France | 0.0 | 183.2 | 218.9 | 0.0 | 549.6 | 656.6 |
| Great Britain | 0.0 | 146.1 | 152.7 | 0.0 | 438.2 | 458.2 |
| Ireland | 0.0 | 14.6 | 13.2 | 0.0 | 43.8 | 39.7 |
| Northern Ireland | 0.0 | 4.9 | 4.4 | 0.0 | 14.7 | 13.3 |
| Bulgaria | 30.0 | 34.8 | 31.5 | 89.9 | 104.5 | 94.4 |
| Czech Republic | 54.2 | 63.0 | 56.8 | 162.5 | 189.0 | 170.4 |
| Denmark | 12.4 | 2.8 | 2.8 | 37.3 | 40.9 | 38.9 |
| Estonia | 6.7 | 7.8 | 7.0 | 20.1 | 23.3 | 21.0 |
| Greece | 36.2 | 42.1 | 37.7 | 108.7 | 126.4 | 113.2 |
| Spain | 206.6 | 240.2 | 215.9 | 619.9 | 720.5 | 647.8 |
| Finland | 0.8 | 2.9 | 3.8 | 43.9 | 43.9 | 43.9 |
| Croatia | 0.4 | 2.1 | 4.3 | 42.6 | 49.3 | 32.6 |
| Italy | 126.4 | 126.4 | 126.4 | 379.3 | 379.3 | 379.3 |
| Lithuania | 6.1 | 7.1 | 6.3 | 18.3 | 21.2 | 18.8 |
| Latvia | 4.9 | 5.7 | 5.1 | 14.8 | 17.2 | 15.4 |
| Norway | 18.0 | 3.6 | 4.0 | 54.0 | 54.0 | 54.0 |
| Poland | 118.5 | 137.7 | 123.8 | 355.5 | 413.2 | 371.5 |
| Portugal | 37.9 | 44.1 | 39.6 | 113.8 | 132.2 | 118.8 |
| Romania | 43.4 | 50.1 | 55.8 | 130.3 | 150.2 | 167.3 |
| Sweden | 0.7 | 2.0 | 2.7 | 65.4 | 65.4 | 65.4 |
| Slovenia | 16.2 | 19.9 | 11.2 | 48.6 | 59.8 | 33.7 |
| Cyprus | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Malta | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ***Total*** | *0.72 €bn* | *1.14 €bn* | *1.21 €bn* | *2.30 €bn* | *3.64 €bn* | *4.37 €bn* |

*Source: Frontier Economics*

7.2.36 In the majority of countries, the wedge between the low and high case for this benefit is driven by the assumption made when deriving the net welfare effect from the consumer surplus.

7.2.37 For Switzerland, Germany, Denmark, Finland, Croatia, the Netherlands, Norway, and Sweden, an additional wedge between the low and high case is due to the fact that the volume effect in the low case is based on survey responses.

7.2.38 Finally, we note that the estimated benefit is higher in some countries when moving to a 5-minute ISP than when moving to a 15-minute ISP. This is due to the sample used to derive the stylised volume effect in each case:

- The stylised estimate of the volume effect when moving to a *five* minute ISP is based on data from those countries where five-minute load and generation data has been provided (GB, RO, HU, FR, CH, DE, FI, NO).
- The stylised estimate of the volume effect when moving to a *fifteen* or *thirty* minute ISP is based on a larger dataset as two additional TSOs were able to provide load and generation profiles at 15-minute granularity (SI and IT).

7.2.39 The load and generation profiles in SI and IT suggest a lower size for the volume effect when moving to fifteen and thirty minutes (relative to local demand and generation) than the average effect estimated based on the other seven countries listed above. Therefore, the inclusion of those two countries in the sample for the 15-minute and 30-minute volume effect drives the value down, to a level that is below the average 5-minute effect estimated from the reduced sample size.

## Lower reserve capacity cost

### Views of respondents

7.2.40 The large majority of respondents to the survey have not provided any quantitative or qualitative evidence. However, 36 stakeholders have provided input as to how a change in ISP duration could, in principle, lead to an impact on the capacity withheld from forward markets by the BRPs and/or a reduction in the reserves held by the TSO. The majority of respondents that have provided evidence on this benefit are TSOs, while some aggregators, retail suppliers and generators have also given answers.

7.2.41 It is interesting to note that a range of stakeholders have pointed out the difficulty to estimate and quantify some or all of the effects associated with this benefit. In particular, an ES vertically integrated player, a GB retail supplier, as well as GB and FR TSOs all explicitly consider cost differences difficult to evaluate.

7.2.42 The majority of respondents has pointed out that they expect little or no incentive for BRPs to withhold capacity from forward markets following a reduction in ISP duration. This is mainly driven by the market designs in place in the different countries or balancing areas. Additionally, some stakeholders have pointed out that capacity decisions by BRPs are taken with respect to the way in which imbalances are priced and settled and how balancing energy is paid for.

7.2.43 When asked to provide an estimate for the potential reduction in TSO reserve capacity requirements, a large number of stakeholders have also indicated doubt as to the extent to which the ISP duration will influence the reserve dimensioning that is undertaken by TSOs:

- While some respondents have argued that a reduction of reserve capacity following a reduction in ISP duration could, in principle, be possible, in practice it is the case that the majority of stakeholders estimate there not to be a significant reduction in the quantity of reserves held (with this being driven more by imbalance pricing);
- According to the responses received, this is driven by reserve dimensioning being mainly influenced by criteria other than ISP duration, such as N-1 or additional factors of system security like congestion issues or frequency excursions;
- Additionally, respondents have argued that the potential benefit, if any, would be lower following a reduction of ISP duration to under 15 minutes because this would not allow enough time to restore frequency and could lead to increases in uncertainty and forecast errors. In such a scenario, TSOs might actually be required to increase their reserve capacity requirements and withdraw additional capacity from forward or intraday markets; and
- Finally, respondents noted that changes in ISP duration could cause changes in the behaviour of some BRPs (uncertainty on behaviour, forecast errors) creating periods of additional variability or uncertainty, which would increase the need for TSOs to hold reserves.

7.2.44 Some stakeholders did provide limited quantification (or at least analysis) of a potential effect:

- A Swiss respondent quoted a research paper (Abbaspourtorbati, F.; Zima, M., “The Swiss Reserve Market: Stochastic Programming in Practice,” in Power Systems, IEEE Transactions, vol.PP, no.99, pp.1-7) to argue that a reduction in reserve capacity might, in principle, be possible but does not provide any value;
- A supplier considers that the reduction in ISP duration could lead to ‘a sharp decline’ in reserves held by TSOs and also provides a quantitative estimate.
- A vertically integrated player indicated that a reduction in ISP duration should lead to a reduction in reserve capacity held by TSOs and provided estimates of its expectations on reserves held in 2020 and 2030 for the different scenarios;
- A TSO expected a potential for reserve capacity reduction by 100 to 500 MW when moving to an ISP duration of five minutes, without providing details on the underlying methodology used;

### Our analysis

7.2.45 As noted above, there are potentially two effects on benefits:

- BRPs withholding capacity from forward markets in order to have the capacity available in intraday timescales to manage imbalances, either for their own use or by trading the capacity in intraday timescales; and

- TSOs changing reserve dimensioning as a result of there being smaller imbalances to manage, as a result of any shift from balancing energy to intraday energy (described in the previous sub-section).

7.2.46 Many stakeholders have clearly stated they do not believe the BRPs face incentives to withhold capacity from forward markets as a result of a change to ISP duration. In addition, no stakeholders have quantified the impact from BRPs withholding capacity from forward markets. Therefore, we conclude that we should not consider in the CBA the cost or benefit of any change to the way BRPs choose to sell capacity in the forward market and intraday market. Either the scale of the behavioural effect is not material or the consequence of any change to behaviour is not material.

7.2.47 We do however conclude that at least in some countries the may be a material effect of the TSO changing its reserve dimensioning as a result of a reduction in ISP duration.

7.2.48 The first part of our approach to analysis is as follows:

- For 2020 we would assume that any effect on reserve dimensioning is not material for those countries for which the TSO has clearly stated that their dimensioning methodology is such that they do not expect an impact. The estimated benefit will be zero in all scenarios for those countries.
- For countries where the TSO has indicated a potential to reduce the quantity of reserves held or where the TSO has remained silent, we would assume that there is a potential for the quantity of reserves held in 2020 to be reduced.
- By 2030 we assume there is scope for changes in the reserve dimensioning methodology for all countries. Intraday markets will be better functioning by then, and BRPs and TSOs will have learned how to operate under the conditions of the new ISP.

7.2.49 The second part of our approach is described below:

- We first categorise countries into those where reserve dimensioning is unlikely to be affected and those where it may be affected by ISP duration by considering whether or not N-1 security requirements are driving reserve dimensioning. We do this by comparing the size of reserves held to the estimated N-1 security requirement. Where the N-1 security requirement is close to 100% of reserves held, we assume reserve dimensioning would not be affected by ISP duration. For other countries we assume reserve dimensioning would be affected by ISP duration.
- For those countries where reserve dimensioning may be affected we:
  - take the minimum value of the reduction in balancing energy (both upwards and downwards) per factual ISP across one year from the analysis of the change to reserve energy actions (the benefit sub-section immediately above); and
  - convert this into MW as the reduction in reserve capacity held that is consistent with the reduction in balancing actions.

- We estimate the cost saving per MW of reduction in reserve held by the TSO. We provisionally estimate this to be 15 €/MW based on cost data submitted by TSOs[23].
- We multiply the cost saving per MW by the reduction in reserve capacity, and multiply by 8760 hours to estimate the saving for a year.
- We interpolate linearly between 2020 and 2030 in the case of those countries whose savings differ between the two years.

7.2.50 The minimum value for the reduction in balancing energy across the year is low, in the order of 0 – 0.33 MW, depending on the country, when converted into MW quantities. We therefore use a value of 1 MW as the reduction for the reserve quantity up and down for each hour for those countries that we assume change their reserve capacity.

7.2.51 We note that this estimate is materially lower (by a factor of 100-300) than the two quantitative indications provided by survey respondents. This implies that it could be taken as an extremely conservative estimate of the scale of the benefit.

7.2.52 The exhibit below shows the countries with a potential saving in 2020 and 2030, based on a combination of information provided by the TSO as to whether reserve dimension would change in 2020, and the N-1 analysis for 2020 and 2030.

7.2.53 Applying the above analysis, the present value of the benefit in 2019 amounts to:

- €36 million in moving to a 30 minute ISP;
- €41 million in moving to a 15 minute ISP; and
- €57 million in moving to a 5 minute ISP.

7.2.54 In the exhibit below, we show how these results break down for each country under investigation in our analysis.

[23] We would note that there is some uncertainty around this estimate given the diversity of data provided by TSOs. However the analysis indicates that the order of magnitude for this benefit remains negligible compared to other benefit items, therefore we have not investigated this further.

**Exhibit 37. Break-down of the present value of the benefit associated with lower reserve capacity cost by country and by ISP duration**

| Country | 30 minutes | 15 minutes | 5 minutes |
|---|---|---|---|
| Austria | 0 €mn | 0 €mn | 2 €mn |
| Belgium | 0 €mn | 0 €mn | 0 €mn |
| Switzerland | 0 €mn | 0 €mn | 1 €mn |
| Germany | 0 €mn | 0 €mn | 2 €mn |
| Hungary | 0 €mn | 0 €mn | 2 €mn |
| Lichtenstein | 0 €mn | 0 €mn | 2 €mn |
| Luxemburg | 0 €mn | 0 €mn | 2 €mn |
| Netherlands | 0 €mn | 0 €mn | 1 €mn |
| Slovakia | 0 €mn | 0 €mn | 2 €mn |
| France | 0 €mn | 0 €mn | 0 €mn |
| Great Britain | 0 €mn | 0 €mn | 0 €mn |
| Ireland | 0 €mn | 2 €mn | 2 €mn |
| Northern Ireland | 0 €mn | 2 €mn | 2 €mn |
| Bulgaria | 2 €mn | 2 €mn | 2 €mn |
| Czech Republic | 2 €mn | 2 €mn | 2 €mn |
| Denmark | 0 €mn | 0 €mn | 0 €mn |
| Estonia | 1 €mn | 1 €mn | 1 €mn |
| Greece | 2 €mn | 2 €mn | 2 €mn |
| Spain | 0 €mn | 0 €mn | 0 €mn |
| Finland | 0 €mn | 0 €mn | 0 €mn |
| Croatia | 2 €mn | 2 €mn | 2 €mn |
| Italy | 2 €mn | 2 €mn | 2 €mn |
| Lithuania | 2 €mn | 2 €mn | 2 €mn |
| Latvia | 2 €mn | 2 €mn | 2 €mn |
| Norway | 2 €mn | 2 €mn | 2 €mn |
| Poland | 2 €mn | 2 €mn | 2 €mn |
| Portugal | 2 €mn | 2 €mn | 2 €mn |
| Romania | 2 €mn | 2 €mn | 2 €mn |
| Sweden | 2 €mn | 2 €mn | 2 €mn |
| Slovenia | 2 €mn | 2 €mn | 2 €mn |
| Cyprus | 2 €mn | 2 €mn | 2 €mn |
| Malta | 2 €mn | 2 €mn | 2 €mn |
| ***Total*** | ***36 €mn*** | ***40 €mn*** | ***71 €mn*** |

*Source: Frontier Economics*

**Exhibit 38. Countries whose reserve dimensioning is potentially affected by ISP**

| Country | 2020 | 2030 |
|---|---|---|
| Austria | | |
| Belgium | No impact | No impact |
| Switzerland | No impact | |
| Germany | | |
| Hungary | | |
| Lichtenstein | | |
| Luxemburg | | |
| Netherlands | No impact | |
| Slovakia | | |
| France | No impact | No impact |
| Great Britain | No impact | No impact |
| Ireland | | |
| Northern Ireland | | |
| Bulgaria | | |
| Czech Republic | | |
| Denmark | No impact | No impact |
| Estonia | No impact | |
| Greece | | |
| Spain | No impact | No impact |
| Finland | No impact | No impact |
| Croatia | | |
| Italy | | |
| Lithuania | | |
| Latvia | | |
| Norway | | |
| Poland | | |
| Portugal | | |
| Romania | | |
| Sweden | | |
| Slovenia | | |
| Cyprus | | |
| Malta | | |

*Source: Frontier based on TSO information and N-1 analysis*

## Greater intraday competition from cross border BSPs

### Views of respondents

7.2.55 The vast majority of respondents have not provided an answer for this question. Compared to previous benefits, we would also note that they provided fewer qualitative comments.

7.2.56 Those respondents that have provided the most comments tend to be generators, retailers and traders. TSO have not produced quantified analysis. A number of players have clearly stated they did not feel concerned by this benefit because they do not trade cross-border.

7.2.57 Where a value has been indicated in the survey, most of the time this value is equal to zero. Respondents suggested other barriers to cross-border trading than market design:

- A TSO suggested that “the Nordic ID trade with Germany (ISP=15 min) is liquid. Limiting factor is capacity, not Market design (ISP)”;
- A vertically integrated player stated that no effect was expected because of levels of interconnection;
- A generator stated that as interconnectors are limited and at full capacity, there is likely to be very little intra-day volume/spare capacity available.

7.2.58 One TSO also noted that the social welfare may be less than the value of the pure energy trade under an unlimited capacity/unlimited rate-of-change wholesale market exchange model, at least in the case of HVDC interconnectors. This is because the maximum total change between periods and/or rate-of-change will need to be controlled by market-rules, increased reserve holding and domestic re-despatch or firm rights for TSO-buy-back and SO-SO actions to reduce flow changes and levels that would harm system security.

7.2.59 Some players were not committal:

- A TSO stated that “it depends on market design and behaviour of BSP”;
- Another TSO stated: “we are not able to compute”;
- A retailer stated that “we do not know if any price discount would be achieved”;
- A TSO said the effect is: “unknown”; and
- A generator stated that it was “unable to provide a response without significant additional modelling and analysis that could not be completed within the timescales of this CBA”.

7.2.60 Some players were more positive:

- Two TSOs agreed that increased ISP harmonization across borders would lead to more efficient and liquid cross-border trade as long as harmonization is accompanied by appropriate harmonization schemes (such as XBID); and
- A generator stated that “the harmonisation of ISPs would also have a significant impact on the ability to exchange cross-border volumes on the intraday”.

7.2.61 Two players suggested some quantification of a potential positive effect:

- A retailer / trader suggested that “trading for specific small periods will push the imbalance prices to a simular level for connected countries” and suggested a discount of €5/MWh (with a range of €0/MWh to €10/MWh). This respondent also indicated a €1/MW capacity related benefit in a 5 minute ISP scenario (this was the only suggested impact in relation to capacity); and

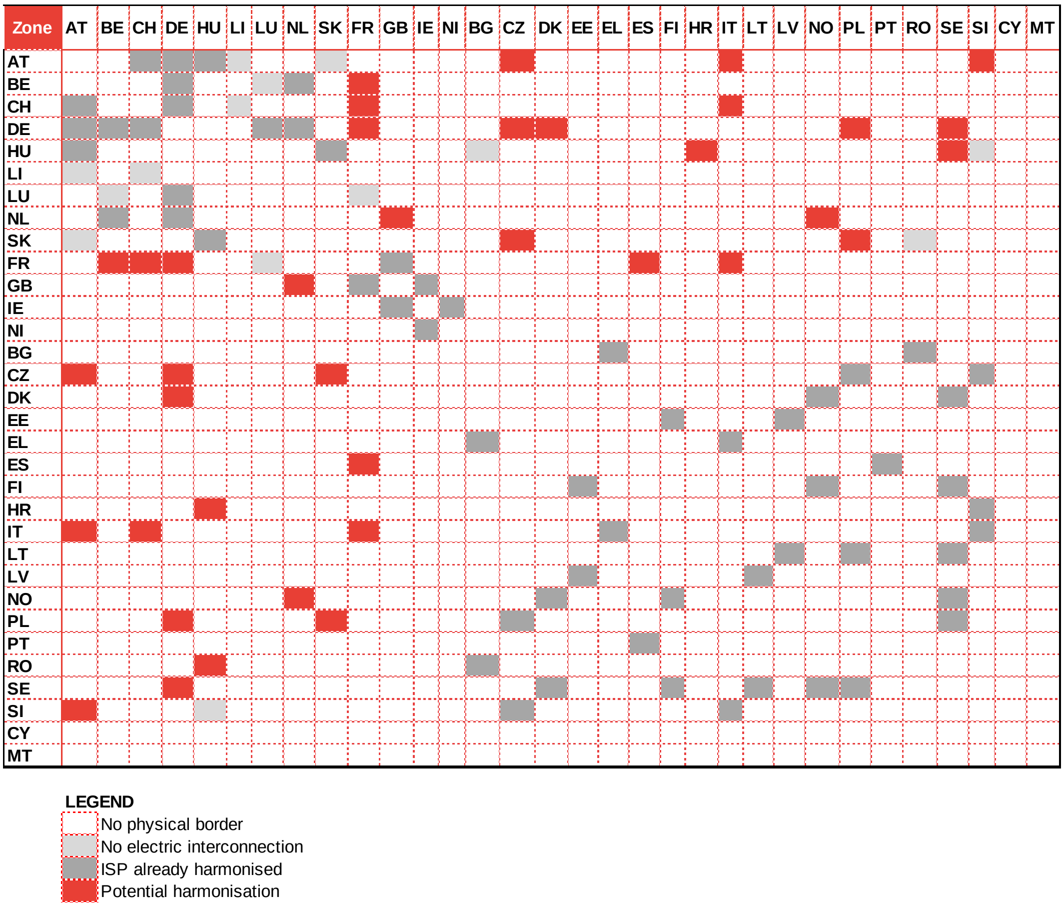
- A retailer expected a trading discount of €5/MWh (with a range of €3/MWh to €6/MWh), corresponding to the difference between trading cross-border at 15 minutes and 5 minutes.

7.2.62 The majority of other respondents did not indicate whether a price discount could be achieved by trading cross-border at finer granularity, and about 15 respondents specifically indicated that they expected no discount to be achievable.

### Our analysis

7.2.63 Our stylised analysis focuses on those borders where the ISP duration is currently different on either side of the border and therefore where a change in ISP duration would potentially lead to harmonised ISPs.

**Exhibit 39. Borders potentially affected by change in ISP duration**




*Source: Frontier Economics*

7.2.64 For each potentially affected border, we collected data on hourly flows from the ENTSO-E platform. We identified net flow direction in each hour and assessed the utilisation ratio (measured as flow over capacity) in each hour. In hours where the interconnector is already full, we expect no further benefit from a reduction in the ISP duration. Where there is spare capacity however, we consider the potential benefit from increased cross-border trading at the new ISP duration. To quantify this, we estimate the increase in cross-border flow in each hour.

- In 2020, we assume this is equal to the minimum of:
  - Additional flows assuming the interconnector is fully used in this hour; and
  - Additional flows corresponding to a 10% increase in flow.
- In 2030, we consider total interconnection capacity is likely to have increased across the EU in line with a target of each country having interconnection capacity equal to 15% of local generation capacity. We then calculate potential increased flows due to ISP harmonisation as the minimum of:
  - Additional flows assuming the interconnector is fully used in this hour; and
  - Additional flows corresponding to a 15% increase in flow.

7.2.65 We estimate additional flows across potentially affected borders ranging from 6.6 to 10.4 TWh per year between 2020 and 2030 in the case of a move to a harmonised 5- or 15-minute ISP duration across Europe.

7.2.66 We then turn to price and cost effects to consider the benefit and distributional effects associated with this increase in cross-border trading. As indicated earlier, the welfare effect will be equal to the difference between the dispatch cost achieved cross-border and that achieved on the local market. Consistently with the approach used for other benefit item, we reflect the uncertainty around the shape of the supply curve and therefore the degree to which the price effect will be the reflection of an underlying change in cost by introducing a low and a high case for the benefit value. In the low case we assume a sloping supply curve and estimate the producer surplus as the product of the price reduction times demand divided by 2; in the high case where we assume the price effect fully stems from a reduction in cost.

7.2.67 Our first estimate of the potential price effect is drawn from intraday price data for Germany and Austria, available at 15-minute granularity. We compute an average 30-minute price for Germany and Austria based on this data, and assume this would be the price observed both in those market areas and interconnected market areas with an ISP higher than 15 minutes where the interconnector is not full in the corresponding period (ie level where cross-border prices converge absent congestion). We then compare the 30-minute price with the 15-minute price in each quarter in Germany: where the 30-minute price is lower than the quarterly price in Germany, we assume that if interconnected countries also had a quarterly ISP period and intraday products, then the cross-border prices would converge at that granularity as well. We assume the estimate price reduction for quarterly products in Germany would be equal to the current differential between quarterly and half-hourly products. This indicates that a price reduction of 3.2€/MWh would be achieved on quarterly products if it were possible for Germany to trade intraday and cross-border in that time unit.

7.2.68 We then consider price data for Great Britain, available at 30 minute granularity, and replicate the analysis there in the case of cross-border exchanges with neighbouring interconnected countries with current ISP duration equal to one hour. We obtain an estimated price reduction of 1.1€/MWh.

7.2.69 We are only able to carry out the analysis for those two markets due to data availability constraints. We therefore propose to retain an average estimate price effect of 2.15 €/MWh.

7.2.70 The net welfare effect will be driven by the corresponding cost effect, multiplied by traded volumes. To estimate this, we assume a sloping supply curve, so that consumer surplus is equal to the price effect times volumes, and the producer surplus is equal to the negative of the price effect times volumes divided by 2.

7.2.71 In the low (resp. high) case we estimate a net welfare effect of net present value €0.80bn (resp. €1.59bn) over the CBA horizon in the case of a harmonised move to either 5- or 15-minutes ISP durations, and net present value €0.04bn resp. €1.08bn) in the case of a harmonised move to 30-minute ISP durations across Europe. The large gap in estimates is due to the fact that, with a move to 30 minutes, only two borders would be affected.

7.2.72 The exhibit below shows the breakdown of this benefit for each of the countries covered in the analysis. Since the benefit in relation to cross-border harmonisation cannot be investigated on an isolated by-country basis, we provide below an overview of what border between two countries is affected by a planning case. In addition, we then provide the breakdown of the cross-border benefit by country and planning case.

**Exhibit 40. Overview of whether a cross-border benefit from ISP duration harmonisation is expected to occur by border under investigation and planning case**

| Border from | Border to | Planning case 1 | Planning case 2 | Planning case 3 | Planning case 4 |
|---|---|---|---|---|---|
| Austria | Czech Republic | yes | yes | yes | yes |
| Austria | Italy | yes | yes | yes | yes |
| Austria | Slovenia | yes | yes | yes | yes |
| Belgium | France | yes | no | no | yes |
| Switzerland | France | yes | no | no | yes |
| Switzerland | Italy | yes | yes | yes | yes |
| Germany | France | yes | no | no | yes |
| Germany | Czech Republic | yes | yes | yes | yes |
| Germany | Denmark | yes | yes | yes | yes |
| Germany | Poland | yes | yes | yes | yes |
| Germany | Sweden | yes | yes | yes | yes |
| Hungary | Croatia | yes | yes | yes | yes |
| Hungary | Romania | yes | yes | yes | yes |
| Netherlands | Great Britain | yes | no | no | yes |
| Netherlands | Norway | yes | yes | yes | yes |
| Slovak Republic | Czech Republic | yes | yes | yes | yes |
| Slovak Republic | Poland | yes | yes | yes | yes |
| France | Spain | yes | no | yes | yes |
| France | Italy | yes | no | no | yes |

*Source: Frontier Economics*

**Exhibit 41. Net present value of the cross-border benefit broken down by country covered in the analysis and by planning case (in €mn)**

| | Low Case (€mn) | | | | High Case (€mn) | | | |
|---|---|---|---|---|---|---|---|---|
| **Country** | **PC 1** | **PC 2** | **PC3** | **PC4** | **PC 1** | **PC 2** | **PC3** | **PC4** |
| Austria | 47 | 47 | 47 | 47 | 93 | 93 | 93 | 93 |
| Belgium | 22 | 0 | 0 | 22 | 44 | 0 | 0 | 44 |
| Switzerland | 272 | 236 | 236 | 272 | 544 | 472 | 472 | 544 |
| Germany | 185 | 111 | 111 | 185 | 370 | 223 | 223 | 370 |
| Hungary | 53 | 53 | 53 | 53 | 106 | 106 | 106 | 106 |
| Netherlands | 84 | 0 | 0 | 84 | 167 | 1 | 1 | 167 |
| Slovakia | 93 | 93 | 93 | 93 | 185 | 185 | 185 | 185 |
| France | 41 | 0 | 9 | 41 | 83 | 0 | 18 | 83 |
| ***Total*** | ***796*** | ***540*** | ***549*** | ***796*** | ***1592*** | ***1080*** | ***1097*** | ***1592*** |

*Source: Frontier Economics*

## Further impact on prices

### Views of respondents

7.2.73 Largely based on responses, we now take the view that the net effect on prices will be negligible since volumes are potentially transferring from one market to another (i.e. from the balancing market to the intraday market) and that the overall effect on the demand and supply balance from a change to ISP is negligible. Reserve dimensioning may allow more capacity to supply the market although this effect is expected to be very small relative to overall supply.

7.2.74 We do not consider this benefit further.

## Greater entry of BSPs to intraday markets

### Views of respondents

7.2.75 About 20% of respondents provided an answer to this question. Overall the expectation appears to be that there will be little effect.

7.2.76 Some participants indicated that they thought an effect was possible:

- A TSO indicated that they assumed a BSP capacity increase could be linked to possibilities for aggregation of DSR. However, they noted that reduced balancing prices might on the other hand reduce the incentives;
- A vertically integrated respondent stated that “in case of a reduction in ISP, we assume that it will also result in a change of Standard Products as defined by the TSOs… [This] may result in new BSPs entering the market but also existing BSPs exiting the market (or at least have a reduction in available capacity) as they are no longer able to provide the Standard Product. We refer in this case to the aFRR study by E-Bridge/IAEW as an example of how a change in balancing product characteristic may impact the available capacity”;

- A retailer noted that ISP reduction could lower the barriers for households to undertake demand response and to participate in intraday markets and balancing mechanisms;
- a vertically integrated respondent described how they would expect the change in ISP (and MTU) to lead to both the intraday and balancing price better reflecting the value of energy;

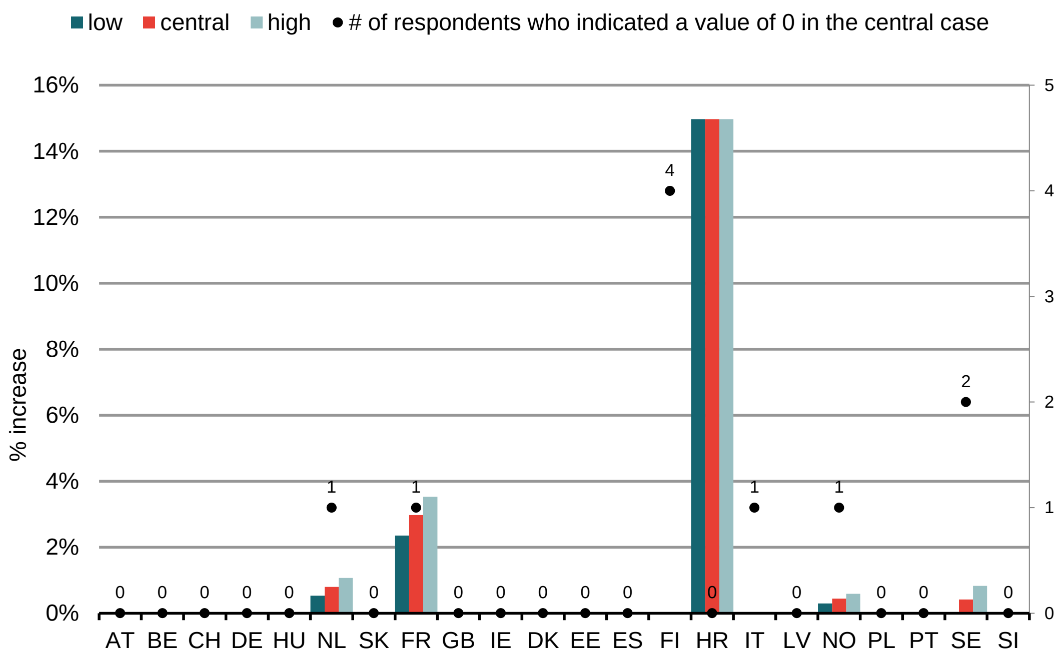
7.2.77 Other respondents indicated they did not believe any effect was likely:

- Two TSOs indicated they expected little change; and
- One TSO suggested that “ISP 10 or 5 mins will sterilize BRP flexibility and kill presently functioning Aggregator business”;
- Another respondent indicated they expected “technical challenges” to limit opportunities for offers on a shorter ISP basis; and
- A vertically integrated respondent indicated that products demanded by TSOs were more significant than the duration of the ISP.

7.2.78 In the round, whilst responses received do not allow quantifying the value of the potential benefit across countries and ISP durations, they provide indicative orders of magnitude for the potential size of the benefit.

7.2.79 As shown in the charts below, where respondents have estimated a volume of new BSP capacity, the expectation would be for this to amount to up to 14% of installed capacity in the corresponding market area.

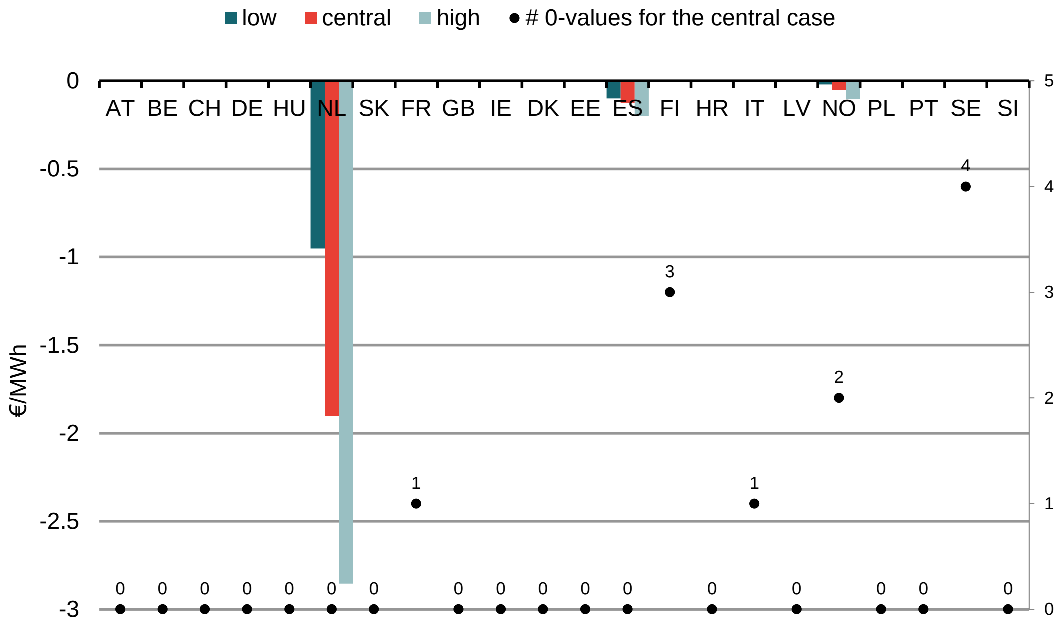
**Exhibit 42. 3.1.5 a) Average change in the total volume of BSP capacity by 2020 – scaled with the installed capacity in MW, in the case of a move to 15-minutes**




*Source: Frontier Economics based on survey responses*

7.2.80 The chart below displays the expected order of magnitude of the price impact in the wholesale market, where respondents have quantified this.

**Exhibit 43. 3.1.5 c) Impact on average intraday price by 2020**




*Source: Frontier Economics based on survey responses*

## Our analysis

7.2.81 We have carried out stylised analysis to assess the potential magnitude of the benefit associated with greater entry of BSPs to intraday markets. In this analysis, we estimate the potential reduction in the average wholesale price (in €/MWh) associated with increased entry. We then estimate the corresponding increase in consumer surplus by multiplying this price reduction by local power demand. Finally we net off the reduction in producer surplus to derive the net welfare effect. The size of the change in producer surplus for a given observed level of price reduction will depend on the shape of the supply curve. In order to reflect the uncertainty around this we derive a low range in which we assume a sloping supply curve and estimate the producer surplus as the product of the price reduction times demand divided by 2 and a high case where we assume the price effect fully stems from a reduction in cost.

7.2.82 Stakeholder responses to the survey have emphasised the potential technical barriers of greater BSP entry into the wholesale market, with those barriers being highest in the case of a move to 5-minute ISPs. We reflect this in the stylised analysis by making the following assumptions:

- Where the ISP is reduced to 15 or 30 minutes, we estimate the average price impact of new entrants reducing the price by 10% in the 10% trading periods with the highest power price in the year;
- Where the ISP is reduced to 5 minutes, we estimate the average price impact of new entrants reducing the price by 10% in the 5% trading periods with the highest power price in the year.

7.2.83 We display the results of our analysis below. For simplicity we display the estimated net welfare effect of moving all countries included in the scope of the analysis to a 30-minutes, 15-minute and 5-minute ISP (only for countries where the current ISP duration is higher than the target ISP duration).

7.2.84 We note that the size of the potential reduction in wholesale prices is consistent with the orders of magnitude indicated in survey responses.

**Exhibit 44. Potential benefit from greater entry of BSPs to intraday market**

| | | | **Low Case** | | | **High Case** |
|---|---|---|---|---|---|---|
| | **Move to 30 minutes** | **Move to 15 minutes** | **Move to 5 minutes** | **Move to 30 minutes** | **Move to 15 minutes** | **Move to 5 minutes** |
| Average wholesale power price reduction (€/MWh) | 0.44-0.81 | 0.44-0.81 | 0.24-0.45 | 0.44-0.81 | 0.44-0.81 | 0.24-0.45 |
| Annual benefit (k€) | 428 | 731 | 552 | 856 | 1,461 | 1,104 |
| *NPV of benefit (k€)* | *3,750* | *6,400* | *4,835* | *7,499* | *12,800* | *9,670* |

*Source: Frontier Economics*

7.2.85 In the low case, we estimate a potential benefit ranging from € 3.8m to € 6.4m across all countries included in the scope of the study. In the high case, estimate a potential benefit ranging from € 7.5m to € 12.8. The highest benefit value would be expected to arise for a move to 15-minute ISP. The exhibit below presents the breakdown of these results by country covered in the analysis.

**Exhibit 45. Net present value of the benefit related to greater entry by BSPs to the intraday market by country and ISP duration (in €mn)**

| | Low Case (€mn) | | | High Case (€mn) | | |
|---|---|---|---|---|---|---|
| Country | 30 min | 15 min | 5 min | 30 min | 15 min | 5 min |
| Austria | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.2 |
| Belgium | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.3 |
| Switzerland | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.2 |
| Germany | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | 1.4 |
| Hungary | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 |
| Lichtenstein | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Luxemburg | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Netherlands | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.3 |
| Slovakia | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| France | 0.0 | 1.4 | 0.8 | 0.0 | 2.7 | 1.5 |
| Great Britain | 0.0 | 1.2 | 0.7 | 0.0 | 2.4 | 1.3 |
| Ireland | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 |
| Northern Ireland | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Bulgaria | 0.1 | 0.1 | 0.0 | 0.2 | 0.2 | 0.1 |
| Czech Republic | 0.2 | 0.2 | 0.1 | 0.3 | 0.3 | 0.2 |
| Denmark | 0.1 | 0.1 | 0.0 | 0.2 | 0.2 | 0.1 |
| Estonia | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Greece | 0.1 | 0.1 | 0.1 | 0.3 | 0.3 | 0.2 |
| Spain | 0.7 | 0.7 | 0.4 | 1.4 | 1.4 | 0.8 |
| Finland | 0.2 | 0.2 | 0.1 | 0.5 | 0.5 | 0.3 |
| Croatia | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 |
| Italy | 0.9 | 0.9 | 0.5 | 1.7 | 1.7 | 0.9 |
| Lithuania | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| Latvia | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Norway | 0.4 | 0.4 | 0.2 | 0.7 | 0.7 | 0.4 |
| Poland | 0.4 | 0.4 | 0.2 | 0.8 | 0.8 | 0.5 |
| Portugal | 0.1 | 0.1 | 0.1 | 0.3 | 0.3 | 0.1 |
| Romania | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 |
| Sweden | 0.3 | 0.3 | 0.2 | 0.6 | 0.6 | 0.3 |
| Slovenia | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| Cyprus | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Malta | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ***Total*** | *3.8* | *6.4* | *3.8* | *7.5* | *12.8* | *9.7* |

*Source: Frontier Economics*

7.2.86

### Further impact on balancing

#### Views of respondents

7.2.87 Very few responses to the questionnaire considered there to be any additional benefit not already captured by the benefit related to the shift from balancing energy to intraday energy. Therefore, we do not consider this benefit further.

## 7.3 Increased secondary trading volumes

#### Views of respondents

7.3.1 Between three and 14 respondents have answered this question quantitatively, with up to a third of responses indicated an expected benefit of zero in each case.

7.3.2 Some respondents suggested a positive impact on liquidity:

- A TSO commented that shorter ISP may increase trading on the intraday market. However they noted it was "not possible to make reliable estimation of increase";
- A generator stated that "All else equal we expect a shift of volumes from Balancing market towards ID market";
- A retailer expected a slight decrease in prices following an increase in liquidity on wholesale markets;
- A generator commented that "harmonization would definitively increase liquidity as intraday coupling is lacking at the moment between core markets" (although it is not clear that this is a benefit to harmonisation as opposed to integration around the target model); and
- A vertically integrated respondent stated that "The increase of liquidity in cross border exchange should arise as a result of the harmonization of the ID market products duration".

7.3.3 A number of respondents expect a reduction in liquidity as a result of splitting of products (as we noted above, while this may relate to absolute liquidity this may not be the most appropriate measure):

- An industry associated expected that splitting volumes across shorter products will lead to reduced liquidity per product;
- A retailer commented that "we expect a reduction in ISP duration to have an adverse effect on liquidity with liquidity being reduced due to existing liquidity being spread over multiple products"; and
- A vertically integrated respondent commented "liquidity could also decrease as an effect of segmentation (1 hourly product may be more liquid of 4 products of 15' duration)".

7.3.4 A small number of respondents flagged a risk of increased complexity in trading due to multiple products / MTUs.

7.3.5 A number of other respondents indicated they did not foresee a change in liquidity:

- A TSO commented "limited impact expected";
- Another TSO commented "increased volumes due to uniformity of information is probably marginal and not related to ISP harmonization";
- An industry association stated "No change expected. The change in ISP will not affect trading volumes nor market liquidity";
- A vertically integrated respondent stated "no change expected" in any planning case; and
- Another vertically integrated respondent stated "overall volume required to buy/sell would be unchanged".

7.3.6 A small number of respondents provided some quantification of effects. The most comprehensive response came from a vertically integrated respondent which has forecast balancing volumes on various ISP durations and assumes gaps with the counterfactual (no change in ISP duration) will transfer to the intraday market. A TSO also provided estimates in this area.

7.3.7 We provide below an overview of estimated increases in traded volume subsequent to a change in ISP duration. To ensure comparability, these estimates have been expressed in % of current intraday trading volumes.

- None of the respondents indicated an expected increase in traded volumes subsequent to a move to 30-minute ISP duration;
- Respondents expect increases in traded volumes ranging from 0.04% to 0.69% subsequent to moving to 15-minute ISP durations; and
- Respondents expect increases in traded volumes ranging from 0.22% to 21% subsequent to moving to 15-minute ISP durations.

**Exhibit 46. Overview of estimated increases in liquidity subsequent to changes in ISP duration**

| | | Introduction of 15 minute ISP - 2020 | Introduction of 15 minute ISP - 2020 | Introduction of 15 minute ISP - 2020 | Introduction of 5 minute ISP - 2020 | Introduction of 5 minute ISP - 2020 | Introduction of 5 minute ISP - 2020 |
|---|---|---|---|---|---|---|---|
| | | *Low* | *Central* | *High* | *Low* | *Central* | *High* |
| Country | Benefit item | Benefits_2020_15_low | Benefits_2020_15_central | Benefits_2020_15_high | Benefits_2020_5_low | Benefits_2020_5_central | Benefits_2020_5_high |
| *CH* | *3.2.1.a)* | | | | 0.37% | 0.48% | 0.60% |
| *FI* | *3.2.1.a)* | | 0.04% | | | 0.22% | |
| *SE* | *3.2.1.a)* | | 0.30% | 0.61% | | 0.30% | 0.61% |
| *CH* | *3.2.2.a)* | | | | 8.05% | 8.78% | 9.33% |
| *GB* | *3.2.2.a)* | 0.00% | 0.35% | 0.69% | 0.00% | 0.69% | 1.04% |
| *NL* | *3.2.2.a)* | | | | | 21.08% | |

*Source: Frontier Economics based on survey responses*

## Our analysis

### Does the introduction of shorter term products reduce liquidity

7.3.8 We look to understand whether a reduction in ISP and alongside this the introduction of shorter duration traded products on the intra-day market alongside longer duration products might affect liquidity. We do this by considering evidence from markets where shorter term products have been introduced alongside longer term products. Specifically we look at Germany, Austria and Switzerland.

7.3.9 Germany introduced 15 minute intraday products on December 14$^{th}$, 2011. Previously, the shortest available intraday products were hourly and hourly products do remain available to market participants. The 15 minute products were initially available from two hours before the start of the delivery hour and trading closed 45 minutes before the start of delivery.

7.3.10 Austria introduced an intraday market in mid-October 2016, without 15 minute products. This is in effect a joint market with Germany since the market sees no commercial transmission congestion between the two countries.

7.3.11 In March 2013, EPEX Spot announced more flexible trading rules for 15 minute products on the German intraday market. These products could be traded from 4pm the previous day up until 45 minutes before the start of the delivery period.

7.3.12 A Swiss intraday market was launched on June 26th 2013, including 15 minute traded products. These products could be traded across borders.

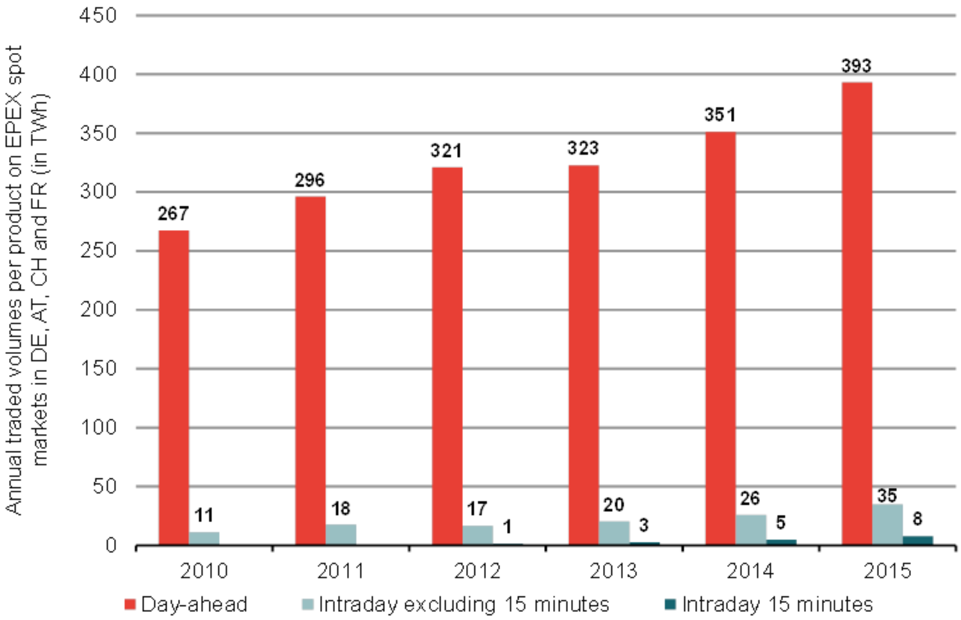
7.3.13 On December 9th, 2014 EPEX Spot launched a 15 minute auction on the German intraday market that takes place every day at 3pm for each 15 minute period on the next day. This auction is in addition to the continuously traded intraday market.

7.3.14 On July 16th, 2015 EPEX Spot reduced the lead time (i.e. gate closure time) by 15 minutes on all intraday markets to 30 minutes before the start of the delivery period for Germany, France and Austria, and to 60 minutes for Switzerland and for cross-border trades.

7.3.15 Finally, Austria introduced 15 minute intraday products on October 2nd, 2015.

7.3.16 Since the introduction of 15 minute products in Germany in 2011, intraday volumes for hourly and 15 minute products for trade on the German / Austrian markets have been increasing. However, this is in the context of a broader increase in day ahead and intraday traded volumes, see exhibit below.

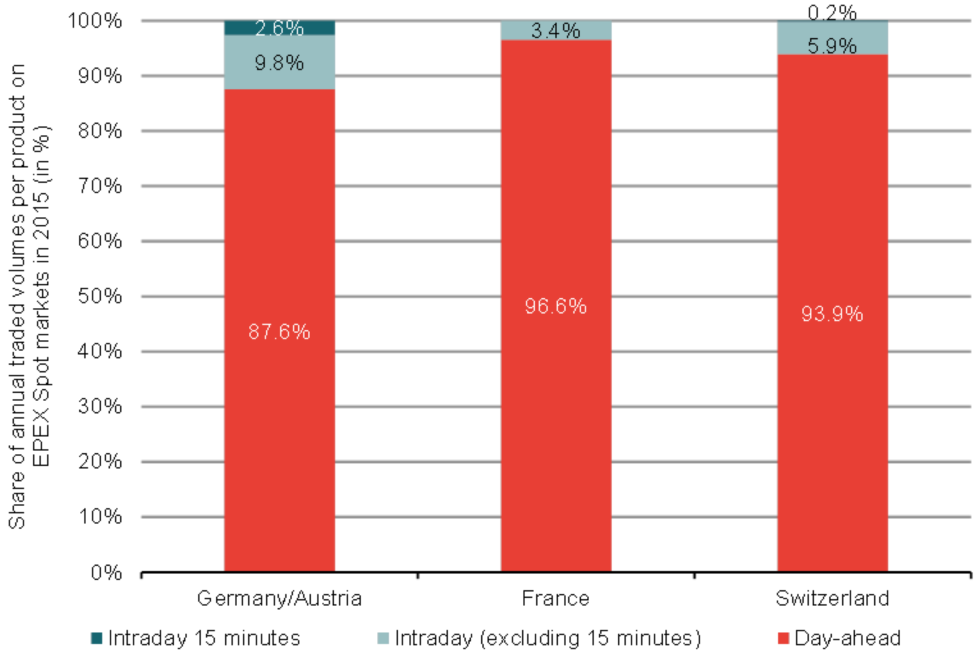
**Exhibit 47. Day-ahead and intraday traded volumes for Germany, Austria, Switzerland and France**




*Source: EPEX Spot, Frontier Economics*

7.3.17 For context the exhibit below shows the breakdown of trade by market for each of the three markets: Germany/Austria, France and Switzerland.

**Exhibit 48. Split of annual traded volumes on EPEX Spot by product in 2015**

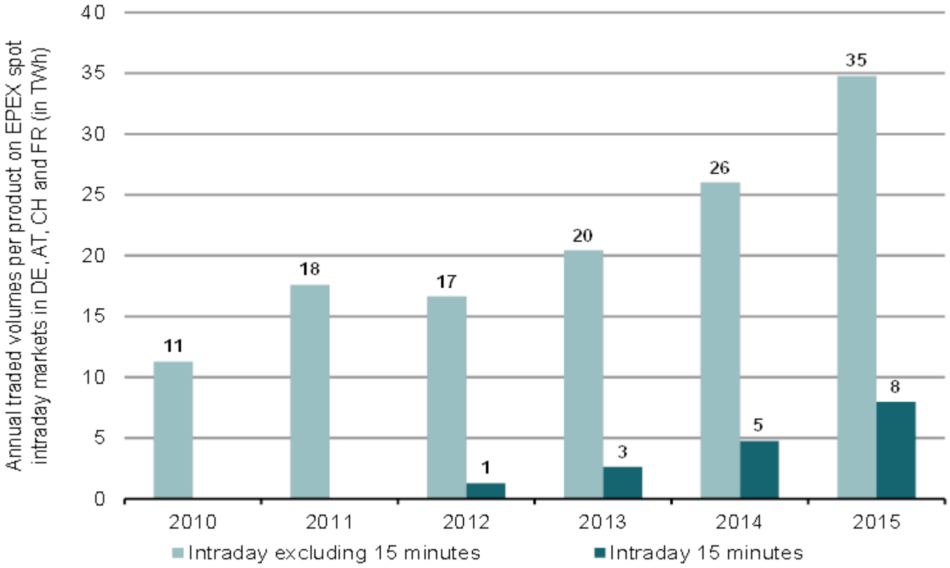



*Source: EPEX Spot, Frontier Economics*

7.3.18 Across the German, Austrian and Swiss markets, traded volumes on the intraday market have established themselves at a level of roughly 10-14% of traded volumes on day-ahead market.

7.3.19 The share of 15 minute products in overall intraday volumes has increased from 13% in 2013 to 24% in 2015, which suggests some degree of substitution between hourly and 15 minute intraday products. The exhibit below shows the increase in intraday volumes and 15 minute intraday volumes.

**Exhibit 49. Intraday traded volumes for Germany, Austria, Switzerland and France**




*Source: EPEX Spot, Frontier Economics*

7.3.20 The increase in overall intraday traded volumes does not suggest there to be a reduction in liquidity after the introduction of shorter duration products on intraday markets.

7.3.21 As an aside, it is interesting to observe that the PX has been adapting over time to better meet the needs of the market, e.g. by increasing the time during which a product may be traded and introducing an auction. These developments help to reinforce the idea that initially the intraday market may not allow the full benefits of ISP changes to be captured but that this is likely to improve over time.

### How would the increase in intraday trade affect liquidity

7.3.22 We previously noted that some volumes will move from the balancing market to the intraday market. We also note that harmonisation of ISP across borders would allow for more cross border trade.

7.3.23 We estimated that throughout Europe about 40 TWh of volumes would move from the balancing market to the intraday market, i.e. about 5000 MWh per hour, in moving to a 5 minute ISP. For a country such as Germany, the volume shift was estimated as a little under 4 TWh or a little over 400 MWh per hour. For the combined markets of Germany, France, Austria and Switzerland, the volume shift is about 10 TWh or a little over 1100 MWh per hour.

7.3.24 We estimated the increase in intraday trade as a result of increased cross border trade as 6-10 TWh for Europe as a whole (per year) in moving to a 15 or 5 minute ISP. Based on generation volumes, for the groups of countries Germany, France, Austria and Switzerland this would imply an increase in intraday volumes of around 2-3 TWh.

7.3.25 Some of the volume shift may be reflected in solely a change to physical production or demand plans and may not pass through the traded market. Even if only half of the increase in volumes was traded in the intraday market, this would be relatively large (about one sixth) compared to the total intraday traded volumes for Germany, France, Austria and Switzerland in 2015 on EPEX Spot, 35 TWh.

### What is the effect on price spreads and the resultant benefit

7.3.26 An increase in traded volumes of this order of magnitude is likely to reduce bid ask spreads in the intraday market. It is difficult to know how much spreads would be affected. However, suppose they were reduced by 10%.

7.3.27 Currently, the difference between high and low prices for a delivery period on relatively well developed intraday markets is €9.94/MWh in Switzerland, €11.85/MWh in France and €30.86/MWh in Germany and Austria. The average is about €21/MWh. Some of this spread relates to changes in expectations of the supply and demand balance over the course of the continuously traded intraday market and some relates to the bid – ask spread. We assume half of the difference between high and low prices relates to the bid – ask spread, i.e. €4.97/MWh in Switzerland, €5.92/MWh in France and €15.43/MWh in Germany and Austria, and €10.44/MWh for other a countries (based on 50% of the average).

7.3.28 Applying 10% to this bid – ask spread implies a reduction in bid – ask spread of €0.50/MWh in Switzerland, €0.59/MWh in France and €1.54/MWh in Germany and Austria, and €1.04/MWh for other countries.

7.3.29 Not all countries currently have intraday markets. However, we expect such markets to be developed in line with the target model. We therefore need an estimate of intraday volumes for countries with intraday markets and countries without. Germany / Austria, France and Switzerland intraday traded volumes are 6.4%, 0.8% and 2.3% of demand respectively – we use these volumes to calculate the benefits for these countries. It would be reasonable to assume that intraday volumes were 2% of demand in a relatively well developed market in the case of other countries.

7.3.30 Based on the above assumptions, the present value benefit from increased liquidity at the end of 2019 would be €906 million if all countries moved to an ISP of 5 minutes. In the case of a 15 minute ISP, the benefit for those countries that needed to change would be €343 million and in the case of a 30 minute ISP €256 million. The exhibit below shows the breakdown of this benefit for each of the countries under investigation.

**Exhibit 50. Net present value of the benefit in relation to an increase in liquidity by country and by ISP duration (in €mn)**

| Country | 30 minutes | 15 minutes | 5 minutes |
|---|---|---|---|
| Austria | 0 €mn | 0 €mn | 61 €mn |
| Belgium | 0 €mn | 0 €mn | 15 €mn |
| Switzerland | 0 €mn | 0 €mn | 6 €mn |
| Germany | 0 €mn | 0 €mn | 446 €mn |
| Hungary | 0 €mn | 0 €mn | 7 €mn |
| Lichtenstein | 0 €mn | 0 €mn | 0 €mn |
| Luxemburg | 0 €mn | 0 €mn | 1 €mn |
| Netherlands | 0 €mn | 0 €mn | 21 €mn |
| Slovakia | 0 €mn | 0 €mn | 5 €mn |
| France | 0 €mn | 20 €mn | 20 €mn |
| Great Britain | 0 €mn | 61 €mn | 61 €mn |
| Ireland | 0 €mn | 5 €mn | 5 €mn |
| Northern Ireland | 0 €mn | 2 €mn | 2 €mn |
| Bulgaria | 6 €mn | 6 €mn | 6 €mn |
| Czech Republic | 12 €mn | 12 €mn | 12 €mn |
| Denmark | 6 €mn | 6 €mn | 6 €mn |
| Estonia | 1 €mn | 1 €mn | 1 €mn |
| Greece | 9 €mn | 9 €mn | 9 €mn |
| Spain | 48 €mn | 48 €mn | 48 €mn |
| Finland | 15 €mn | 15 €mn | 15 €mn |
| Croatia | 3 €mn | 3 €mn | 3 €mn |
| Italy | 58 €mn | 58 €mn | 58 €mn |
| Lithuania | 2 €mn | 2 €mn | 2 €mn |
| Latvia | 1 €mn | 1 €mn | 1 €mn |
| Norway | 24 €mn | 24 €mn | 24 €mn |
| Poland | 28 €mn | 28 €mn | 28 €mn |
| Portugal | 9 €mn | 9 €mn | 9 €mn |
| Romania | 10 €mn | 10 €mn | 10 €mn |
| Sweden | 21 €mn | 21 €mn | 21 €mn |
| Slovenia | 2 €mn | 2 €mn | 2 €mn |
| Cyprus | 1 €mn | 1 €mn | 1 €mn |
| Malta | 0 €mn | 0 €mn | 0 €mn |
| ***Total*** | *256 €mn* | *343 €mn* | *906 €mn* |

*Source: Frontier Economics*

7.3.31 We do not differentiate this benefit between ISPs of different duration, other than that we apply the benefit only to those countries that change ISP in moving from the counterfactual to the factual.

## 7.4 Improved investment outcomes

### Views of respondents

7.4.1 About 10 stakeholders have provided an answer in their surveys, though only two have provided quantitative responses. The majority of other stakeholders have taken the view that there would be no impact.

7.4.2 Some respondents suggested a positive impact:

- A retailer stated that "especially small customers will be added to reserve markets like cars, batteries, smart buildings"; and
- A trader stated that "this is certainly a positive impact, but difficult to measure, since it is marginal compared to other legislative hurdles."

7.4.3 In contrast, others suggested a negative impact:

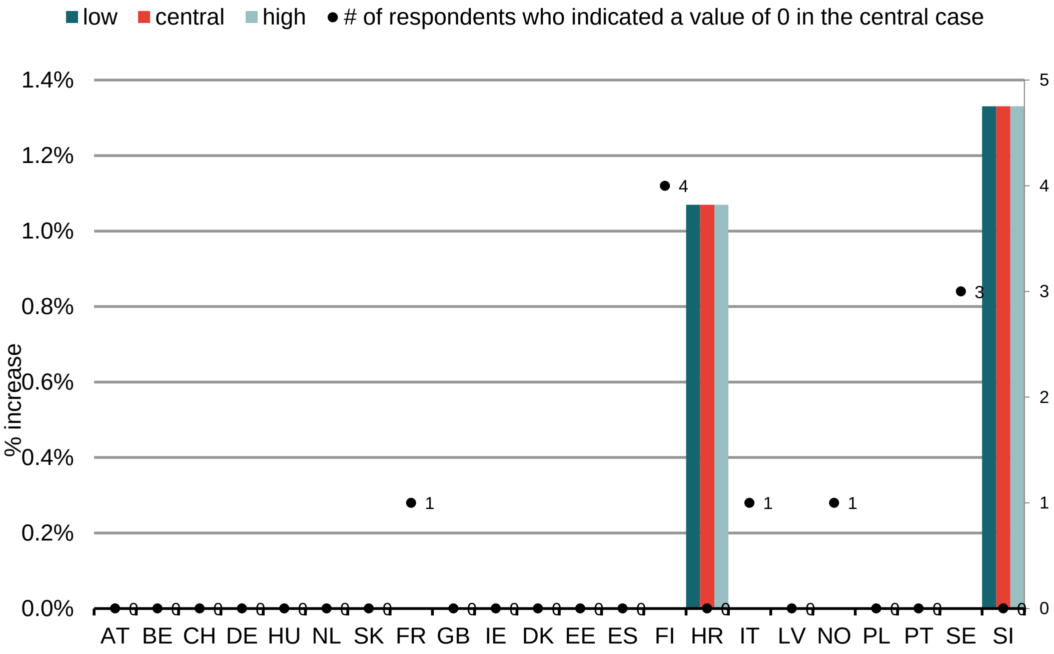
- A TSO stated that "ISP 10 or 5 mins will sterilize BRP flexibility and kill presently functioning Aggregator business"; and
- Another TSO stated that it "cannot quantify. If shorter ISP transfers revenues to the wholesale market via new market products and this means increased (intraday) trade then the increasing amount of traded electricity should break down wholesale prices which leads to a negative impact on investments."

7.4.4 A more significant number suggested little impact:

- A TSO stated that "currently … investments in new capacity is not primarily motivated by balancing purposes. Wholesale market is the investment driver";
- Another TSO stated that "investment decisions are based on information on forward and DA markets given the larger volumes traded on those markets with respect to the ID or balancing market and no significant impact from potential volumes shifting from the balancing market to the DA market are expected";
- Another TSO stated "impact negligible compared to 15min period";
- Another TSO stated "currently investment in new capacity is not primarily motivated by balancing purposes."
- A vertically integrated respondent stated "no benefit foreseen";
- A retailer stated "no evidence to suggest there will be a transfer of revenues"; and
- A generator stated "the application of small scale units will require 15 minutes settlement as real time measurement is not realistic for distributed generation."

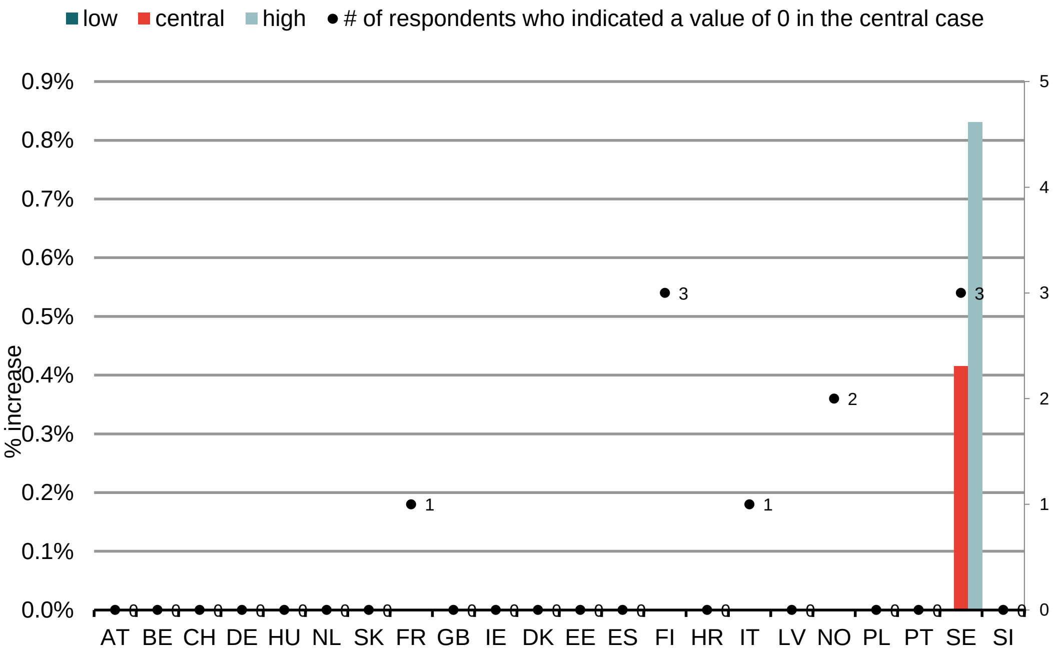
7.4.5 The exhibits below show the magnitude of new investment expected in the two countries where a stakeholder has quantified this. We do not present any data on the corresponding cost or price effect because none of the respondents have quantified this.

**Exhibit 51. 3.3.1 a) Transfer of revenues from the balancing stream to the wholesale stream - Impact on volume of new investment in 2030 - scaled with Installed capacity in MW**




*Source: Frontier Economics based on survey responses*

**Exhibit 52. 3.3.2 a) Lower barrier to market entry for some technologies - Impact on volume of new investment in 2020 - scaled with Installed capacity in MW**




*Source: Frontier Economics based on survey responses*

### Our analysis

7.4.6 Overall the survey responses provide little information on the assumptions under which we would see a benefit arise in this area. Only three stakeholders have provided quantification of expected volumes of investment with very little comments around them and no indication on potential associated price and cost effects. 10 respondents stated that they expect no benefit.

7.4.7 We believe it would be difficult to quantify the potential scale of this benefit in any meaningful way. The relationship between the strength of price signals (particularly those from short term markets) and investment decisions is clearly complex, and may evolve over time as participants understand better the frequency, scale and reliability of price spikes. We have not therefore sought to quantify this effect.

## 7.5 Other benefits

### Frequency excursions

7.5.1 Between four and ten answers have been provided for this benefit category (depending on the planning case considered), with just above 50% of values indicated there being non-zero effect. A majority of players expect a benefit even if they don't quantify it:

- A TSO cites a paper on the issue ("Influence of 15-minute contracts on frequency deviations and on the demand for balancing energy" International ETG Congress 2015, November 2015, Bonn);
- The Nordic TSOs also agreed that shorter ISPs may improve frequency quality;
- A generator also noted that frequency quality was expected to improve, and grid costs to go down; and
- A vertically integrated respondent cited analysis suggesting that an ISP lower than 30 minutes would appear not to improve quality.

7.5.2 Other responses were less positive:

- A TSO noted that their existing 15 minute ISP implied there were few additional gains to be made;
- Another TSO indicated that frequency quality issues were not prevalent today; and
- Another TSO indicated that their analysis showed a null impact.

7.5.3 One TSO provided a quantified estimate of the reduced risk of blackout/brownout at the current level of frequency quality.

7.5.4 Overall the survey responses provide little information on the assumptions under which we would see a benefit arise in this area, and what the size of the benefit might be in that case. The relationship between the ISP and frequency quality is also clearly complex and will be driven by very specific behavioural changes by participants. As a result we have not have not therefore sought to quantify this effect.

## 7.6 Non-monetary benefits

### Increased participation as BSP and increased exposure to imbalance prices for RES

7.6.1 The majority of stakeholders that have provided comments on the potential for an increased participation of renewable energy sources (RES) are TSOs, vertically integrated players and generators. However, some DSOs and retail suppliers have also responded on this sub-benefit.

7.6.2 The first point commented on by stakeholders is whether or not production forecast quality at ISP granularity would be improved with a reduction in ISP duration. There is no consensus among respondents that this would be the case:

- some respondents point that there are technical limitations to real-time measurement for small-scale installations,
- others argue the quality of forecasts can reduce beyond a certain degree of granularity.

7.6.3 Where there is an expectation of improved forecasts at ISP granularity, then stakeholders go on to discuss separately:

- Implications for RES trading on wholesale markets; and
- Implications for RES participation in balancing market.

7.6.4 In both cases, stakeholders identify a number of conditions that would need to be met in order for a change to materialise:

- Some players flag that for now RES are by default not allowed to participate in balancing markets given market arrangements;
- Some TSOs or vertically integrated players state that they do not believe the liquidity in both markets to be sufficient for RES participation to increase;
- Other stakeholders have emphasised that a reduction in gate closure would be required to see material benefits. We note that under the assumptions retained for the CBA it is the case that the average time between gate closure and delivery is reduced, suggesting that this condition will be met for a large share of the time.

7.6.5 Finally, in relation specifically to participation in balancing markets, some stakeholders have flagged that, even with improved forecasts, RES will still face significant risk of facing large imbalances between actual production and forecasts. In fact, the reduction in ISP duration would rather reduce the opportunity for smoothing such large and unexpected jumps in production. This would be likely to deter RES generators from committing to participate in balancing markets.

### Security of supply

7.6.6 Only 32 stakeholders have provided comments on the potential for increasing security of supply through a larger amount of cross-border balancing actions. A third of them are TSOs, a few other are generators or retail suppliers. Some DSOs, metering service providers, NRAs, and traders have also provided an answer. However, part of the non-TSOs stakeholders have answered that security of supply is a TSO responsibility and they cannot comment on this matter.

7.6.7 Some stakeholders agree with the idea that a reduction in ISP may increase security of supply through fostering cross-border trade. However, the majority of them are sceptical on the possibility to increase security of supply thanks to an ISP alignment across countries.

7.6.8 The disagreement seems to stem from the following reasons:

- Some stakeholders state that they see no clear evidence of the linkage between increased cross-border balancing and security of supply.
- Some stakeholders point to the fact that TSOs are already able to trade balancing products and share reserves across countries with different ISP durations. Stakeholders argue that this signals that the ISP duration does not constitute a major obstacle to security of supply.
- Whilst this is recognised by all stakeholders, some believe that cross-border balancing, albeit possible today, would be facilitated and fostered with harmonised ISP durations, further reducing security of supply.

7.6.9 We would note that some stakeholders expect a beneficial impact not due to cross-border balancing trades but due to the general reduction in imbalances (see benefit on reduced balancing costs).

# 8 ANALYSIS OF NET BENEFITS

## 8.1 Introduction

8.1.1 In this section we use the cost and benefit information described in Sections 6 and 7 to develop costs and benefits for each of the four planning cases we are considering, relative to the counterfactual. We do this:

- in aggregate for the EU + 3 to show the net benefit or net welfare effect of each factual planning case;
- in aggregate by country; and
- in aggregate by stakeholder group (producers and consumers).

8.1.2 We provide the information for the two cost scenarios (profiling and unadjusted) with central cost estimates, and for the high and low benefit cases.

8.1.3 As a reminder, the four planning cases are:

- Planning case 1 - all countries move to a 15 minute ISP;
- Planning case 2 – all countries with a current ISP of 60 minutes move to an ISP of 15 minutes;
- Planning case 3 – countries change their ISP to match their neighbours; and
- Planning case 4 – all countries move to a 5 minute ISP.

## 8.2 Mapping cost and benefit information to planning cases

8.2.1 To determine the costs and benefits for each of the planning cases, we map the cost and benefit information from Sections 6 and 7 to each planning case according to the ISP duration to which a country changes (if there is a change) and whether any borders of a country are affected by the change to ISP.

8.2.2 Exhibit 53 shows the ISP duration for each of the four factual planning cases and for the counterfactual (status quo) for each country.

**Exhibit 53. ISP duration for each planning case and each country**

| Country | Current ISP duration | Planning case 1 | Planning case 2 | Planning case 3 | Planning case 4 |
|---|---|---|---|---|---|
| *Austria* | 15 | 15 | 15 | 15 | 5 |
| *Belgium* | 15 | 15 | 15 | 15 | 5 |
| *Switzerland* | 15 | 15 | 15 | 15 | 5 |
| *Germany* | 15 | 15 | 15 | 15 | 5 |
| *Hungary* | 15 | 15 | 15 | 15 | 5 |
| *Lichtenstein* | 15 | 15 | 15 | 15 | 5 |
| *Luxemburg* | 15 | 15 | 15 | 15 | 5 |
| *Netherlands* | 15 | 15 | 15 | 15 | 5 |
| *Slovakia* | 15 | 15 | 15 | 15 | 5 |
| *France* | 30 | 15 | 30 | 30 | 5 |
| *Great Britain* | 30 | 15 | 30 | 30 | 5 |
| *Ireland* | 30 | 15 | 30 | 30 | 5 |
| *Northern Ireland* | 30 | 15 | 30 | 30 | 5 |
| *Bulgaria* | 60 | 15 | 15 | 15 | 5 |
| *Czech Republic* | 60 | 15 | 15 | 15 | 5 |
| *Denmark* | 60 | 15 | 15 | 15 | 5 |
| *Estonia* | 60 | 15 | 15 | 15 | 5 |
| *Greece* | 60 | 15 | 15 | 15 | 5 |
| *Spain* | 60 | 15 | 15 | 30 | 5 |
| *Finland* | 60 | 15 | 15 | 15 | 5 |
| *Croatia* | 60 | 15 | 15 | 15 | 5 |
| *Italy* | 60 | 15 | 15 | 15 | 5 |
| *Lithuania* | 60 | 15 | 15 | 15 | 5 |
| *Latvia* | 60 | 15 | 15 | 15 | 5 |
| *Norway* | 60 | 15 | 15 | 15 | 5 |
| *Poland* | 60 | 15 | 15 | 15 | 5 |
| *Portugal* | 60 | 15 | 15 | 30 | 5 |
| *Romania* | 60 | 15 | 15 | 15 | 5 |
| *Sweden* | 60 | 15 | 15 | 15 | 5 |
| *Slovenia* | 60 | 15 | 15 | 15 | 5 |
| *Cyprus* | 60 | 15 | 15 | 15 | 5 |
| *Malta* | 60 | 15 | 15 | 15 | 5 |

*Source: Frontier*

8.2.3 Exhibit 74 shows the borders that are affected for each of the planning cases.

**Exhibit 54. Borders affected by each planning case**

| Border from | Border to | Planning case 1 | Planning case 2 | Planning case 3 | Planning case 4 |
|---|---|---|---|---|---|
| *Austria* | Czech Republic | yes | yes | yes | yes |
| *Austria* | Italy | yes | yes | yes | yes |
| *Austria* | Slovenia | yes | yes | yes | yes |
| *Belgium* | France | yes | no | no | yes |
| *Switzerland* | France | yes | no | no | yes |
| *Switzerland* | Italy | yes | yes | yes | yes |
| *Deutschland* | France | yes | no | no | yes |
| *Deutschland* | Czech Republic | yes | yes | yes | yes |
| *Deutschland* | Denmark | yes | yes | yes | yes |
| *Deutschland* | Poland | yes | yes | yes | yes |
| *Deutschland* | Sweden | yes | yes | yes | yes |
| *Hungary* | Croatia | yes | yes | yes | yes |
| *Hungary* | Romania | yes | yes | yes | yes |
| *Netherlands* | Great Britain | yes | no | no | yes |
| *Netherlands* | Norway | yes | yes | yes | yes |
| *Slovak Republic* | Czech Republic | yes | yes | yes | yes |
| *Slovak Republic* | Poland | yes | yes | yes | yes |
| *France* | Spain | yes | no | yes | yes |
| *France* | Italy | yes | no | no | yes |

*Source: Frontier*

## 8.3 Planning case 1 – all harmonise on 15 minute ISP

8.3.1 If all countries harmonise their ISP durations at 15 minutes it is ambiguous as to whether there is a positive net benefit for the EU + 3, as is shown by Exhibit 55.

**Exhibit 55. Planning case 1 – net welfare (split by costs and benefits)**

| | Total benefit (€bn) | Total cost (€bn) | Net welfare (€bn) |
|---|---|---|---|
| Profiling with high benefits | 5.6 | -4.0 | 1.6 |
| Profiling with low benefits | 2.3 | -4.0 | -1.7 |
| Unadjusted with high benefits | 5.6 | -5.3 | 0.3 |
| Unadjusted with low benefits | 2.3 | -5.3 | -3.0 |

*Source: Frontier*

8.3.2 If metering costs are reduced by using profiling where it would not be economic to adapt meters to the new ISP and where we use the higher estimate of benefits, there would be a clear net welfare gain from moving to a 15 minute ISP. However, even were profiling to be used there would be a net welfare loss if we use the lower estimate of benefits.

8.3.3 If profiling was not used to reduce metering costs, the net welfare gain from moving to a 15 minute ISP would be marginal at best, and there could be a significant welfare loss.

8.3.4 Individual countries are affected differently by the move to harmonise ISP duration across Europe at 15 minutes. Exhibit 56 shows total benefits, costs and net welfare by country for planning case 1.

8.3.5 Net benefits accrue to those countries that already have a 15 minute ISP – these countries incur no material costs and accrue some cross border benefits related to harmonisation. This is shown clearly for the countries Austria to Slovakia, towards the top of Exhibit 56.

8.3.6 Some countries that change to ISP duration in this planning case have a net benefit, e.g. France, the Czech Republic, Poland etc. However, most countries that require a change to ISP duration would see a net welfare loss.

**Exhibit 56. Planning case 1 – net welfare by country (profiling and high benefits)**

| Country | Total benefit (€m) | Total cost (€m) | Net welfare (€m) |
|---|---|---|---|
| Austria | 93.3 | - | 93.3 |
| Belgium | 44.4 | - | 44.4 |
| Switzerland | 543.8 | - | 543.8 |
| Germany | 369.7 | - | 369.7 |
| Hungary | 105.6 | - | 105.6 |
| Lichtenstein | - | - | - |
| Luxemburg | - | - | - |
| Netherlands | 167.1 | - | 167.1 |
| Slovakia | 185.2 | - | 185.2 |
| France | 654.6 | 189.3 | 465.3 |
| Great Britain | 501.5 | 781.6 | - 280.1 |
| Ireland | 51.2 | 91.3 | - 40.1 |
| Northern Ireland | 18.8 | 46.2 | - 27.4 |
| Bulgaria | 113.1 | 169.7 | - 56.6 |
| Czech Republic | 203.2 | 97.1 | 106.1 |
| Denmark | 47.0 | 117.0 | - 70.0 |
| Estonia | 25.9 | 52.9 | - 27.0 |
| Greece | 138.3 | 152.1 | - 13.8 |
| Spain | 770.1 | 811.0 | - 41.0 |
| Finland | 59.6 | 108.8 | - 49.2 |
| Croatia | 54.9 | 81.7 | - 26.8 |
| Italy | 440.9 | 265.2 | 175.7 |
| Lithuania | 25.6 | 148.9 | - 123.3 |
| Latvia | 20.9 | 130.8 | - 109.8 |
| Norway | 80.8 | 86.9 | - 6.1 |
| Poland | 443.9 | 307.2 | 136.7 |
| Portugal | 143.8 | 72.7 | 71.1 |
| Romania | 162.8 | 123.8 | 39.0 |
| Sweden | 89.0 | 88.8 | 0.2 |
| Slovenia | 64.7 | 15.5 | 49.2 |
| Cyprus | 3.2 | 42.1 | - 38.9 |
| Malta | 2.3 | 37.9 | - 35.6 |
| ***Total*** | ***5,625.3*** | ***4,018.6*** | ***1,606.7*** |

*Source: Frontier*

8.3.7 Exhibit 57, Exhibit 58, and Exhibit 59 show country specific net welfare for profiling with low benefits, unadjusted costs with high benefits, and unadjusted costs with low benefits, respectively. In each case those countries that do not need to change ISP duration have a positive net welfare.

### Exhibit 57. Planning case 1 – net welfare by country (profiling and low benefits)

| Country | Total benefit (€m) | Total cost (€m) | Net welfare (€m) |
|---|---|---|---|
| Austria | 46.6 | - | 46.6 |
| Belgium | 22.2 | - | 22.2 |
| Switzerland | 271.9 | - | 271.9 |
| Germany | 184.9 | - | 184.9 |
| Hungary | 52.8 | - | 52.8 |
| Lichtenstein | - | - | - |
| Luxemburg | - | - | - |
| Netherlands | 83.6 | - | 83.6 |
| Slovakia | 92.6 | - | 92.6 |
| France | 245.5 | 189.3 | 56.2 |
| Great Britain | 208.2 | 781.6 | - 573.4 |
| Ireland | 21.9 | 91.3 | - 69.4 |
| Northern Ireland | 9.0 | 46.2 | - 37.2 |
| Bulgaria | 43.3 | 169.7 | - 126.4 |
| Czech Republic | 77.0 | 97.1 | - 20.1 |
| Denmark | 8.8 | 117.0 | - 108.2 |
| Estonia | 10.4 | 52.9 | - 42.6 |
| Greece | 53.9 | 152.1 | - 98.2 |
| Spain | 289.0 | 811.0 | - 522.0 |
| Finland | 18.4 | 108.8 | - 90.4 |
| Croatia | 7.6 | 81.7 | - 74.1 |
| Italy | 187.2 | 265.2 | - 78.1 |
| Lithuania | 11.4 | 148.9 | - 137.5 |
| Latvia | 9.4 | 130.8 | - 121.4 |
| Norway | 30.1 | 86.9 | - 56.9 |
| Poland | 168.1 | 307.2 | - 139.1 |
| Portugal | 55.5 | 72.7 | - 17.2 |
| Romania | 62.5 | 123.8 | - 61.3 |
| Sweden | 25.3 | 88.8 | - 63.4 |
| Slovenia | 24.8 | 15.5 | 9.3 |
| Cyprus | 3.2 | 42.1 | - 39.0 |
| Malta | 2.3 | 37.9 | - 35.6 |
| ***Total*** | ***2,327.5*** | ***4,018.6*** | ***- 1,691.1*** |

*Source: Frontier*

### Exhibit 58. Planning case 1 – net welfare by country (unadjusted costs and high benefits)

| Country | Total benefit (€m) | Total cost (€m) | Net welfare (€m) |
|---|---|---|---|
| Austria | 93.3 | - | 93.3 |
| Belgium | 44.4 | - | 44.4 |
| Switzerland | 543.8 | - | 543.8 |
| Germany | 369.7 | - | 369.7 |
| Hungary | 105.6 | - | 105.6 |
| Lichtenstein | - | - | - |
| Luxemburg | - | - | - |
| Netherlands | 167.1 | - | 167.1 |
| Slovakia | 185.2 | - | 185.2 |
| France | 654.6 | 189.3 | 465.3 |
| Great Britain | 501.5 | 1,838.2 | -1,336.7 |
| Ireland | 51.2 | 91.3 | -40.1 |
| Northern Ireland | 18.8 | 46.2 | -27.4 |
| Bulgaria | 113.1 | 169.7 | -56.6 |
| Czech Republic | 203.2 | 97.1 | 106.1 |
| Denmark | 47.0 | 276.6 | -229.7 |
| Estonia | 25.9 | 52.9 | -27.0 |
| Greece | 138.3 | 152.1 | -13.8 |
| Spain | 770.1 | 811.0 | -41.0 |
| Finland | 59.6 | 209.9 | -150.3 |
| Croatia | 54.9 | 81.7 | -26.8 |
| Italy | 440.9 | 265.2 | 175.7 |
| Lithuania | 25.6 | 148.9 | -123.3 |
| Latvia | 20.9 | 130.8 | -109.8 |
| Norway | 80.8 | 65.7 | 15.2 |
| Poland | 443.9 | 307.2 | 136.7 |
| Portugal | 143.8 | 72.7 | 71.1 |
| Romania | 162.8 | 123.8 | 39.0 |
| Sweden | 89.0 | 55.7 | 33.3 |
| Slovenia | 64.7 | 15.5 | 49.2 |
| Cyprus | 3.2 | 42.1 | -38.9 |
| Malta | 2.3 | 37.9 | -35.6 |
| ***Total*** | ***5,625.3*** | ***5,281.7*** | ***343.6*** |

*Source: Frontier*

**Exhibit 59. Planning case 1 – net welfare by country (unadjusted costs and low benefits)**

| Country | Total benefit (€m) | Total cost (€m) | Net welfare (€m) |
|---|---|---|---|
| Austria | 46.6 | - | 46.6 |
| Belgium | 22.2 | - | 22.2 |
| Switzerland | 271.9 | - | 271.9 |
| Germany | 184.9 | - | 184.9 |
| Hungary | 52.8 | - | 52.8 |
| Lichtenstein | - | - | - |
| Luxemburg | - | - | - |
| Netherlands | 83.6 | - | 83.6 |
| Slovakia | 92.6 | - | 92.6 |
| France | 245.5 | 189.3 | 56.2 |
| Great Britain | 208.2 | 1,838.2 | - 1,630.0 |
| Ireland | 21.9 | 91.3 | - 69.4 |
| Northern Ireland | 9.0 | 46.2 | - 37.2 |
| Bulgaria | 43.3 | 169.7 | - 126.4 |
| Czech Republic | 77.0 | 97.1 | - 20.1 |
| Denmark | 8.8 | 276.6 | - 267.8 |
| Estonia | 10.4 | 52.9 | - 42.6 |
| Greece | 53.9 | 152.1 | - 98.2 |
| Spain | 289.0 | 811.0 | - 522.0 |
| Finland | 18.4 | 209.9 | - 191.5 |
| Croatia | 7.6 | 81.7 | - 74.1 |
| Italy | 187.2 | 265.2 | - 78.1 |
| Lithuania | 11.4 | 148.9 | - 137.5 |
| Latvia | 9.4 | 130.8 | - 121.4 |
| Norway | 30.1 | 65.7 | - 35.6 |
| Poland | 168.1 | 307.2 | - 139.1 |
| Portugal | 55.5 | 72.7 | - 17.2 |
| Romania | 62.5 | 123.8 | - 61.3 |
| Sweden | 25.3 | 55.7 | - 30.4 |
| Slovenia | 24.8 | 15.5 | 9.3 |
| Cyprus | 3.2 | 42.1 | - 39.0 |
| Malta | 2.3 | 37.9 | - 35.6 |
| ***Total*** | ***2,327.5*** | ***5,281.7*** | ***- 2,954.1*** |

*Source: Frontier*

8.3.8 Different stakeholders are affected differently by the change to ISP duration. Here we show the effect on producer and consumer welfare in aggregate for the EU + 3 and for individual countries.

8.3.9 Exhibit 60 shows the breakdown of net welfare for the EU + 3 by producers and consumers. Unambiguously consumers are made better off by a move to a shorter ISP and producers are made worse off. Even though consumers bear the cost of the change to meters, they are made better off overall since they see most of the benefit from reductions in TSO balancing costs. Conversely, producers see reduced revenues from a reduction in TSO balancing actions. This is why the use of high or low benefit estimates has a large effect on producer welfare.

**Exhibit 60. Planning case 1 – net welfare (split by producer and consumer welfare)**

| | Producer net welfare (€bn) | Consumer net welfare (€bn) | Net welfare (€bn) |
|---|---|---|---|
| Profiling with high benefits | -1.8 | 3.4 | 1.6 |
| Profiling with low benefits | -4.9 | 3.2 | -1.7 |
| Unadjusted with high benefits | -2.1 | 2.4 | 0.3 |
| Unadjusted with low benefits | -5.1 | 2.2 | -3.0 |

*Source: Frontier*

8.3.10 Exhibit 74 shows the breakdown of net welfare by producer and consumer surplus for each country. We show this only for the first sub-case, profiling with high benefits since the pattern of the breakdown is consistent across all four sub-cases. This clearly shows that where ISP changes producers see a welfare reduction.

**Exhibit 61. Planning case 1 – net welfare by producer and consumer welfare and country (profiling and high benefits)**

| Country | Producer net welfare (€m) | Consumer net welfare (€m) | Net welfare (€m) |
|---|---|---|---|
| Austria | - | 93.3 | 93.3 |
| Belgium | - | 44.4 | 44.4 |
| Switzerland | - | 543.8 | 543.8 |
| Germany | - | 369.7 | 369.7 |
| Hungary | - | 105.6 | 105.6 |
| Lichtenstein | - | - | - |
| Luxemburg | - | - | - |
| Netherlands | - | 167.1 | 167.1 |
| Slovakia | - | 185.2 | 185.2 |
| France | -212.2 | 677.5 | 465.3 |
| Great Britain | -260.3 | -19.8 | -280.1 |
| Ireland | -31.1 | -9.0 | -40.1 |
| Northern Ireland | -10.7 | -16.7 | -27.4 |
| Bulgaria | -63.1 | 6.5 | -56.6 |
| Czech Republic | -78.1 | 184.1 | 106.1 |
| Denmark | -34.1 | -35.9 | -70.0 |
| Estonia | -15.0 | -12.0 | -27.0 |
| Greece | -65.0 | 51.2 | -13.8 |
| Spain | -382.3 | 341.3 | -41.0 |
| Finland | -26.8 | -22.4 | -49.2 |
| Croatia | -27.0 | 0.2 | -26.8 |
| Italy | -166.3 | 341.9 | 175.7 |
| Lithuania | -33.0 | -90.3 | -123.3 |
| Latvia | -28.7 | -81.2 | -109.8 |
| Norway | -30.0 | 23.9 | -6.1 |
| Poland | -187.1 | 323.8 | 136.7 |
| Portugal | -54.2 | 125.3 | 71.1 |
| Romania | -70.4 | 109.4 | 39.0 |
| Sweden | -34.5 | 34.7 | 0.2 |
| Slovenia | -22.3 | 71.6 | 49.2 |
| Cyprus | -5.1 | -33.8 | -38.9 |
| Malta | -4.5 | -31.1 | -35.6 |
| ***Total*** | ***-1,841.8*** | ***3,448.5*** | ***1,606.7*** |

*Source: Frontier*

# 8.4 Planning case 2 – those with 60 minute ISP move to 15 minutes

8.4.1 If all countries that currently have a 60 minute ISP duration were to move to a 15 minute ISP, again it is ambiguous as to whether there is a positive net benefit for the EU + 3, as is shown by Exhibit 62.

**Exhibit 62. Planning case 2 – net welfare (split by costs and benefits)**

| | Total benefit (€bn) | Total cost (€bn) | Net welfare (€bn) |
|---|---|---|---|
| Profiling with high benefits | 4.0 | -2.9 | 1.1 |
| Profiling with low benefits | 1.6 | -2.9 | -1.3 |
| Unadjusted with high benefits | 4.0 | -3.1 | 0.9 |
| Unadjusted with low benefits | 1.6 | -3.1 | -1.5 |

*Source: Frontier*

8.4.2 Compared to panning case 1, benefits have fallen but costs have fallen relatively more.

8.4.3 If metering costs are reduced by using profiling where it would not be economic to adapt meters to the new ISP and where we use the higher estimate of benefits, there would be a clear net welfare gain from moving to a 15 minute ISP. However, even were profiling to be used there would be a net welfare loss if we use the lower estimate of benefits.

8.4.4 If profiling was not used to reduce metering costs, the net welfare gain from moving to a 15 minute ISP would be positive (compared to a marginal benefit for planning case 1). However, there would be a significant welfare loss if low benefits were used.

8.4.5 Exhibit 63 shows the breakdown of net welfare for the EU + 3 by producers and consumers. As with planning case 1, unambiguously consumers are made better off by a move to a shorter ISP and producers are made worse off.

**Exhibit 63. Planning case 2 – net welfare (split by producer and consumer welfare)**

| | Producer net welfare (€bn) | Consumer net welfare (€bn) | Net welfare (€bn) |
|---|---|---|---|
| Profiling with high benefits | -1.3 | 2.4 | 1.1 |
| Profiling with low benefits | -3.4 | 2.1 | -1.3 |
| Unadjusted with high benefits | -1.4 | 2.2 | 0.9 |
| Unadjusted with low benefits | -3.4 | 1.9 | -1.5 |

*Source: Frontier*

8.4.6 Exhibit 64 shows the breakdown of net welfare by producer and consumer surplus for each country. Again, we show this only for the first sub-case, profiling with high benefits since the pattern of the breakdown is consistent across all four sub-cases. Where the ISP changes, producers see a welfare reduction.

**Exhibit 64. Planning case 2 – net welfare by producer and consumer welfare and country (profiling and high benefits)**

| Country | Producer net welfare (€m) | Consumer net welfare (€m) | Net welfare (€m) |
|---|---|---|---|
| Austria | - | 93.3 | 93.3 |
| Belgium | - | - | - |
| Switzerland | - | 471.7 | 471.7 |
| Germany | - | 222.7 | 222.7 |
| Hungary | - | 105.6 | 105.6 |
| Lichtenstein | - | - | - |
| Luxemburg | - | - | - |
| Netherlands | - | 1.0 | 1.0 |
| Slovakia | - | 185.2 | 185.2 |
| France | - | - | - |
| Great Britain | - | - | - |
| Ireland | - | - | - |
| Northern Ireland | - | - | - |
| Bulgaria | - 63.1 | 6.5 | - 56.6 |
| Czech Republic | - 78.1 | 184.1 | 106.1 |
| Denmark | - 34.1 | - 35.9 | - 70.0 |
| Estonia | - 15.0 | - 12.0 | - 27.0 |
| Greece | - 65.0 | 51.2 | - 13.8 |
| Spain | - 382.3 | 341.3 | - 41.0 |
| Finland | - 26.8 | - 22.4 | - 49.2 |
| Croatia | - 27.0 | 0.2 | - 26.8 |
| Italy | - 166.3 | 341.9 | 175.7 |
| Lithuania | - 33.0 | - 90.3 | - 123.3 |
| Latvia | - 28.7 | - 81.2 | - 109.8 |
| Norway | - 30.0 | 23.9 | - 6.1 |
| Poland | - 187.1 | 323.8 | 136.7 |
| Portugal | - 54.2 | 125.3 | 71.1 |
| Romania | - 70.4 | 109.4 | 39.0 |
| Sweden | - 34.5 | 34.7 | 0.2 |
| Slovenia | - 22.3 | 71.6 | 49.2 |
| Cyprus | - 5.1 | - 33.8 | - 38.9 |
| Malta | - 4.5 | - 31.1 | - 35.6 |
| ***Total*** | ***- 1,327.5*** | ***2,386.8*** | ***1,059.3*** |

*Source: Frontier*

## 8.5 Planning case 3 – harmonisation with neighbours

8.5.1 If all countries that currently have a 30 or 60 minute ISP duration were to move to the same (shorter) ISP duration of their neighbours, again it is ambiguous as to whether there is a positive net benefit for the EU + 3, as is shown by Exhibit 65.

**Exhibit 65. Planning case 3 – net welfare (split by costs and benefits)**

| | Total benefit (€bn) | Total cost (€bn) | Net welfare (€bn) |
|---|---|---|---|
| Profiling with high benefits | 3.9 | -2.4 | 1.5 |
| Profiling with low benefits | 1.6 | -2.4 | -0.8 |
| Unadjusted with high benefits | 3.9 | -2.6 | 1.3 |
| Unadjusted with low benefits | 1.6 | -2.6 | -1.0 |

*Source: Frontier*

8.5.2 Compared to planning case 1, benefits have fallen but costs have fallen relatively more. Costs and benefits are similar to planning case 2.

8.5.3 As before, profiling brings added net welfare, and the largest effect on net welfare is whether we use high or low benefits. Using low benefits results in a net welfare loss and high benefits results in a net welfare gain.

8.5.4 Exhibit 66 shows the breakdown of net welfare for the EU + 3 by producers and consumers. As with planning cases 1 and 2, unambiguously consumers are made better off by a move to a shorter ISP and producers are made worse off.

**Exhibit 66. Planning case 3 – net welfare (split by producer and consumer welfare)**

| | Producer net welfare (€bn) | Consumer net welfare (€bn) | Net welfare (€bn) |
|---|---|---|---|
| Profiling with high benefits | -1.2 | 2.7 | 1.5 |
| Profiling with low benefits | -3.2 | 2.4 | -0.8 |
| Unadjusted with high benefits | -1.2 | 2.5 | 1.3 |
| Unadjusted with low benefits | -3.2 | 2.2 | -1.0 |

*Source: Frontier*

8.5.5 Exhibit 67 shows the breakdown of net welfare by producer and consumer surplus for each country. Again, we show this only for the first sub-case, profiling with high benefits since the pattern of the breakdown is consistent across all four sub-cases. Where the ISP changes, producers see a welfare reduction.

**Exhibit 67. Planning case 3 – net welfare by producer and consumer welfare and country (profiling and high benefits)**

| Country | Producer net welfare (€m) | Consumer net welfare (€m) | Net welfare (€m) |
|---|---|---|---|
| Austria | - | 93.3 | 93.3 |
| Belgium | - | - | - |
| Switzerland | - | 471.7 | 471.7 |
| Germany | - | 222.7 | 222.7 |
| Hungary | - | 105.6 | 105.6 |
| Lichtenstein | - | - | - |
| Luxemburg | - | - | - |
| Netherlands | - | 1.0 | 1.0 |
| Slovakia | - | 185.2 | 185.2 |
| France | - | 17.8 | 17.8 |
| Great Britain | - | - | - |
| Ireland | - | - | - |
| Northern Ireland | - | - | - |
| Bulgaria | -63.1 | 6.5 | -56.6 |
| Czech Republic | -78.1 | 184.1 | 106.1 |
| Denmark | -34.1 | -35.9 | -70.0 |
| Estonia | -15.0 | -12.0 | -27.0 |
| Greece | -65.0 | 51.2 | -13.8 |
| Spain | -238.5 | 648.9 | 410.4 |
| Finland | -26.8 | -22.4 | -49.2 |
| Croatia | -27.0 | 0.2 | -26.8 |
| Italy | -166.3 | 341.9 | 175.7 |
| Lithuania | -33.0 | -90.3 | -123.3 |
| Latvia | -28.7 | -81.2 | -109.8 |
| Norway | -30.0 | 23.9 | -6.1 |
| Poland | -187.1 | 323.8 | 136.7 |
| Portugal | -47.2 | 103.9 | 56.6 |
| Romania | -70.4 | 109.4 | 39.0 |
| Sweden | -34.5 | 34.7 | 0.2 |
| Slovenia | -22.3 | 71.6 | 49.2 |
| Cyprus | -5.1 | -33.8 | -38.9 |
| Malta | -4.5 | -31.1 | -35.6 |
| ***Total*** | ***-1,176.8*** | ***2,690.7*** | ***1,514.0*** |

*Source: Frontier*

## 8.6 Planning case 4 – all harmonise on 5 minute ISP

8.6.1 If all countries changed ISP duration to harmonise on a 5 minute ISP duration, net welfare unambiguously falls for the EU + 3, as is shown by Exhibit 68.

**Exhibit 68. Planning case 4 – net welfare (split by costs and benefits)**

| | Total benefit (€bn) | Total cost (€bn) | Net welfare (€bn) |
|---|---|---|---|
| Profiling with high benefits | 7.0 | -7.7 | -0.7 |
| Profiling with low benefits | 3.0 | -7.7 | -4.7 |
| Unadjusted with high benefits | 7.0 | -14.5 | -7.5 |
| Unadjusted with low benefits | 3.0 | -14.5 | -11.5 |

*Source: Frontier*

8.6.2 Compared to the other planning case 1, costs have increased significantly.

8.6.3 As before, profiling brings added net welfare, and the largest effect on net welfare is whether we use high or low benefits. Using low benefits results in a net welfare loss and high benefits results in a net welfare gain.

8.6.4 Exhibit 69 shows the breakdown of net welfare for the EU + 3 by producers and consumers. Producers are unambiguously made worse off and with this planning case consumers are made better off only where profiling is used to reduce the cost of meter adaptation.

**Exhibit 69. Planning case 4 – net welfare (split by producer and consumer welfare)**

| | Producer net welfare (€bn) | Consumer net welfare (€bn) | Net welfare (€bn) |
|---|---|---|---|
| Profiling with high benefits | -2.5 | 1.8 | -0.7 |
| Profiling with low benefits | -5.5 | 0.8 | -4.7 |
| Unadjusted with high benefits | -3.9 | -3.6 | -7.5 |
| Unadjusted with low benefits | -6.8 | -4.6 | -11.5 |

*Source: Frontier*

8.6.5 Exhibit 70 shows the breakdown of net welfare by producer and consumer surplus for each country. Again, we show this only for the first sub-case, profiling with high benefits since the pattern of the breakdown is consistent across all four sub-cases. Producers see a welfare reduction in all countries (since ISP changes in all countries) and consumers see a welfare reduction in several countries.

**Exhibit 70. Planning case 4 – net welfare by producer and consumer welfare and country (profiling and high benefits)**

| Country | Producer net welfare (€m) | Consumer net welfare (€m) | Net welfare (€m) |
|---|---|---|---|
| Austria | -56.0 | -44.8 | -100.8 |
| Belgium | -75.5 | -100.7 | -176.2 |
| Switzerland | -42.8 | 541.4 | 498.6 |
| Germany | -283.7 | 701.6 | 417.9 |
| Hungary | -32.4 | 33.2 | 0.8 |
| Lichtenstein | -5.2 | -40.8 | -46.0 |
| Luxemburg | -14.1 | -67.1 | -81.2 |
| Netherlands | -34.9 | 191.0 | 156.1 |
| Slovakia | -20.0 | 126.5 | 106.4 |
| France | -256.2 | 610.5 | 354.3 |
| Great Britain | -292.5 | -216.5 | -509.0 |
| Ireland | -31.5 | -28.9 | -60.4 |
| Northern Ireland | -11.3 | -33.1 | -44.3 |
| Bulgaria | -65.3 | -52.8 | -118.1 |
| Czech Republic | -73.2 | 132.9 | 59.7 |
| Denmark | -41.2 | -95.0 | -136.2 |
| Estonia | -15.8 | -29.6 | -45.4 |
| Greece | -63.4 | -11.8 | -75.2 |
| Spain | -388.6 | 27.0 | -361.7 |
| Finland | -30.3 | -35.5 | -65.8 |
| Croatia | -21.8 | -30.1 | -51.9 |
| Italy | -154.6 | 242.4 | 87.8 |
| Lithuania | -38.5 | -131.2 | -169.6 |
| Latvia | -48.7 | -176.8 | -225.5 |
| Norway | -34.8 | -6.7 | -41.6 |
| Poland | -179.9 | 180.0 | 0.1 |
| Portugal | -58.5 | 46.3 | -12.2 |
| Romania | -80.4 | 98.8 | 18.4 |
| Sweden | -37.5 | 16.6 | -20.9 |
| Slovenia | -13.6 | 33.3 | 19.7 |
| Cyprus | -6.2 | -47.1 | -53.2 |
| Malta | -5.5 | -43.1 | -48.6 |
| ***Total*** | ***-2,513.9*** | ***1,790.1*** | ***-723.8*** |

*Source: Frontier*

## 8.7 Comparison of planning cases

8.7.1 Exhibit 71 summarises the total net benefits and net benefits by producer and consumer for the four planning cases and for each of the sub-cases that we consider

**Exhibit 71. Net benefits by planning case and sub-case**

| | Planning case 1 (€bn) | Planning case 2 (€bn) | Planning case 3 (€bn) | Planning case 4 (€bn) |
|---|---|---|---|---|
| Profiling with high benefits | 1.6 | 1.1 | 1.5 | -0.7 |
| Profiling with low benefits | -1.7 | -1.3 | -0.8 | -4.7 |
| Unadjusted with high benefits | 0.3 | 0.9 | 1.3 | -7.5 |
| Unadjusted with low benefits | -3.0 | -1.5 | -1.0 | -11.5 |

*Source: Frontier*

8.7.2 Exhibit 72 and Exhibit 73 show the net producer benefit and net consumer benefits respectively. As noted above, producers show a net dis-benefit in all planning cases and sub-cases. Consumers generally show a net benefit, with the exception of planning case 4.

**Exhibit 72. Net producer benefit by planning case and sub-case**

| | Planning case 1 (€bn) | Planning case 2 (€bn) | Planning case 3 (€bn) | Planning case 4 (€bn) |
|---|---|---|---|---|
| Profiling with high benefits | -1.8 | -1.3 | -1.2 | -2.5 |
| Profiling with low benefits | -4.9 | -3.4 | -3.2 | -5.5 |
| Unadjusted with high benefits | -2.1 | -1.4 | -1.2 | -3.9 |
| Unadjusted with low benefits | -5.1 | -3.4 | -3.2 | -6.8 |

*Source: Frontier*

**Exhibit 73. Net consumer benefit by planning case and sub-case**

| | Planning case 1 (€bn) | Planning case 2 (€bn) | Planning case 3 (€bn) | Planning case 4 (€bn) |
|---|---|---|---|---|
| Profiling with high benefits | 3.4 | 2.4 | 2.7 | 1.8 |
| Profiling with low benefits | 3.2 | 2.1 | 2.4 | 0.8 |
| Unadjusted with high benefits | 2.4 | 2.2 | 2.5 | -3.6 |
| Unadjusted with low benefits | 2.2 | 1.9 | 2.2 | -4.6 |

*Source: Frontier*

# 9 CONCLUSIONS AND LIMITATIONS

## 9.1 Introduction

9.1.1 In this final section, we consider the conclusions which policymakers could draw from our analysis, and then set out some important limitations which should be borne in mind as decisions on the ISP are made.

## 9.2 Conclusions

9.2.1 The analysis presented above demonstrates that, under a range of assumptions, the net benefits of the different planning cases could be either strongly positive or negative. For reasons we will return to below, we would caution against placing too much emphasis on the absolute magnitude of estimates. Notwithstanding this caution, however, we do believe it is possible to draw some conclusions from our analysis.

9.2.2 We have assessed two cost cases. However, from our perspective, it would seem that the profiling case is more realistic:

- It seems highly unlikely that there will be a material difference between the engagement of households in relation to demand management across 60, 30, 15 or 5 minute periods. It is therefore most likely that the benefit of having actual meter readings for small customers on a basis different from that today will be small. We would presume that national regulators or governments would be slow to sign-off on material expenditure, for example, to install or configure universal 5 minute metering; and
- Relative to the complications of profiling annual, quarterly or monthly meter readings into current ISP periods, where a range of variables (e.g. day of the week, sunrise / sunset times, temperature etc.) need to be taken into account, the approach to profiling even a 60 minute ISP into 15 or 5 minute intervals for small customers would appear simple. There would be little basis to do anything other than assume consumption was constant over the new smaller ISP intervals. Profiling of this nature is unlikely to be expensive to implement – it is hard to believe that ensuring that actual meter readings are divided by 4 or 12 during the settlement process will constitute a major programme of work, or lead to the broader customer engagement complications of current profiling approaches.

9.2.3 For these reasons, we would suggest focusing on the profiling sub-cases shown in Exhibit 74.

**Exhibit 74. Net benefits by planning case and for profiling sub-cases**

| | Planning case 1 (€bn) | Planning case 2 (€bn) | Planning case 3 (€bn) | Planning case 4 (€bn) |
|---|---|---|---|---|
| Profiling with high benefits | 1.6 | 1.1 | 1.5 | -0.7 |
| Profiling with low benefits | -1.7 | -1.3 | -0.8 | -4.7 |

*Source: Frontier Economics*

9.2.4 From these cases, it is clear that planning case 4 is the least beneficial, resulting in a detriment to net welfare irrespective of whether low or high benefits are assumed. This suggests that, on the basis of this CBA, a move to harmonise on a 5 minute ISP could be rejected

9.2.5 Among the remaining cases, the choice is less clear cut.

9.2.6 In the high benefit case, while it would appear that planning case 1 is more beneficial than planning cases 2 and 3, the difference is small. Given the number of assumptions which we have had to make in the assessment process, it may be that it is safest to assume that planning cases 1 and 3 effectively have an equal net benefit, with planning case 2 slightly lower. In contrast, with the low benefits case, while all of the net benefits are negative, it is could be reasonable to assume that planning case 3 is preferable to planning case 1, and also to planning case 2 though by a smaller amount.

9.2.7 It could therefore be argued that planning case 3 could be preferred. Given uncertainty over benefits, it has an upside similar in scale to planning case 1, but the downside risk is lower. In this sense, based on our analysis it constitutes the change with least potential regret. Equally, the risk involved in a change from the *status quo* appears to be asymmetric. The upside net benefit is larger in absolute size than the downside net cost.

9.2.8 It is still clearly the case that the potential downside would be significant (relative to doing nothing) if the benefits turn out to be towards the low end of our estimates. This is a risk which policymakers will need to consider. In this regard, it is important to note that there are some benefits which we have not measured quantitatively. Based on their qualitative description, policymakers will need to form a judgement of the likely magnitude of these benefits relative to any estimated disbenefit. The relevant non-measured benefits are:

- benefits of improved investment efficiency;
- benefits of improved frequency quality;
- benefits from increased participation / imbalance exposure for RES; and
- benefits in relation to security of supply.

9.2.9 Turning to distributional issues, while planning case 3 is positive across the countries studied, Exhibit 67 shows that we estimate the impact for some countries would be negative. It also shows that, as is systematically the case, there is a net producer disbenefit, although the asymmetry between producer and consumer net benefit is greatest in planning case 3 (i.e. the ratio between the amount by which consumers are better off and the amount by which producers are worse is larger).

9.2.10 It is not clear how their typical disbenefit could be compensated. Similarly, given the logic of planning case 3 involves harmonisation across borders, it may be difficult to mitigate the impact on individual countries by exempting them from the change. Phasing in of any change may, however, be worth further consideration.

## 9.3 Limitations

9.3.1 Assessing the net impact of a change in ISP is clearly a complex and uncertain undertaking. We have made efforts to engage with stakeholders across Europe in relation to both the collection of data on expected costs and benefits and its interpretation. Our engagement has been constrained by the overall limited timescale provided for the work.

9.3.2 It should be clear from the preceding sections that the information we received from stakeholders was insufficient in many areas to permit an assessment which can be treated as highly robust in terms of quantitative accuracy.

9.3.3 Information provided in relation to costs was significantly more complete than for benefits, and we have attempted to address various issues of interpretation in survey responses during the course of our work. Stakeholders have been highly co-operative throughout this exercise. However, other than by cross-comparison between responses and addressing extreme outliers, we have not undertaken work to assess whether all responses have included reasonable estimates of comparable cost items. It may be that some respondents have over- or under-estimated costs in a way which has affected the overall estimates.

9.3.4 Information provided in relation to benefits was much less complete. This is in no way a criticism of stakeholder efforts. It is clear that assessing likely benefits of a change in ISP is highly subjective, as it requires assumptions on stakeholder behaviour in market conditions for which there are few benchmarks and then an assessment of market outcomes given new behaviour. It is therefore not surprising that the majority of responses to our survey did not suffice to quantify fully the scale of potential benefits.

9.3.5 As a result, however, our estimates of benefits have had to rely on stylised modelling, using existing data where possible to ensure that the broad magnitude of inputs to our analysis were reasonable. While we have tried to ensure relevant factors are taken into account in our estimations, in many cases we have had to rely on highly selective evidence, or in some cases on judgement rather than evidence to derive results.

9.3.6 Given this, it is critical to understand that our estimates should have broad confidence intervals placed around them. Drawing conclusions based on small differences between estimated effects would, given the nature of our analysis, be unwise.

# ANNEX A DETAILS OF COST ANALYSIS

A.1.1 In this annex we provide additional details on the cost analysis. We first present the scaling variables which are used to scale up reported costs to full representativity and to fill gaps for countries outside the sample of responses received.

## A.2 Scaling variables

**Exhibit 75. Scaling variables for the cost analysis (section 6)**

| Country | Total Number of Connected Customers | Number of households (2014) | Number of main electricity generating companies | Number of main electricity retailers |
|---|---|---|---|---|
| | Source: Eurelectric (2013) | Source: Eurostat | Source: Eurostat | Source: Eurostat |
| AT | 5,870,000 | 3,768,200 | 4 | 7 |
| BE | 5,243,796 | 4,651,800 | 2 | 4 |
| BG | 4,915,497 | 2,759,900 | 5 | 5 |
| CH | 4,500,000 | - | 3 | 3 |
| CY | 535,050 | 288,800 | 1 | 1 |
| CZ | 5,837,119 | 4,606,900 | 2 | 3 |
| DE | 49,294,962 | 39,709,600 | 4 | 4 |
| DK | 3,277,000 | 2,360,200 | 3 | 6 |
| EE | 652,000 | 561,100 | 1 | 2 |
| EL | 8,195,725 | 4,344,500 | 3 | 1 |
| ES | 27,786,798 | 18,328,900 | 4 | 3 |
| FI | 3,309,146 | 2,595,000 | 4 | 3 |
| FR | 33,999,393 | 28,718,200 | 2 | 2 |
| GB | 29,949,462 | 27,358,713 | 7 | 6 |
| HR | 1,860,921 | 1,518,900 | 2 | 3 |
| HU | 5,527,463 | 4,129,700 | 2 | 6 |
| IE | 2,237,232 | 1,707,200 | 6 | 4 |
| IT | 31,423,623 | 25,767,600 | 3 | 2 |
| LI | 18,958 | 15,474 | 1 | 1 |
| LT | 1,571,789 | 1,308,900 | 6 | 6 |
| LU | 275,175 | 224,600 | 2 | 3 |
| LV | 873,856 | 830,300 | 1 | 2 |
| MT | 183,777 | 150,000 | 1 | 1 |
| NI | 878,804 | 717,287 | 1 | 1 |
| NL | 8,110,000 | 7,594,600 | 4 | 3 |
| NO | 2,747,253 | 2,349,460 | 3 | 6 |
| PL | 16,478,000 | 13,927,600 | 4 | 6 |
| PT | 6,137,611 | 4,062,600 | 4 | 4 |
| RO | 2,639,318 | 7,470,200 | 3 | 5 |
| SE | 5,309,000 | 4,590,900 | 3 | 4 |
| SI | 925,275 | 862,200 | 2 | 9 |
| SK | 2,392,418 | 1,837,100 | 1 | 4 |
| UK | 30,828,266 | 28,076,000 | 7 | 6 |

Note: *Total number of connected customers for Norway based on http://www.energinorge.no/english/, for Switzerland: https://www.news.admin.ch/message/index.html?lang=de&msg-id=51090; other missing* *values are estimated by applying the average ratio of households and retail customers where this data is available for our sample. Companies are considered as "main" if they produce at least 5% of the national net electricity generation. Retailers are considered as "main" if they sell at least 5% of the total national electricity consumption. The number of retailers and generators for Switzerland and Northern Ireland are based on our own assumptions; the number for GB is set equal to the UK value from Eurostat.*

## Exhibit 76. Detailed results of Spain and Portugal for ISP 30 (NPV 2019, € real terms)

| Country | Line item | No non-zero observations | Step 1 - Reported Totex (NPV) | | | Step 2 - Scaling factor | | Results - Totex | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Central Case | Low case | Central case | High case | Scaling factor | | Intermediary result | Intermediary result | Intermediary result |
| ES | C2.1 | 2 | 4,123,417 | 18,513,699 | 7,813,747 | 100% | No scaling for central case, High/Low set equal due to lack of observations | 18,513,699 | 18,513,699 | 18,513,699 |
| PT | C2.1 | 1 | 0 | 324,480 | 0 | 100% | No scaling for central case, High/Low set equal due to lack of observations | 324,480 | 324,480 | 324,480 |
| ES | C2.2 - TN | 1 | 177,779 | 33,413,495 | 3,722,515 | 100% | No scaling for central case, High/Low set equal due to lack of observations | 33,413,495 | 33,413,495 | 33,413,495 |
| ES | C2.2 - DN | 2 | 42,912,376 | 30,870,320 | 53,987,748 | 228% | Total connected customers in ES devided by total meters of respondent | 97,675,150 | 70,265,583 | 122,884,395 |
| PT | C2.2 | 0 | 0 | 0 | 0 | 100% | TSO reports zero costs for moving to ISP 30 for TN | 0 | 0 | 0 |
| ES | C2.3 | 3 | 1,564,115 | 8,566,879 | 2,449,886 | 233% | Based on No main retailers and generators, High/Low set equal due to lack of observations | 19,989,384 | 19,989,384 | 19,989,384 |
| PT | C2.3 | 1 | 0 | 0 | 0 | 0% | Reported costs are very small and not seen as representative - therefore set equal to ISP 15 costs | 6,723,227 | 8,403,200 | 10,571,162 |
| ES | C2.4 | 0 | 0 | 0 | 0 | 0% | No observation - set equal to ISP 15 costs | 61,031,081 | 76,281,282 | 95,961,276 |
| PT | C2.4 | 0 | 0 | 0 | 0 | 0% | No observation - set equal to ISP 15 costs | 13,480,684 | 16,849,183 | 21,196,144 |
| ES | C2.5 | 2 | 5,098,319 | 9,951,020 | 14,954,796 | 350% | 0 | 17,844,118 | 34,828,571 | 52,341,786 |
| PT | C2.5 | 0 | 0 | 0 | 0 | 0% | No observation - set equal to ISP 15 costs | 29,058,326 | 36,319,303 | 45,689,410 |
| ES | C2.6 | 1 | 35,693 | 35,693 | 35,693 | 100% | No scaling | 35,693 | 35,693 | 35,693 |
| PT | C2.6 | 0 | 0 | 0 | 0 | 0% | No observation - set equal to ISP 15 costs | 1,512,043 | 1,889,866 | 2,377,438 |
| ES | C2.7 | 0 | 0 | 0 | 0 | 0% | No observation - set equal to ISP 15 costs | 3,938,387 | 4,922,495 | 6,192,461 |
| PT | C2.7 | 0 | 0 | 0 | 0 | 0% | No observation - set equal to ISP 15 costs | 3,938,387 | 4,922,495 | 6,192,461 |
| ES | C2.8 | 1 | 678,912 | 848,640 | 935,168 | 100% | No scaling | 678,912 | 848,640 | 935,168 |
| PT | C2.8 | 0 | 0 | 0 | 0 | 100% | No gaps filled | 0 | 0 | 0 |
| ES | All | | 54,590,611 | 102,199,746 | 83,899,551 | | | 253,119,918 | 259,098,841 | 350,267,357 |
| PT | All | | 0 | 324,480 | 0 | | | 55,037,146 | 68,708,527 | 86,351,095 |

*Source: Frontier*

*Note: For ISP 30, we only determine costs for Spain and Portugal which are the only affected countries by such a change in our Planning Cases. TN= transmission network, DN = distribution network.*

## A.3 Calculations and results

A.3.1 In this section we show all details of the results and the underlying calculations in table form.

**Exhibit 77. Total scaled up cost number by country in million € (NPV 2019, real terms) - Scenario "Profiling"**

| Country | Current ISP | Change to ISP 30 | | | Change to ISP 15 | | | Change to ISP 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | minutes | Low case | Central case | High case | Low case | Central case | High case | Low case | Central case | High case |
| AT | 15 | | | | | | | 279 | 372 | 468 |
| BE | 15 | | | | | | | 223 | 298 | 375 |
| BG | 60 | | | | 131 | 164 | 206 | 203 | 271 | 341 |
| CH | 15 | | | | | | | 133 | 178 | 223 |
| CY | 60 | | | | 33 | 41 | 52 | 46 | 62 | 78 |
| CZ | 60 | | | | 72 | 90 | 114 | 138 | 184 | 231 |
| DE | 15 | | | | | | | 1,053 | 1,407 | 1,769 |
| DK | 60 | | | | 91 | 113 | 142 | 162 | 217 | 272 |
| EE | 60 | | | | 42 | 52 | 66 | 58 | 77 | 97 |
| EL | 60 | | | | 114 | 143 | 179 | 212 | 283 | 356 |
| ES | 60 | 253 | 259 | 350 | 649 | 811 | 1,020 | 729 | 974 | 1,224 |
| FI | 60 | | | | 84 | 105 | 132 | 121 | 161 | 203 |
| FR | 30 | | | | 151 | 189 | 238 | 306 | 408 | 514 |
| GB | 30 | | | | 597 | 747 | 939 | 1,929 | 2,575 | 3,238 |
| HR | 60 | | | | 65 | 82 | 103 | 67 | 90 | 113 |
| HU | 15 | | | | | | | 152 | 203 | 256 |
| IE | 30 | | | | 71 | 89 | 112 | 97 | 130 | 164 |
| IT | 60 | | | | 212 | 265 | 334 | 264 | 352 | 443 |
| LI | 15 | | | | | | | 36 | 49 | 61 |
| LT | 60 | | | | 118 | 147 | 185 | 156 | 209 | 262 |
| LU | 15 | | | | | | | 68 | 91 | 115 |
| LV | 60 | | | | 37 | 46 | 58 | 51 | 68 | 86 |
| MT | 60 | | | | 30 | 38 | 47 | 40 | 53 | 66 |
| NI | 30 | | | | 36 | 45 | 57 | 53 | 71 | 89 |
| NL | 15 | | | | | | | 70 | 93 | 117 |
| NO | 60 | | | | 67 | 84 | 105 | 112 | 150 | 189 |
| PL | 60 | | | | 230 | 288 | 362 | 426 | 569 | 715 |
| PT | 60 | 55 | 69 | 86 | 58 | 73 | 91 | 107 | 142 | 179 |
| RO | 60 | | | | 97 | 121 | 152 | 141 | 188 | 237 |
| SE | 60 | | | | 45 | 56 | 70 | 57 | 77 | 96 |
| SI | 60 | | | | 12 | 14 | 18 | 21 | 28 | 35 |
| SK | 15 | | | | | | | 99 | 132 | 166 |
| **All** | | **308** | **328** | **437** | **3,042** | **3,802** | **4,783** | **7,609** | **10,162** | **12,778** |

*Source: Frontier*

**Exhibit 78. Total scaled up cost number by country in € per retail customer (NPV 2019, real terms) - Scenario "Unadjusted stakeholder data"**

| Country | Current ISP | Change to ISP 30 | | | Change to ISP 15 | | | Change to ISP 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | minutes | Low case | Central case | High case | Low case | Central case | High case | Low case | Central case | High case |
| AT | 15 | | | | | | | 234 | 313 | 393 |
| BE | 15 | | | | | | | 223 | 298 | 375 |
| BG | 60 | | | | 136 | 170 | 214 | 166 | 221 | 278 |
| CH | 15 | | | | | | | 99 | 132 | 166 |
| CY | 60 | | | | 34 | 42 | 53 | 42 | 56 | 71 |
| CZ | 60 | | | | 78 | 97 | 122 | 93 | 125 | 157 |
| DE | 15 | | | | | | | 679 | 907 | 1,140 |
| DK | 60 | | | | 221 | 277 | 348 | 620 | 828 | 1,041 |
| EE | 60 | | | | 42 | 53 | 67 | 53 | 70 | 88 |
| EL | 60 | | | | 122 | 152 | 191 | 150 | 200 | 252 |
| ES | 60 | 253 | 259 | 350 | 649 | 811 | 1,020 | 4,010 | 5,355 | 6,734 |
| FI | 60 | | | | 168 | 210 | 264 | 364 | 486 | 612 |
| FR | 30 | | | | 151 | 189 | 238 | 306 | 408 | 514 |
| GB | 30 | | | | 1,471 | 1,838 | 2,312 | 1,929 | 2,575 | 3,238 |
| HR | 60 | | | | 65 | 82 | 103 | 67 | 90 | 113 |
| HU | 15 | | | | | | | 110 | 147 | 185 |
| IE | 30 | | | | 73 | 91 | 115 | 80 | 107 | 135 |
| IT | 60 | | | | 212 | 265 | 334 | 264 | 352 | 443 |
| LI | 15 | | | | | | | 36 | 48 | 61 |
| LT | 60 | | | | 119 | 149 | 187 | 144 | 193 | 242 |
| LU | 15 | | | | | | | 66 | 88 | 111 |
| LV | 60 | | | | 105 | 131 | 165 | 183 | 245 | 308 |
| MT | 60 | | | | 30 | 38 | 48 | 38 | 51 | 64 |
| NI | 30 | | | | 37 | 46 | 58 | 46 | 62 | 78 |
| NL | 15 | | | | | | | 70 | 93 | 117 |
| NO | 60 | | | | 53 | 66 | 83 | 76 | 101 | 127 |
| PL | 60 | | | | 246 | 307 | 386 | 301 | 402 | 505 |
| PT | 60 | 55 | 69 | 86 | 58 | 73 | 91 | 107 | 142 | 179 |
| RO | 60 | | | | 99 | 124 | 156 | 121 | 161 | 203 |
| SE | 60 | | | | 45 | 56 | 70 | 57 | 77 | 96 |
| SI | 60 | | | | 12 | 15 | 19 | 14 | 19 | 24 |
| SK | 15 | | | | | | | 80 | 107 | 135 |
| **All** | | **308** | **328** | **437** | **4,226** | **5,282** | **6,644** | **10,830** | **14,462** | **18,186** |

*Source: Frontier*

## Exhibit 79. Detailed results for line item 2.1 (trading platforms) for ISP 5 and ISP 15 (NPV 2019, € real terms)

| Country | Step 1 - Reported Totex (NPV) | | Main scale variable | Step 2 - Scaling factor - within-sample | | | Step 3 - Scaling factor to fill gaps | | | Results - Totex | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISP 15 (central case) | ISP 5 (central case) | | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) |
| AT | 0 | 26,637,543 | | 0% | 100% | | none | none | | **0** | **26,637,543** |
| BE | 0 | 1,252,766 | | 0% | 100% | | none | none | | **0** | **1,252,766** |
| BG | 0 | 0 | | 0% | 0% | | 100% | 100% | | **10,052,072** | **11,419,430** |
| CH | 0 | 0 | | 0% | 0% | | none | 100% | | **0** | **11,419,430** |
| CY | 0 | 0 | | 0% | 0% | | 100% | 100% | | **10,052,072** | **11,419,430** |
| CZ | 2,925,590 | 3,150,058 | | 100% | 100% | | none | none | | **2,925,590** | **3,150,058** |
| DE | 0 | 600,900 | | 0% | 100% | | none | none | | **0** | **600,900** |
| DK | 696,904 | 0 | | 100% | 0% | | none | 100% | | **696,904** | **11,419,430** |
| EE | 0 | 0 | | 0% | 0% | | 100% | 100% | | **10,052,072** | **11,419,430** |
| EL | 0 | 0 | | 0% | 0% | | 100% | 100% | | **10,052,072** | **11,419,430** |
| ES | 19,015,606 | 19,266,560 | | 100% | 100% | | none | none | | **19,015,606** | **19,266,560** |
| FI | 31,226,414 | 32,054,538 | | 100% | 100% | | none | none | | **31,226,414** | **32,054,538** |
| FR | 862,242 | 1,381,141 | | 100% | 100% | | none | none | | **862,242** | **1,381,141** |
| GB | 46,454,067 | 65,403,869 | | 100% | 100% | | none | none | | **46,454,067** | **65,403,869** |
| HR | 34,611 | 151,424 | | 100% | 100% | No scaling up - where available observations are treated as fully representative | none | none | Uniform scaling (i.e. sample average is applied) | **34,611** | **151,424** |
| HU | 0 | 4,898,601 | None | 0% | 100% | | none | none | | **0** | **4,898,601** |
| IE | 3,118,800 | 4,158,401 | | 100% | 100% | | none | none | | **3,118,800** | **4,158,401** |
| IT | 18,113,252 | 0 | | 100% | 0% | | none | 100% | | **18,113,252** | **11,419,430** |
| LI | 0 | 0 | | 0% | 0% | | none | 100% | | **0** | **11,419,430** |
| LT | 0 | 0 | | 0% | 0% | | 100% | 100% | | **10,052,072** | **11,419,430** |
| LU | 0 | 0 | | 0% | 0% | | none | 100% | | **0** | **11,419,430** |
| LV | 0 | 0 | | 0% | 0% | | 100% | 100% | | **10,052,072** | **11,419,430** |
| MT | 0 | 0 | | 0% | 0% | | 100% | 100% | | **10,052,072** | **11,419,430** |
| NI | 0 | 0 | | 0% | 0% | | 100% | 100% | | **10,052,072** | **11,419,430** |
| NL | 0 | 3,058,575 | | 0% | 100% | | none | none | | **0** | **3,058,575** |
| NO | 4,916,864 | 7,300,296 | | 100% | 100% | | none | none | | **4,916,864** | **7,300,296** |
| PL | 0 | 0 | | 0% | 0% | | 100% | 100% | | **10,052,072** | **11,419,430** |
| PT | 324,480 | 324,480 | | 100% | 100% | | none | none | | **324,480** | **324,480** |
| RO | 0 | 0 | | 0% | 0% | | 100% | 100% | | **10,052,072** | **11,419,430** |
| SE | 2,966,473 | 2,954,917 | | 100% | 100% | | none | none | | **2,966,473** | **2,966,473** |
| SI | 21,632 | 122,573 | | 100% | 100% | | none | none | | **21,632** | **122,573** |
| SK | 0 | 25,430,821 | | 0% | 100% | | none | none | | **0** | **25,430,821** |
| **All** | **130,676,937** | **198,147,464** | | **13** | **17** | | | | | **231,197,657** | **369,450,475** |

*Source: Frontier*

**Exhibit 80. Detailed results for line item 2.2 (metering and notification systems) for the transmission network (NPV 2019, € real terms)**

| Country | Step 1 - Reported Totex (NPV) | | Main scale variable | Step 2 - Scaling factor - within-sample | | | Step 3 - Scaling factor to fill gaps | | | Results - Totex | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISP 15 (central case) | ISP 5 (central case) | No. of retail customers | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) |
| AT | 0 | 26,637,543 | 5,870,000 | 0% | 100% | | none | none | | **0** | **26,637,543** |
| BE | 0 | 36,126,503 | 5,243,796 | 0% | 100% | | none | none | | **0** | **36,126,503** |
| BG | 0 | 0 | 4,915,497 | 0% | 0% | | 43% | 57% | | **5,779,539** | **8,144,033** |
| CH | 0 | 3,922,135 | 4,500,000 | 0% | 100% | | none | none | | **0** | **3,922,135** |
| CY | 0 | 0 | 535,050 | 0% | 0% | | 5% | 6% | | **629,101** | **886,475** |
| CZ | 88,053 | 992,608 | 5,837,119 | 100% | 100% | | none | none | | **88,053** | **992,608** |
| DE | 0 | 2,601,493 | 49,294,962 | 0% | 100% | | none | none | | **0** | **2,601,493** |
| DK | 0 | 0 | 3,277,000 | 0% | 0% | | 29% | 38% | | **3,853,029** | **5,429,359** |
| EE | 0 | 0 | 652,000 | 0% | 0% | | 6% | 8% | | **766,608** | **1,080,239** |
| EL | 0 | 0 | 8,195,725 | 0% | 0% | | 72% | 95% | | **9,636,363** | **13,578,740** |
| ES | 13,132,474 | 13,132,474 | 27,786,798 | 100% | 100% | | none | none | | **13,132,474** | **13,132,474** |
| FI | 14,198,060 | 29,090,870 | 3,309,146 | 100% | 100% | | none | none | | **14,198,060** | **29,090,870** |
| FR | 89,323,779 | 0 | 33,999,393 | 100% | 0% | | none | 392% | | **89,323,779** | **56,330,453** |
| GB | 0 | 0 | 29,949,462 | 0% | 0% | | 262% | 346% | | **35,213,957** | **49,620,497** |
| HR | 0 | 0 | 1,860,921 | 0% | 0% | No scaling up - where available observations are treated as fully representative | 16% | 21% | Scaling by the number of retail customers (source: Eurelectric) | **2,188,033** | **3,083,189** |
| HU | 0 | 2,564,897 | 5,527,463 | 0% | 100% | | none | none | | **0** | **2,564,897** |
| IE | 6,757,401 | 7,797,001 | 2,237,232 | 100% | 100% | | none | none | | **6,757,401** | **7,797,001** |
| IT | 50,000 | 0 | 31,423,623 | 100% | 0% | | none | 363% | | **50,000** | **52,062,898** |
| LI | 0 | 0 | 18,958 | 0% | 0% | | none | 0% | | **0** | **31,410** |
| LT | 0 | 0 | 1,571,789 | 0% | 0% | | 14% | 18% | | **1,848,077** | **2,604,152** |
| LU | 0 | 0 | 275,175 | 0% | 0% | | none | 3% | | **0** | **455,912** |
| LV | 1,186,677 | 1,186,677 | 873,856 | 100% | 100% | | none | none | | **1,186,677** | **1,186,677** |
| MT | 0 | 0 | 183,777 | 0% | 0% | | 2% | 2% | | **216,081** | **304,482** |
| NI | 0 | 0 | 878,804 | 0% | 0% | | 8% | 10% | | **1,033,279** | **1,456,008** |
| NL | 0 | 6,243,200 | 8,110,000 | 0% | 100% | | none | none | | **0** | **6,243,200** |
| NO | 9,529,301 | 14,293,951 | 2,747,253 | 100% | 100% | | none | none | | **9,529,301** | **14,293,951** |
| PL | 0 | 0 | 16,478,000 | 0% | 0% | | 144% | 190% | | **19,374,491** | **27,300,876** |
| PT | 0 | 0 | 6,137,611 | 0% | 0% | | 54% | 71% | | **7,216,476** | **10,168,841** |
| RO | 0 | 0 | 2,639,318 | 0% | 0% | | 23% | 30% | | **3,103,255** | **4,372,842** |
| SE | 244,520 | 355,666 | 5,309,000 | 100% | 100% | | none | none | | **244,520** | **355,666** |
| SI | 56,137 | 129,137 | 925,275 | 100% | 100% | | none | none | | **56,137** | **129,137** |
| SK | 0 | 9,588,053 | 2,392,418 | 0% | 100% | | none | none | | **0** | **9,588,053** |
| **All** | **134,566,401** | **154,662,208** | | **10** | **15** | | | | | **225,424,689** | **391,572,612** |

*Source: Frontier*

## Exhibit 81. Detailed results for line item 2.2 (metering and notification systems) for the distribution network in scenario "Profiling" (NPV 2019, € real terms)

| Country | Step 1 - Reported Totex (NPV) | | Main scale variable | Step 2 - Scaling factor - within-sample | | | Step 3 - Scaling to fill gaps | | | Results - Totex | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISP 15 (central case) | ISP 5 (central case) | No. of retail customers | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) | Source/ comment | ISP 15 (central case) | ISP 5 (central case) |
| AT | 0 | 0 | 5,870,000 | 0% | 0% | | none | average of 8 €/customer | sample average applied to number of retail customers (source: Eurelectric) | 0 | 46,777,171 |
| BE | 0 | 192,998,407 | 5,243,796 | 0% | 100% | No upscaling necessary since TSO provides system level data | none | none | | 0 | 192,998,407 |
| BG | 0 | 0 | 4,915,497 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 39,170,877 | 39,170,877 |
| CH | 0 | 0 | 4,500,000 | 0% | 0% | | none | average of 8 €/customer | | 0 | 35,859,842 |
| CY | 0 | 0 | 535,050 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 4,263,735 | 4,263,735 |
| CZ | 494,611 | 494,611 | 5,837,119 | 0% | 0% | Very small observation, not seen as representative | average of 8 €/customer | average of 8 €/customer | | 46,515,147 | 46,515,147 |
| DE | 0 | 0 | 49,294,962 | 0% | 0% | | none | average of 8 €/customer | | 0 | 392,824,341 |
| DK | 185,757,006 | 670,878,755 | 3,277,000 | 100% | 100% | No upscaling necessary since TSO provides system level data | average of 8 €/customer | average of 8 €/customer | | 26,113,934 | 26,113,934 |
| EE | 0 | 0 | 652,000 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 5,195,693 | 5,195,693 |
| EL | 0 | 0 | 8,195,725 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 65,310,534 | 65,310,534 |
| ES | 259,400,216 | 2,146,123,141 | 27,786,798 | 228% | 228% | Total connected customers in ES devided by total meters of reporting DSO | average of 8 €/customer | average of 8 €/customer | | 590,434,680 | 590,434,680 |
| FI | 114,728,399 | 346,772,029 | 3,309,146 | 111% | 111% | 14 DSOs, including larger ones, assumed to be 90% representative | average of 8 €/customer | average of 8 €/customer | | 26,370,100 | 26,370,100 |
| FR | 2,360,515 | 13,258,531 | 33,999,393 | 500% | 500% | No of large DSOs (source: Eurelectric) devided by number of observations | average of 8 €/customer | average of 8 €/customer | | 11,802,577 | 66,292,654 |
| GB | 1,295,279,871 | 1,782,225,473 | 29,949,462 | 100% | 100% | 100% representitive (one stakeholder provides system level data) | average of 8 €/customer | average of 8 €/customer | | 238,662,885 | 238,662,885 |
| HR | 46,941,440 | 46,941,440 | 1,860,921 | 100% | 100% | No upscaling necessary since single DSO provides system level data | none | none | | 46,941,440 | 46,941,440 |
| HU | 0 | 0 | 5,527,463 | 0% | 0% | | none | average of 8 €/customer | | 0 | 44,047,544 |
| IE | 0 | 0 | 2,237,232 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 17,828,175 | 17,828,175 |
| IT | 23,269,687 | 0 | 31,423,623 | 105% | 0% | 1 devided by market share of 95% for responding DSO | average of 8 €/customer | average of 8 €/customer | | 24,494,407 | 24,494,407 |
| LI | 0 | 0 | 18,958 | 0% | 0% | | none | average of 8 €/customer | | 0 | 151,077 |
| LT | 0 | 0 | 1,571,789 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 12,525,357 | 12,525,357 |
| LU | 0 | 0 | 275,175 | 0% | 0% | | none | average of 8 €/customer | | 0 | 2,192,827 |
| LV | 90,895,310 | 191,971,994 | 873,856 | 100% | 100% | No upscaling necessary since TSO provides system level data | none | none | | 90,895,310 | 191,971,994 |
| MT | 0 | 0 | 183,777 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 1,464,488 | 1,464,488 |
| NI | 0 | 0 | 878,804 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 7,003,057 | 7,003,057 |
| NL | 0 | 35,958,898 | 8,110,000 | 0% | 156% | 1 devided by market share of 64% for two responding DSOs | none | average of 8 €/customer | | 0 | 56,185,778 |
| NO | 636,480 | 0 | 2,747,253 | 100% | 100% | Reported costs , no upsaling due since no significant cost expected by TSO | average of 8 €/customer | average of 8 €/customer | | 21,892,455 | 21,892,455 |
| PL | 0 | 0 | 16,478,000 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 131,310,771 | 131,310,771 |
| PT | 0 | 31,428,160 | 6,137,611 | 100% | 100% | No upscaling necessary since TSO provides system level data | none | none | | 0 | 31,428,160 |
| RO | 0 | 0 | 2,639,318 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 21,032,339 | 21,032,339 |
| SE | 8,330,438 | 5,460,714 | 5,309,000 | 111% | 111% | 7 observations assumed to be 90% representative | average of 8 €/customer | average of 8 €/customer | | 42,306,644 | 42,306,644 |
| SI | 0 | 0 | 925,275 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 7,373,381 | 7,373,381 |
| SK | 0 | 0 | 2,392,418 | 0% | 0% | | none | average of 8 €/customer | | 0 | 19,064,829 |
| All | 2,028,093,972 | 5,464,512,151 | | 17 | 18 | 0 | | | | 1,478,907,985 | 2,456,004,722 |

*Source: Frontier*

## Exhibit 82. Detailed results for line item 2.2 (metering and notification systems) for the distribution network in scenario “Unadjusted stakeholder data” (NPV 2019, € real terms)

| Country | Step 1 - Reported Totex (NPV) | | Main scale variable | Step 2 - Scaling factor - within-sample | | | Step 3 - Scaling to fill gaps | | | Results - Totex | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISP 15 (central case) | ISP 5 (central case) | No. of retail customers | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) | Source/ comment | ISP 15 (central case) | ISP 5 (central case) |
| AT | 0 | 0 | 5,870,000 | 0% | 0% | | none | average of 8 €/customer | | 0 | 46,777,171 |
| BE | 0 | 192,998,407 | 5,243,796 | 0% | 100% | No upscaling necessary since TSO provides system level data | none | none | | 0 | 192,998,407 |
| BG | 0 | 0 | 4,915,497 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 39,170,877 | 39,170,877 |
| CH | 0 | 0 | 4,500,000 | 0% | 0% | | none | average of 8 €/customer | | 0 | 35,859,842 |
| CY | 0 | 0 | 535,050 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 4,263,735 | 4,263,735 |
| CZ | 494,611 | 494,611 | 5,837,119 | 0% | 0% | Very small observation, not seen as representative | average of 8 €/customer | average of 8 €/customer | | 46,515,147 | 46,515,147 |
| DE | 0 | 0 | 49,294,962 | 0% | 0% | | none | average of 8 €/customer | | 0 | 392,824,341 |
| DK | 185,757,006 | 670,878,755 | 3,277,000 | 100% | 100% | No upscaling necessary since TSO provides system level data | none | none | | 185,757,006 | 670,878,755 |
| EE | 0 | 0 | 652,000 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 5,195,693 | 5,195,693 |
| EL | 0 | 0 | 8,195,725 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 65,310,534 | 65,310,534 |
| ES | 259,400,216 | 2,146,123,141 | 27,786,798 | 228% | 228% | Total connected customers in ES devided by total meters of reporting DSO | average of 8 €/customer | average of 8 €/customer | | 590,434,680 | 4,884,905,456 |
| FI | 114,728,399 | 346,772,029 | 3,309,146 | 111% | 111% | 14 DSOs, including larger ones, assumed to be 90% representative | average of 8 €/customer | average of 8 €/customer | | 127,475,999 | 385,302,254 |
| FR | 2,360,515 | 13,258,531 | 33,999,393 | 500% | 500% | No of large DSOs (source: Eurelectric) devided by number of observations | average of 8 €/customer | average of 8 €/customer | | 11,802,577 | 66,292,654 |
| GB | 1,295,279,871 | 1,782,225,473 | 29,949,462 | 100% | 100% | 100% representitive (one stakeholder provides system level data) | none | none | | 1,295,279,871 | 1,782,225,473 |
| HR | 46,941,440 | 46,941,440 | 1,860,921 | 100% | 100% | No upscaling necessary since single DSO provides system level data | none | none | sample average applied to number of retail customers (source: Eurelectric) | 46,941,440 | 46,941,440 |
| HU | 0 | 0 | 5,527,463 | 0% | 0% | | none | average of 8 €/customer | | 0 | 44,047,544 |
| IE | 0 | 0 | 2,237,232 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 17,828,175 | 17,828,175 |
| IT | 23,269,687 | 0 | 31,423,623 | 105% | 0% | 1 devided by market share of 95% for responding DSO | average of 8 €/customer | average of 8 €/customer | | 24,494,407 | 24,494,407 |
| LI | 0 | 0 | 18,958 | 0% | 0% | | none | average of 8 €/customer | | 0 | 151,077 |
| LT | 0 | 0 | 1,571,789 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 12,525,357 | 12,525,357 |
| LU | 0 | 0 | 275,175 | 0% | 0% | | none | average of 8 €/customer | | 0 | 2,192,827 |
| LV | 90,895,310 | 191,971,994 | 873,856 | 100% | 100% | No upscaling necessary since TSO provides system level data | none | none | | 90,895,310 | 191,971,994 |
| MT | 0 | 0 | 183,777 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 1,464,488 | 1,464,488 |
| NI | 0 | 0 | 878,804 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 7,003,057 | 7,003,057 |
| NL | 0 | 35,958,898 | 8,110,000 | 0% | 156% | 1 devided by market share of 64% for two responding DSOs | none | average of 8 €/customer | | 0 | 56,185,778 |
| NO | 636,480 | 0 | 2,747,253 | 100% | 100% | Reported costs , no upsaling due since no significant cost expected by TSO | none | average of 8 €/customer | | 636,480 | 636,480 |
| PL | 0 | 0 | 16,478,000 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 131,310,771 | 131,310,771 |
| PT | 0 | 31,428,160 | 6,137,611 | 100% | 100% | No upscaling necessary since TSO provides system level data | none | none | | 0 | 31,428,160 |
| RO | 0 | 0 | 2,639,318 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 21,032,339 | 21,032,339 |
| SE | 8,330,438 | 5,460,714 | 5,309,000 | 111% | 111% | 7 observations assumed to be 90% representative | average of 8 €/customer | average of 8 €/customer | | 9,256,042 | 9,256,042 |
| SI | 0 | 0 | 925,275 | 0% | 0% | | average of 8 €/customer | average of 8 €/customer | | 7,373,381 | 7,373,381 |
| SK | 0 | 0 | 2,392,418 | 0% | 0% | | none | average of 8 €/customer | | 0 | 19,064,829 |
| All | 2,028,093,972 | 5,464,512,151 | | 17 | 18 | 0 | | | | 2,741,967,365 | 9,243,428,484 |

*Source: Frontier*

# Exhibit 83. Detailed results for line item 2.3 (scheduling and settlement) (NPV 2019, € real terms)

| Country | Step 1 - Reported Totex (NPV) | | Main scale variable | Step 2 - Scaling factor - within-sample | | | Step 3 - Scaling factor to fill gaps | | | Results - Totex | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISP 15 (central case) | ISP 5 (central case) | No. of large retailers and generators | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) |
| AT | 0 | 26,637,543 | 11 | 0% | 100% | No upscaling necessary since TSO provides system level data | none | none | Based on number of large retailers and generators | 0 | 26,637,543 |
| BE | 0 | 7,929,654 | 6 | 0% | 300% | | none | none | | 0 | 23,788,963 |
| BG | 0 | 0 | 10 | 0% | 0% | | 136% | 134% | | 49,029,163 | 66,841,512 |
| CH | 0 | 1,772,362 | 6 | 0% | 600% | | none | none | | 0 | 10,634,173 |
| CY | 0 | 0 | 2 | 0% | 0% | | 27% | 27% | | 9,805,833 | 13,368,302 |
| CZ | 2,970,193 | 3,423,171 | 5 | 167% | 167% | | none | none | | 4,950,321 | 5,705,285 |
| DE | 0 | 21,779,794 | 8 | 0% | 800% | | none | none | | 0 | 174,238,350 |
| DK | 3,484,522 | 0 | 9 | 900% | 0% | | none | 121% | | 31,360,698 | 60,157,361 |
| EE | 0 | 0 | 3 | 0% | 0% | | 41% | 40% | | 14,708,749 | 20,052,454 |
| EL | 0 | 0 | 4 | 0% | 0% | | 54% | 54% | | 19,611,665 | 26,736,605 |
| ES | 8,620,730 | 8,647,655 | 7 | 233% | 233% | | none | none | | 20,115,036 | 20,177,863 |
| FI | 15,633,265 | 13,704,951 | 7 | 100% | 100% | | none | none | | 15,633,265 | 15,633,265 |
| FR | 26,749,135 | 41,660,112 | 4 | 133% | 100% | | none | none | | 35,665,513 | 41,660,112 |
| GB | 183,614,782 | 242,604,482 | 13 | 100% | 118% | Set at 100% since number of observations exceeds scale variable | none | none | | 183,614,782 | 286,714,388 |
| HR | 1,318,228 | 1,318,228 | 5 | 250% | 250% | | none | none | | 3,295,569 | 3,295,569 |
| HU | 0 | 5,442,890 | 8 | 0% | 800% | | none | none | | 0 | 43,543,123 |
| IE | 1,039,600 | 1,039,600 | 10 | 1000% | 1000% | | none | none | | 10,396,002 | 10,396,002 |
| IT | 30,295,615 | 0 | 5 | 250% | 0% | | none | 67% | | 75,739,039 | 33,420,756 |
| LI | 0 | 0 | 2 | 0% | 0% | | none | 27% | | 0 | 13,368,302 |
| LT | 0 | 0 | 12 | 0% | 0% | | 163% | 161% | | 58,834,995 | 80,209,815 |
| LU | 0 | 0 | 5 | 0% | 0% | | none | 67% | | 0 | 33,420,756 |
| LV | 2,341,769 | 2,341,769 | 3 | 300% | 300% | | none | none | | 7,025,308 | 7,025,308 |
| MT | 0 | 0 | 2 | 0% | 0% | | 27% | 27% | | 9,805,833 | 13,368,302 |
| NI | 0 | 0 | 2 | 0% | 0% | | 27% | 27% | | 9,805,833 | 13,368,302 |
| NL | 0 | 3,791,095 | 7 | 0% | 233% | | none | none | | 0 | 8,845,889 |
| NO | 436,718 | 590,077 | 9 | 450% | 450% | | none | none | | 1,965,232 | 2,655,348 |
| PL | 0 | 0 | 10 | 0% | 0% | | 136% | 134% | | 49,029,163 | 66,841,512 |
| PT | 644,800 | 1,050,400 | 8 | 800% | 800% | | none | none | | 5,158,400 | 8,403,200 |
| RO | 0 | 0 | 8 | 0% | 0% | | 109% | 107% | | 39,223,330 | 53,473,210 |
| SE | 2,389,291 | 743,235 | 7 | 117% | 175% | | none | none | | 2,787,506 | 2,787,506 |
| SI | 492,461 | 492,461 | 11 | 550% | 550% | | none | none | | 2,708,537 | 2,708,537 |
| SK | 0 | 0 | 5 | 0% | 0% | | none | 67% | | 0 | 33,420,756 |
| All | 280,031,109 | 384,969,482 | | 4 | 4 | | 7 | 7 | | 660,269,770 | 1,222,898,370 |

*Source: Frontier*



DRAFT

## Exhibit 84. Detailed results for line item 2.4 (billing systems) (NPV 2019, € real terms)

| Country | Step 1 - Reported Totex (NPV) | | Main scale variable | Step 2 - Scaling factor - within-sample | | | Step 3 - Scaling factor to fill gaps | | | Results - Totex | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISP 15 (central case) | ISP 5 (central case) | No. of retail customers | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) |
| AT | 0 | 0 | 5,870,000 | 0% | 0% | | none | 89% | | **0** | **35,285,998** |
| BE | 0 | 10,405,333 | 5,243,796 | 0% | 208% | Based on market share of retailer | none | none | | **0** | **21,677,778** |
| BG | 0 | 0 | 4,915,497 | 0% | 0% | | 40% | 74% | | **13,494,193** | **29,548,249** |
| CH | 0 | 140,090 | 4,500,000 | 0% | 0% | | none | 68% | | **0** | **27,050,595** |
| CY | 0 | 0 | 535,050 | 0% | 0% | | 4% | 8% | | **1,468,838** | **3,216,316** |
| CZ | 356,981 | 356,981 | 5,837,119 | 0% | 0% | | 47% | 88% | | **16,024,262** | **35,088,343** |
| DE | 0 | 5,339,267 | 49,294,962 | 0% | 0% | | none | 744% | | **0** | **296,324,012** |
| DK | 139,381 | 0 | 3,277,000 | 0% | 0% | Observation too small, no ISP meter values provided which could be used | 26% | 49% | | **8,996,134** | **19,698,844** |
| EE | 0 | 0 | 652,000 | 0% | 0% | | 5% | 10% | | **1,789,893** | **3,919,331** |
| EL | 0 | 0 | 8,195,725 | 0% | 0% | | 66% | 124% | | **22,499,189** | **49,266,497** |
| ES | 0 | 0 | 27,786,798 | 0% | 0% | | 224% | 419% | | **76,281,282** | **167,033,204** |
| FI | 12,758,782 | 12,978,733 | 3,309,146 | 119% | 119% | Based on number of ISP meters provided by respondents in 0.8.2 | none | none | | **15,131,830** | **15,506,802** |
| FR | 27,597,689 | 6,249,682 | 33,999,393 | 100% | 0% | 100% coverage for ISP 15, for ISP 5 no scaling variable available by single respondent | none | 513% | | **27,597,689** | **204,378,625** |
| GB | 144,249,830 | 237,619,641 | 29,949,462 | 111% | 111% | All major players have reported values. Assumption: 90% coverage | none | none | | **160,277,589** | **264,021,823** |
| HR | 21,632,000 | 21,632,000 | 1,860,921 | 111% | 111% | Based on retail market share of >90% by respondent | none | none | | **24,035,556** | **24,035,556** |
| HU | 0 | 54,429 | 5,527,463 | 0% | 0% | Observation too small, no ISP meter value | none | 83% | Based on number of retail customers | **0** | **33,226,925** |
| IE | 831,680 | 831,680 | 2,237,232 | 100% | 100% | TSO data (also covering 2.5), no upscaling | none | none | | **831,680** | **831,680** |
| IT | 8,742,830 | 0 | 31,423,623 | 493% | 0% | Based on retail market share of c. 20% in the "free market" by respondent | none | 474% | | **43,068,127** | **188,895,045** |
| LI | 0 | 0 | 18,958 | 0% | 0% | | none | 0% | | **0** | **113,963** |
| LT | 0 | 0 | 1,571,789 | 0% | 0% | | 13% | 24% | | **4,314,930** | **9,448,406** |
| LU | 0 | 0 | 275,175 | 0% | 0% | | none | 4% | | **0** | **1,654,142** |
| LV | 1,170,885 | 1,170,885 | 873,856 | 100% | 100% | TSO data, no upscaling. | none | none | | **1,170,885** | **1,170,885** |
| MT | 0 | 0 | 183,777 | 0% | 0% | | 1% | 3% | | **504,510** | **1,104,726** |
| NI | 0 | 0 | 878,804 | 0% | 0% | | 7% | 13% | | **2,412,522** | **5,282,702** |
| NL | 0 | 887,575 | 8,110,000 | 0% | 385% | Based on retail market share of c. 26% of respondent | none | none | | **0** | **3,413,751** |
| NO | 694,310 | 786,465 | 2,747,253 | 2500% | 2500% | Based on retail market share of c. 4% of respondent | none | none | | **17,357,744** | **19,661,617** |
| PL | 0 | 0 | 16,478,000 | 0% | 0% | | 133% | 249% | | **45,235,977** | **99,053,268** |
| PT | 0 | 0 | 6,137,611 | 0% | 0% | | 49% | 93% | | **16,849,183** | **36,894,673** |
| RO | 0 | 0 | 2,639,318 | 0% | 0% | | 21% | 40% | | **7,245,547** | **15,865,583** |
| SE | 2,063,851 | 2,063,850 | 5,309,000 | 833% | 833% | Based on retail market share of > 12% of respondents | none | none | | **17,198,756** | **17,198,756** |
| SI | 0 | 0 | 925,275 | 0% | 0% | | 7% | 14% | | **2,540,097** | **5,562,053** |
| SK | 0 | 0 | 2,392,418 | 0% | 0% | | none | 36% | | **0** | **14,381,407** |
| **All** | **220,238,217** | **300,516,611** | | | | | | | | **526,326,410** | **1,649,811,554** |

*Source: Frontier*

## Exhibit 85. Detailed results for line item 2.5 (BRP forecasting, trading and scheduling) (NPV 2019, € real terms)

| Country | Step 1 - Reported Totex (NPV) | | Main scale variable | Step 2 - Scaling factor - within-sample | | | Step 3 - Scaling factor to fill gaps | | | Results - Totex | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISP 15 (central case) | ISP 5 (central case) | No. of large retailers and generators | ISP 15 (central case) | ISP 5 (central case) | Based on number of observations in relation to number of large retailers and generators | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) |
| AT | 0 | 0 | 11 | 0% | 0% | | none | 151% | | 0 | 58,653,035 |
| BE | 0 | 5,619,645 | 6 | 0% | 300% | | none | none | | 0 | 16,858,936 |
| BG | 0 | 0 | 10 | 0% | 0% | | 132% | 137% | | 45,399,129 | 53,320,941 |
| CH | 0 | 0 | 6 | 0% | 0% | | none | 82% | | 0 | 31,992,565 |
| CY | 0 | 0 | 2 | 0% | 0% | | 26% | 27% | | 9,079,826 | 10,664,188 |
| CZ | 0 | 0 | 5 | 0% | 0% | | 66% | 69% | | 22,699,565 | 26,660,471 |
| DE | 0 | 851,534 | 8 | 0% | 800% | | none | none | | 0 | 6,812,274 |
| DK | 0 | 0 | 9 | 0% | 0% | | 119% | 124% | | 40,859,216 | 47,988,847 |
| EE | 0 | 0 | 3 | 0% | 0% | | 40% | 41% | | 13,619,739 | 15,996,282 |
| EL | 0 | 0 | 4 | 0% | 0% | | 53% | 55% | | 18,159,652 | 21,328,377 |
| ES | 24,645,047 | 68,245,022 | 7 | 350% | 350% | | none | none | | 86,257,666 | 238,857,576 |
| FI | 2,324,142 | 2,527,226 | 7 | 117% | 117% | | none | none | | 2,711,500 | 2,948,430 |
| FR | 2,144,171 | 8,445,727 | 4 | 200% | 200% | | none | none | | 4,288,343 | 16,891,453 |
| GB | 62,132,050 | 20,728,092 | 13 | 118% | 144% | | none | none | | 73,428,786 | 73,428,786 |
| HR | 77,875 | 542,963 | 5 | 250% | 250% | | none | none | | 194,688 | 1,357,408 |
| HU | 0 | 2,177,156 | 8 | 0% | 800% | Based on number of observations in relation to number of large retailers and generators | none | none | Based on number of large retailers and generators | 0 | 17,417,249 |
| IE | 0 | 0 | 10 | 0% | 0% | | 132% | 137% | | 45,399,129 | 53,320,941 |
| IT | 18,823,597 | 0 | 5 | 500% | 0% | | none | 69% | | 94,117,986 | 26,660,471 |
| LI | 0 | 0 | 2 | 0% | 0% | | none | 27% | | 0 | 10,664,188 |
| LT | 0 | 0 | 12 | 0% | 0% | | 159% | 165% | | 54,478,955 | 63,985,130 |
| LU | 0 | 0 | 5 | 0% | 0% | | none | 69% | | 0 | 26,660,471 |
| LV | 0 | 0 | 3 | 0% | 0% | | 40% | 41% | | 13,619,739 | 15,996,282 |
| MT | 0 | 0 | 2 | 0% | 0% | | 26% | 27% | | 9,079,826 | 10,664,188 |
| NI | 0 | 0 | 2 | 0% | 0% | | 26% | 27% | | 9,079,826 | 10,664,188 |
| NL | 0 | 328,822 | 7 | 0% | 350% | | none | none | | 0 | 1,150,878 |
| NO | 8,772,950 | 15,095,417 | 9 | 300% | 300% | | none | none | | 26,318,851 | 45,286,251 |
| PL | 0 | 0 | 10 | 0% | 0% | | 132% | 137% | | 45,399,129 | 53,320,941 |
| PT | 0 | 0 | 8 | 0% | 0% | | 106% | 110% | | 36,319,303 | 42,656,753 |
| RO | 0 | 0 | 8 | 0% | 0% | | 106% | 110% | | 36,319,303 | 42,656,753 |
| SE | 3,587,736 | 6,631,917 | 7 | 117% | 117% | | none | none | | 4,185,692 | 7,737,237 |
| SI | 2,163 | 2,163 | 11 | 1100% | 1100% | | none | none | | 23,795 | 23,795 |
| SK | 0 | 212,160 | 5 | 0% | 500% | | none | none | | 0 | 1,060,800 |
| **All** | **122,509,734** | **131,407,845** | **214** | | | | | | | **691,039,645** | **1,053,686,087** |

*Source: Frontier*

## Exhibit 86. Detailed results for line item 2.6 (documentation) (NPV 2019, € real terms)

| Country | Step 1 - Reported Totex (NPV) | | Main scale variable | Step 2 - Scaling factor - within-sample | | | Step 3 - Scaling factor to fill gaps | | | Results - Totex | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISP 15 (central case) | ISP 5 (central case) | | ISP 15 (central case) | ISP 5 (central case) | Based on number of observations in relation to number of large | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) |
| AT | 0 | 0 | | 0% | 0% | | none | 100% | | **0** | **1,593,992** |
| BE | 0 | 1,040,533 | | 0% | 100% | | none | none | | **0** | **1,040,533** |
| BG | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| CH | 0 | 58,058 | | 0% | 100% | | none | none | | **0** | **58,058** |
| CY | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| CZ | 24,215 | 24,215 | | 100% | 100% | | none | none | | **24,215** | **24,215** |
| DE | 0 | 361,410 | | 0% | 100% | | none | none | | **0** | **361,410** |
| DK | 197,088 | 0 | | 100% | 0% | | none | 100% | | **197,088** | **1,593,992** |
| EE | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| EL | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| ES | 35,693 | 35,693 | | 100% | 100% | | none | none | | **35,693** | **35,693** |
| FI | 453,161 | 453,161 | | 100% | 100% | | none | none | | **453,161** | **453,161** |
| FR | 909,498 | 409,498 | | 100% | 100% | | none | none | | **909,498** | **909,498** |
| GB | 15,837,494 | 15,586,598 | | 100% | 100% | | none | none | | **15,837,494** | **15,837,494** |
| HR | 62,425 | 62,425 | | 100% | 100% | | none | none | Uniform scaling (i.e. sample average is applied) | **62,425** | **62,425** |
| HU | 0 | 6,629 | None | 0% | 100% | No scaling up - where available observations are treated as fully representative | none | none | | **0** | **6,629** |
| IE | 1,039,600 | 1,039,600 | | 100% | 100% | | none | none | | **1,039,600** | **1,039,600** |
| IT | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| LI | 0 | 0 | | 0% | 0% | | none | 100% | | **0** | **1,593,992** |
| LT | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| LU | 0 | 0 | | 0% | 0% | | none | 100% | | **0** | **1,593,992** |
| LV | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| MT | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| NI | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| NL | 0 | 3,529,102 | | 0% | 100% | | none | none | | **0** | **3,529,102** |
| NO | 30,968 | 46,452 | | 100% | 100% | | none | none | | **30,968** | **46,452** |
| PL | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| PT | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| RO | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| SE | 308,523 | 148,155 | | 100% | 100% | | none | none | | **308,523** | **308,523** |
| SI | 0 | 0 | | 0% | 0% | | 100% | 100% | | **1,889,866** | **1,593,992** |
| SK | 0 | 0 | | 0% | 0% | | none | 100% | | **0** | **1,593,992** |
| **All** | **18,898,665** | **22,801,529** | | | | | | | | **43,466,929** | **52,404,651** |

*Source: Frontier*

## Exhibit 87. Detailed results for line item 2.7 (network related costs) (NPV 2019, € real terms)

| Country | Step 1 - Reported Totex (NPV) | | Main scale variable | Step 2 - Scaling factor - within-sample | | | Step 3 - Scaling factor to fill gaps | | | Results - Totex | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISP 15 (central case) | ISP 5 (central case) | No. of TSOs | ISP 15 (central case) | ISP 5 (central case) | Based on number of observations in relation to number of large | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) |
| AT | 0 | 63,999,330 | 1 | 0% | 100% | | none | none | | **0** | **63,999,330** |
| BE | 0 | 0 | 1 | 0% | 100% | | none | none | | **0** | **0** |
| BG | 0 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| CH | 0 | 0 | 1 | 0% | 0% | | none | 77% | | **0** | **10,981,937** |
| CY | 0 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| CZ | 2,660,118 | 4,522,199 | 1 | 100% | 100% | | none | none | | **2,660,118** | **4,522,199** |
| DE | 8 | 33,051,865 | 4 | 0% | 100% | | none | none | | **0** | **33,051,865** |
| DK | 0 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| EE | 17 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| EL | 0 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| ES | 25 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| FI | 1,560,834 | 1,560,800 | 1 | 100% | 100% | | none | none | | **1,560,834** | **1,560,834** |
| FR | 16,009,577 | 1,463,866 | 1 | 100% | 100% | | none | none | | **16,009,577** | **16,009,577** |
| GB | 3,540,967 | 3,013,567 | 1 | 100% | 100% | | none | none | | **3,540,967** | **3,593,144** |
| HR | 1 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| HU | 0 | 1,632,867 | 1 | 0% | 100% | No scaling up - where available observations are treated as fully representative | none | none | Based on number of TSOs | **0** | **1,632,867** |
| IE | 0 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| IT | 0 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| LI | 0 | 0 | 1 | 0% | 0% | | none | 77% | | **0** | **10,981,937** |
| LT | 0 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| LU | 0 | 0 | 1 | 0% | 0% | | none | 77% | | **0** | **10,981,937** |
| LV | 4,943,648 | 14,227,300 | 1 | 100% | 100% | | none | none | | **4,943,648** | **14,227,300** |
| MT | 0 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| NI | 0 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| NL | 16 | 0 | 1 | 0% | 0% | | none | 77% | | **0** | **10,981,937** |
| NO | 17 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| PL | 0 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| PT | 8 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| RO | 0 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| SE | 26 | 0 | 1 | 0% | 0% | | 100% | 77% | | **4,922,495** | **10,981,937** |
| SI | 819,824 | 1,293,197 | 1 | 100% | 100% | | none | none | | **819,824** | **1,293,197** |
| SK | 8 | 2,874,872 | 1 | 0% | 100% | | none | none | | **0** | **2,874,872** |
| **All** | **29,535,096** | **127,639,862** | | | | | | | | **113,217,379** | **373,385,866** |

*Source: Frontier*

## Exhibit 88. Detailed results for line item 2.8 (other costs) (NPV 2019, € real terms)

| Country | Step 1 - Reported Totex (NPV) | | Main scale variable | Step 2 - Scaling factor - within-sample | | | Step 3 - Scaling factor to fill gaps | | | Results - Totex | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISP 15 (central case) | ISP 5 (central case) | | ISP 15 (central case) | ISP 5 (central case) | Based on number of observations in relation to number of large | ISP 15 (central case) | ISP 5 (central case) | Source/comment | ISP 15 (central case) | ISP 5 (central case) |
| AT | 0 | 26,637,543 | | 0% | 100% | | none | none | | 0 | 26,637,543 |
| BE | 0 | 4,165,533 | | 0% | 0% | | none | none | | 0 | 4,165,533 |
| BG | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| CH | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| CY | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| CZ | 1,209,354 | 2,152,697 | | 0% | 0% | | none | none | | 1,209,354 | 2,152,697 |
| DE | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| DK | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| EE | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| EL | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| ES | 848,640 | 848,640 | | 0% | 0% | | none | none | | 848,640 | 848,640 |
| FI | 1,551,619 | 3,879,047 | | 0% | 0% | | none | none | | 1,551,619 | 3,879,047 |
| FR | 2,809,440 | 3,697,293 | | 0% | 0% | | none | none | | 2,809,440 | 4,517,733 |
| GB | 24,569,060 | 34,559,969 | | 0% | 0% | | none | none | | 24,569,060 | 34,559,969 |
| HR | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| HU | 0 | 0 | None | 0% | 0% | No scaling up - where available observations are treated as fully representative (2.8 is a residual cost position) | none | none | No scaling up - where available observations are treated as fully representative (2.8 is a residual cost position) | 0 | 0 |
| IE | 1,039,600 | 0 | | 0% | 0% | | none | none | | 1,039,600 | 1,039,600 |
| IT | 2,840,967 | 0 | | 0% | 0% | | none | none | | 2,840,967 | 2,840,967 |
| LI | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| LT | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| LU | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| LV | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| MT | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| NI | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| NL | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| NO | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| PL | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| PT | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| RO | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| SE | 13,841,402 | 24,908,515 | | 0% | 0% | | none | none | | 13,841,402 | 24,908,515 |
| SI | 40,377 | 40,377 | | 0% | 0% | | none | none | | 40,377 | 40,377 |
| SK | 0 | 0 | | 0% | 0% | | none | none | | 0 | 0 |
| All | 48,750,458 | 100,889,614 | | | | | | | | 48,750,458 | 105,590,621 |

*Source: Frontier*

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