BZR CG Meeting

1st September 2022

Reliable Sustainable Connected

Agenda

1. **Welcome**
2. **Pan EU Studies of the BZR (10:00-11:30)**
    1. Transition cost questionnaire
    2. Liquidity study
    3. Timeline
3. **LMPs report (11:30-12:45)**
    1. Background
    2. Model used for simulation high-level
    3. Methodologies developed
    4. Overview of the simulation process
    5. Results
    6. Technical complexity
    7. LMP report
    8. Summary
4. **AOB (12:45-13:00)**
    1. ACER decision on alternative configurations
    2. Public Workshop on the 16 September
    3. Next meeting CG on the 13 October

Transition cost study – Methodology

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Transition cost study: Overview of Methodology

Recap on what the BZ-methodology says: mandatory and optional aspects for consideration in the bidding zone review process.

Transition cost definition

*Transition costs refer to the **one-off costs expected to be incurred** in case the BZ configuration is amended.*

*Shall relate to **adaptations** that are inherently and unambiguously **related to a specific BZ configuration change**.*

[…]

*Shall **not relate to adaptations** that are, in general, **necessary to ensure sufficient flexibility** of the systems to cope with a variable number of BZs due to a potential amendment of the BZ configuration in the future.*

Aim of the Study

*In order to identify and possibly estimate transition costs, a study shall be jointly performed for all BZRRs. The study shall aim to **provide an overview of necessary adaptations and possibly a range of related cost estimates**. The study shall also consider stakeholders' replies to the public consultation conducted pursuant to Article 17.4.*

*The resulting estimates shall be considered to **calculate the minimum 'lifetime'**, in years, of a BZ configuration, as described in Step 4 in Article 13.1(d)*

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Transition costs: Questionnaire and Feedback

Our approach and where we stand:

- Step 1 **Define groups** of market participants
- Step 2 **Develop questionnaire**
  - Break down costs into cost categories
  - Pre-questionnaire consultation with BZR consultative group
- Step 3 **Method for cost estimation**
  - Costs are estimated separately for
    - Each group of recipients
    - Each proposed BZ re-configuration
    - Each BZ directly or indirectly affected by specific re-configuration
- In October/November: Process data and draft report to be consulted

We have defined exhaustive categories and TSOs and ENTSO-E will push-out an online questionnaire to a large number of market participants.

We have consulted the questionnaire with ACER, NRAs and the BZ-consultative group, and will present feedback and updates to questionnaire today.

Because the question came up in the questionnaire feedback, we will elaborate on the method for extrapolation today.

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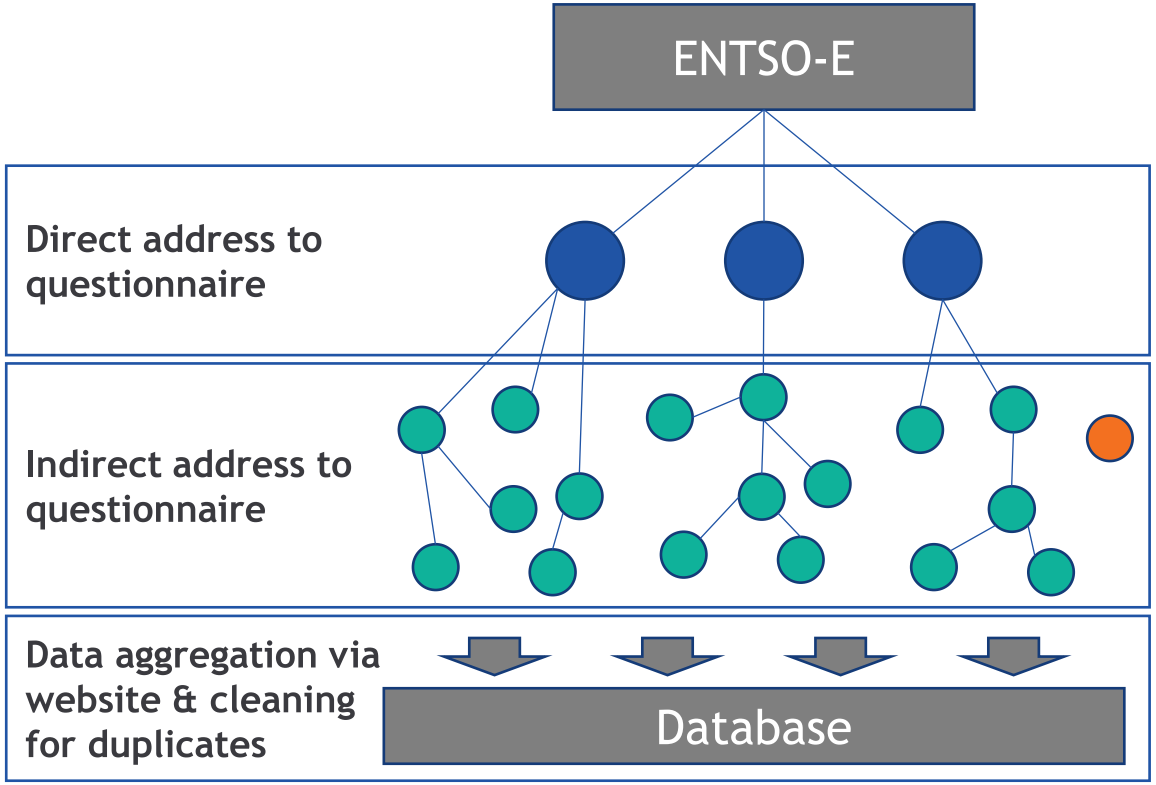
Transition cost study: Data aggregation

The data for the transition cost study is aggregated through a publicly available questionnaire, distributed in the industry



Organisation types directly and indirectly addressed
Generator or storage operator
Large-scale industrial consumer
Energy trader
Retailer
Aggregator
NEMO
Clearing house
Ministry or national regulatory authority
TSO
DSO
Other

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Transition cost study: Data quality checks

The cost estimates are aggregated and checked for quality and robustness. Below, a high-level excerpt is provided.

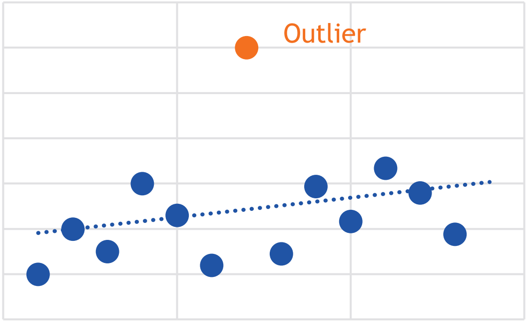
Quality checks

- Depending on the sample size, different quality checks will be applied to:
  - **Identify the best method** for finding total transition costs
  - Estimate the **expected error** and transition cost range
  - Clean the data for data entry errors
- **Typical checks** that will be applied are:
  - Model specificities test
  - Outlier tests (see bottom right)
  - Matching tests (see top right)
  - Estimates against benchmarks
  - Calculation of the regression power

Example matching Analysis

- Two entries of similar companies are compared.
- Differences between them are analysed for plausibility.
- This approach is used for small data sets

Example outlier Analysis



- A trend between entries of all or many companies is identified through statistical methods.
- Outliers are analysed for plausibility.
- This approach is used for large data sets.

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Transition cost study: Approach to cost extrapolation

Total cost extrapolation follows a scaling approach and results in a bandwidth of costs per BZ reconfiguration.

Data coordinates				Cost data				Market metrics			
Company ID	BZ reconfi-guration	Company type	Cost category	FTE	FTE Cost	Other cost	Share inde-pendent of comp. size	Market share (physical)	Market share (revenue)	Number of companies	Prior experience
1	1 (DE2)	A	IT Systems	2	55 000	500 000	50%	5% of A in 1		100	Yes
2	1 (DE2)	A	IT Systems	4	60 000	400 000	50%	5% of A in 1		100	No
3	1 (DE2)	A	IT Systems							100	
4	1 (DE2)	B	IT Systems							600	
1	2 (DE2)	A	IT Systems	1	55 000	300 000	50%			100	Yes
2	2 (DE2)	A	IT Systems	4	60 000	400 000	50%			100	No
…	…	…	…	…	…	…	…	…	…	…	…

Grouping conditional on quality check outcome

Total cost = FTE*FTE Cost +Other cost>

BZ reconfiguration transition cost independent of company size = Number of companies * Total cost * Share of costs independent of comp. size

BZ reconfiguration transition cost dependent on company size = Avg(Market shares) * Total cost * (1-Share of costs independent of comp. size)

Average total cost estimate = Avg(BZ recon. transition cost independent of company size + BZ recon. transition cost dependent on company size)

Transition cost study – Feedback

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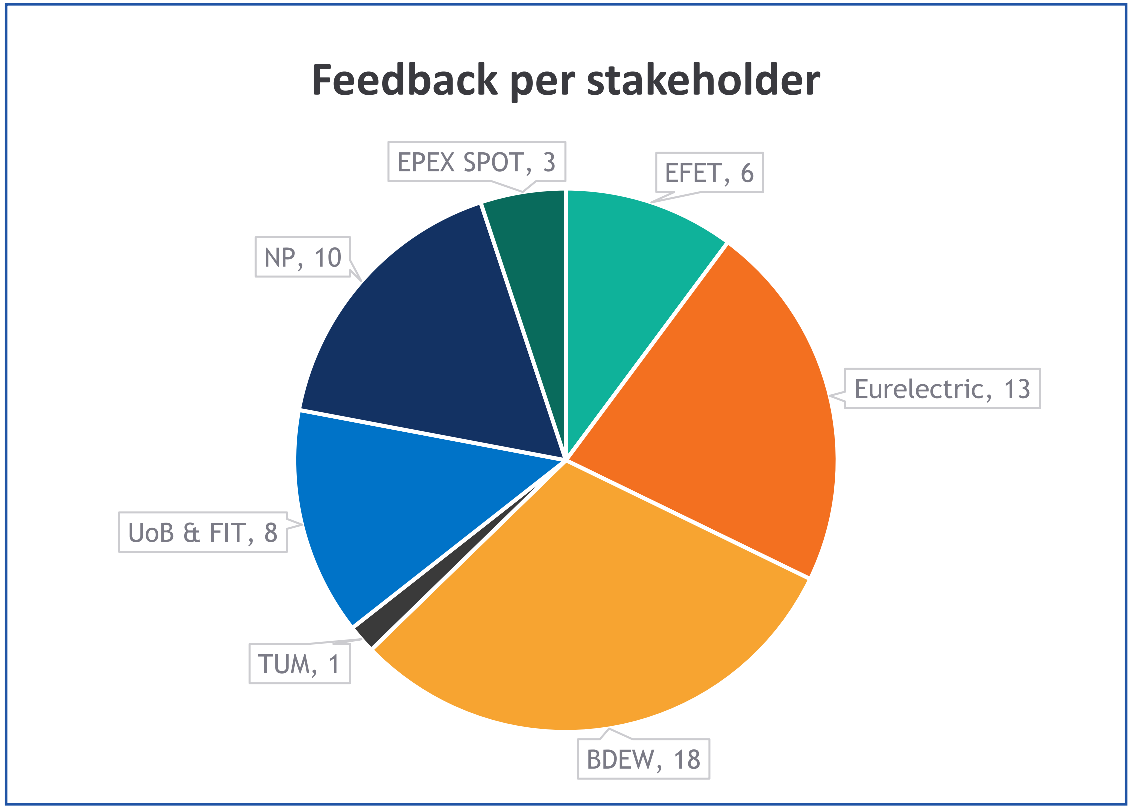
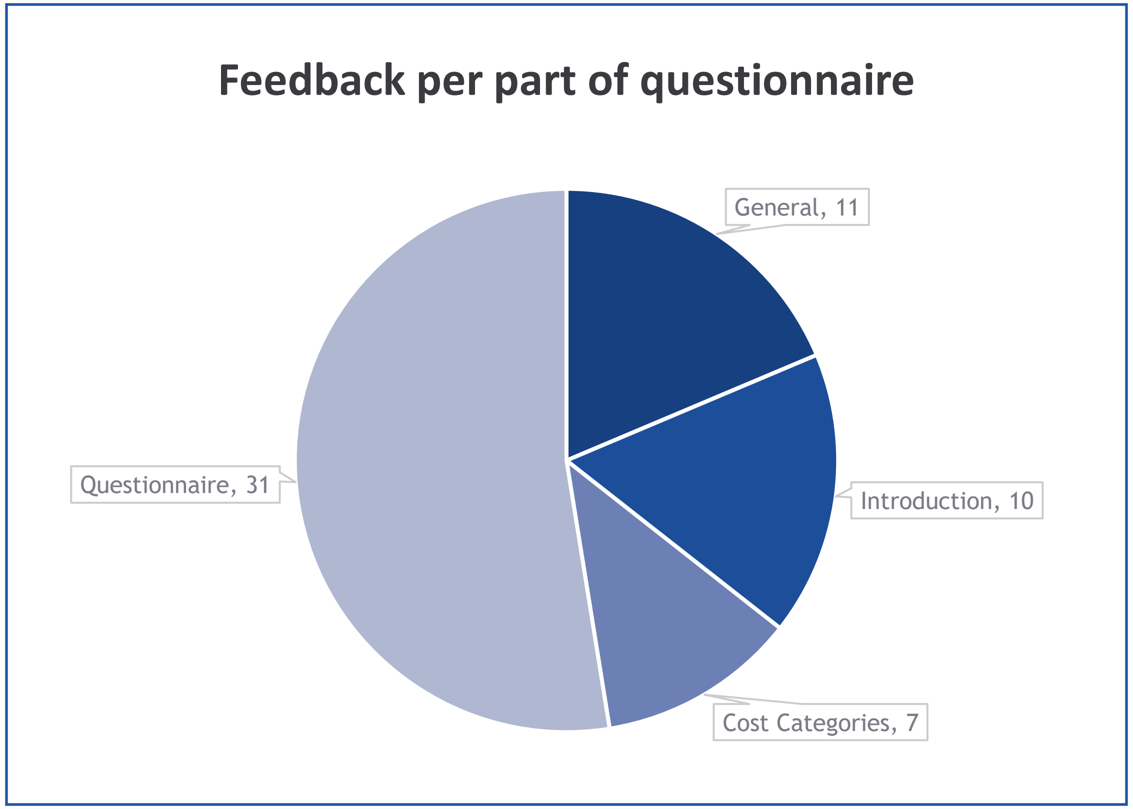
Transition cost study: Overview feedback consultative group

We have received 60 comments most of which were directed at the questionnaire itself.





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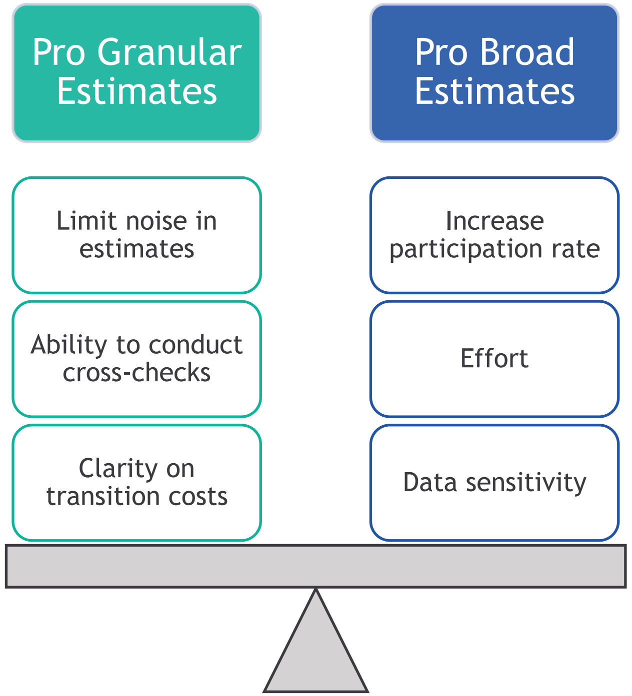
Transition cost study: Questions on data granularity

Competing interests and arguments make the decision on estimation granularity non-trivial.



Approach

Remain with granularity currently in place, but

- *In case of data sensitivity for FTE cost:* leave open FTE cost cell. We will then use **standard FTE** cost
- *In case of FTE sensitivity:* Leave open FTE cells and **include aggregated costs in FTE-non-specific "other cost"**
- **Explain** sensitivity in "comments" cell

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Transition cost study: Questions on optional data submission

The questionnaire includes questions that are not required from the methodology , but would be useful for the analysis.

Rationale for inclusion of questions

- **Make explicit the difference between transition costs** to be included **and those costs that are relatable** to a BZ reconfiguration but should not be included
- System flexibility and prior experience may be a **confounding factor** to transition costs. Information on its existence may inform the robustness checks and method to be used for total cost scaling
- Historic data and explanations such as the effect from lead time may **substantiate the estimation rationale** behind the difference in cost estimates conditional on lead time

Treatment of answers

- The description of the previous effect of the lead time will be used to **qualitatively substantiate** the difference in cost estimates per lead time and assess the robustness of the estimates in case of a small response rate
- It will be generally assessed, **if companies with experience** in BZ reconfigurations **expect lower costs** than companies without experience. Within the experienced group, this will be further elaborated through a linear relationship between cost estimates and prior costs (conditional on company size). This further helps in **making informed decisions** on the scaling process

Optional data

1. Have you been affected by a past BZ re-configuration in a way that incurred transition costs? ☐ Yes ☐ No
   a. If yes, please note the specific re-configuration that affected you:
   b. If yes, was your main area (the area where you are most active in in terms of generated/ traded/ throughput/ consumed/ overseen volume) of business subject to re-configuration or have you been affected by a re-configuration outside your main area of business?
   c. If yes, what was the lead-time for this re-configuration and how did the lead-time affect your transition costs?

Prior Process: Making systems / processes flexible (such that BZ-change is possible)**

FTE (existing staff) [total #]	FTE (new staff) [total #]	Cost per FTE*** [EUR / #]	Other cost (in total during lead time) [EUR]

entsoe

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Transition cost study: Questions and comments for clarification

We would like to clarify some comments that have not been clear.

Stakeholder Comment	Reference	Question
added: MPs impacted by IT changes happening for TSOs (ancillary services, balancing) / Market participants impacted by IT changes (ancillary services, balancing)	Adjustments of processes with TSOs and public bodies	IT changes can be included in cost category "Changes to internal business processes and IT systems". In how far do you consider these costs **outside of IT systems**?
Question not clear / Question is very difficult to answer, as it is not clear.	Have you been affected by a past BZ re-configuration in a way that incurred transition costs?	The idea is to receive indicative information on whether the stakeholder has **experience in BZ reconfigurations** and transition costs or not.
As past projects are concerned, TSOs should already have all the cost related data, as EPEX and other NEMOs/PXs were required to report them in full detail.		It may be that TSOs have historic data. The issue at stake here is **estimated data for specific reconfigurations.**
Although we cannot confirm that every BZ reconfiguration will cause the same costs, it is almost impossible to identify different subtypes of reconfigurations. And many characteristics that have an impact on NEMOs/PXs (e.g., handling of futures contracts) might not be equally important for other stakeholders.		What is meant by **"subtypes of reconfigurations"**?

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Transition cost study: Updates of the questionnaire

The updated questionnaire incorporates your feedback and includes the to be assessed BZ reconfigurations

Chapter	Content	Change log
Introduction	• Outline of context, i.e. the bidding zone review process • Reference to the BZ reconfigurations that shall be assessed in the study • Introduction to an definition of transition costs as described in the Methodology • High-level description of treatment of submitted data	• Inclusion of reference to ACER documents • Addition of reference to the BZ reconfigurations • Clarification of treatment of submitted data • Minor changes in wording
Cost categories	• Description of cost categories including non-exhaustive list of examples	• Added and amended examples as suggested by consultative group

Questionnaire	• General questions to group the respondents and facilitate data processing
	• Table for cost estimates per cost category and lead time as well as other cost elements; provision of space for explaining the individual cost items
	• Questions/ thought-experiments for intra-company transition costs
	• Room for additional remarks from the respondents
		• Included that energy traders should submit data with physical metrics
		• Clarified some of the text in accordance to the feedback from the consultative group
		• In table:
		    • erased “other cost” in first cost category
		    • Clarified explanations
		    • Changed some wording

Liquidity and transaction cost study – Approach

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Liquidity study

NEMOs have been requested to provide data for the purposes of the BZ-review, according to CACM regulation[1]

Historic data for the liquidity study comes from NEMOs, ACER and public data

	Proposed short-term analyses	Necessary data	Data
Step 1: What is the state of liquidity in Europe?	**Churn rates and traded volumes**, **patterns** of daily churn rates (seasonal, weekly, trends) and effect of **events** (e.g., cold spells)	**DA traded volumes by BZ** • At least yearly but higher granularity preferred • 2017 to 2020 • All affected BZ plus relevant neighbours	***→ traded volumes need to come from NEMOs – CL has prepared a data request***
		Electricity consumption and generation by BZ	ENTSO-E transparency platform
	Retail risk premium = quantity weighted average wholesale price – retail price	DA hourly wholesale prices by BZ	ENTSO-E transparency platform
		Retail prices by BZ and customer	Eurostat
Step 2: What can we learn from previous splits?	Analysis of the impact of the **DE/AT BZ split** on the liquidity indicators in **DA and ID**	**DA and ID traded volumes by BZ** • At least monthly but higher granularity preferred • At least one year prior and after split in October 2018	***→ traded volumes need to come from NEMOs – CL has prepared a data request***
		Electricity consumption and generation by BZ	ENTSO-E transparency platform
	Literature research on changes in the BZ configurations in **Italy and Scandinavia**	Literature review	
Step 3: Effect of inter company transactions	Effect of intra-company transactions on short-term market liquidity	Questionnaire	

Notes: [1] as established in Commission Regulation (EU) 2015/1222 Article 32 (4)(c)

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Liquidity study

NEMOs have been requested to provide data for the purposes of the BZ-review, according to CACM regulation[1]

Historic data for the liquidity study comes from NEMOs, ACER and public data

	Proposed long-term analyses	Necessary data	Primary and back-up sources
Step 1: State of long-term liquidity in Europe?	Volume of trade and **churn ratios** in organised and non-organised markets	**Forward traded volumes by BZ** • Yearly granularity sufficient, but higher might be of value too • 2017 to 2020 • All affected BZ plus relevant neighbours	***→ traded volumes need to come from NEMOs – CL has prepared a data request***
		Electricity consumption and generation by BZ	ENTSO-E transparency platform
	Average of lowest **bid-ask spread** per period (yearly, monthly, quarterly products)	**Bid-ask spread (OTC and NEMOs)** • Daily granularity if available • 2017 to 2020 • All affected BZ plus relevant neighbours	***→ B/A spreads need to come from NEMOs – CL has prepared a data request***
Step 2: Are markets correlated?	**Correlation** of **historical** DA prices	DA historical prices or modelled DA prices under the status quo BZ	ENTSO-E Transparency Platform
	Correlation of **future** DA prices	DA prices in the alternative BZ configurations	TSOs modelling results
Step 3: Relationship between liquidity and competition	How do **competition and liquidity metrics interact? - panel regression**	HHI and RSI in the status quo and alternative BZ configurations	TSOs modelling results
		Retail market organisation (HHI)	TSOs modelling results

Liquidity and transaction cost study – Feedback

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Liquidity study

The feedback from the consultative group suggests additional areas of analysis to better cover

Stakeholder comments

- Multiple remarks on the markets and products to be analysed as well as the elements to be considered (see left hand side)
- Lack of data representativity for intra-company transactions on short term market liquidity
- Correlation analysis does not correspond to real practice of cross-border hedging practices
- Some indicators are missing (i.e. variants of B-A spread)

Specifications from the Methodology

- The Methodology does not specify all details of the study approach
- It differentiates between short term and long term market liquidity but shies away from an exhaustive list of markets and products to be considered
- It calls for minimum elements (such as volume, churn ratio, B-A spread, impacts caused by changes in competition) and includes further elements that may be analysed

	churn rates / traded volumes	retail risk premium	B/A spread	Market depth indicators: bid curve analysis / order book analysis
Intraday market	Additional analysis requested	Analysis neither requested nor included	Additional analysis requested	Additional analysis requested
Day-ahead market	Analysis included	Analysis included	Analysis neither requested nor included	Additional analysis requested
Forward markets	Analysis included	Analysis neither requested nor included	Analysis included	Additional analysis requested

Timeframe	Add 2016 and 2021

Legend
- Additional analysis requested
- Analysis included
- Analysis neither requested nor included

Next steps

Timeline

- Questionnaire on Transition costs to be published around 5 September;
- public webinar on 16 September;
- next BZR consultative group on 13 October;
- deadline for sending answers to the questionnaire on Transition costs: 31 October (8 weeks after publication)

ENTSO-E LMP project

Agenda points

ENTSO-E LMP project

1. Background
2. Model used for simulation high-level
3. Methodologies developed
4. Overview of the simulation process
5. Results
6. Technical complexity
7. LMP report
8. Summary

Background information on Bidding Zone Review (BZR) process

What is the Bidding zone review?

- **What: an All-TSO study** of alternative bidding zone configurations
- **Why:** Article 14 Regulation (EU) 2019/943 triggers a bidding zone review
- **How this BZR shall be done?**
  - General methodology: CACM art 32-33
  - Specific methodology/assumptions: approved by ACER in 24 November 2020
  - Specific configuration: August 2022
- **Purpose:** investigate whether alternative bidding zone configurations **increase the economic efficiency** and cross-border trade opportunities, **while maintaining the operational security** of the electricity grid
- Year to be studied: **2025**
- **Deliverables**
  - A final **report** with an assessment of 22 indicators
  - A joint **recommendation** to the governments of the involved Member States for the future configuration
- **Leading to: Decision of Member States** to maintain or amend the bidding zone configuration.

Steps of the current Bidding Zone Review

The All TSOs proposal of methodology and configurations submited in October 2019 ended in ACER´desk…

We are here today

Methodology and assumptions
- by ACER decision
- Approved: 24 November 2020

LMP
- by All TSOs
- Delivered: April 2022

Alternative Configurations
- by ACER
- Approved: 9th of August 2022

Bidding Zone Review
- by the TSOs of the BZRRs
- From August 2022 to August 2023

MS unanimous decision to maintain or amend the BZ in 6 months. (EC last resource with ACER – 6 months)

ACER methodology approved has 2 steps:
1. Methodology + request to TSOs to deliver LMP
2. Definition of alternative configurations

The LMP project for Continental EU and Ireland ´at a glance´

Scope

- Locational Marginal Prices of each node
- Bi-hourly simulation
- 8 weeks x 3 climate years
- Year (grid and generation/load): June 2025
- Continental EU and Ireland (Nordic TSOs carried out simular LMP project)

Timeline

- Legal timeline (ACER methodology): 12 months (November 2020 – November 2021)
- Delay: 5 months (agreed with ACER in order to avoid stronger simplifications)
- Total time: 17 months (November 2020 – April 2022)

Purpose of the LMPs

- Define alternative configurations
- The models, data and assumptions are the base for the next step of the process

Model used for simulation

The LMP simulation model (CE & Ireland) – main model

MODEL DIMENSION

- *25000 nodes*
- *16000 generators batteries*
- *22000 lines*
- *12000 trafos*
- *25000 CNECs**

MAIN FEATURES

- *Planned outage of generators*
- *Optimized storages*
- *All reserves modeled*
- *Implicit & explicit DSR***
- *DC Power Flow with N-1*
- *Market-based RES model*

MAIN SIMPLIFICATIONS

- *Linear Unit Commitment*
- *2h granularity*
- *Parallel daily optimization*
- *No topological Remedial Actions*

- Simulations were performed for eight representative weeks of three climate years each (24 weeks in total)
- *Additional runs were carried out to assess the effect of topological remedial actions (TRA) as well as of other methodological simplifications (e.g. integer approach). Sensitivity tests on CO2 and/or fuel price assumptions has been also done.*

** Critical Network Elements and Contingencies* *** Demand Side Response*

The LMP simulation model (CE & Ireland) – Input data

DECENTRALIZED DATA SOURCES

- *Dynamic Line Rating*
- *Demand Side Res-ponse parameters*
- *Reserve requirements*
- *CNECs (validation)*
- *Topological Remedial actions*

CENTRALIZED DATA SOURCES

TYNDP* 20 grid model
Downgraded to June 2025

PEMMDB**
*MAF*** 2020 Scenarios*

A set of tools and a detailed model and simulation chain have been developed in the framework of the LMP study

** Ten Year Network Development Plan* *** Pan European Market Modelling Database* *** Mid-Term Adequacy Forecast

Methodologies developed

The LMP simulation model (CE & Ireland) – methodologies

NEW METHODS

- Climate years and weeks selection
- CNEC selection
- Implicit DSR modelling
- Nodal allocation of generation and load

Climate year & week selection

GOAL

Identify a subset of scenarios to derive representative results, without endagering the project legal deadline

1. Residual Load distributions

- Use residual load(1) on hourly resolution timeseries
- Temporal and spatial variability of the system state due to climatic conditions fully captured

(1)Demand - RES infeed

2. Delta Indicators Year/Region

- Assess how a reduced set of years differs from the 30-year combination using two main indicators:
  a) energy content (mean value)
  b) variability (std dev)
- Keep regional approach (as in TYNDP), ensuring representativeness of different regions

3. Selection of candidate combination

- Choose the most representative combination of 3 years.
- Analysis of all combinations of 3 years (in total 4500) and choose most representative ones

Similar methodology applied for selection of 8 out of 52 representative weeks in each climate year

Final choice

Climate year 1989	Weeks: 04, 10, 11, 17, 20, 31, 40, 52
Climate year 1995	Weeks: 02, 12, 16, 21, 27, 36, 38, 49
Climate year 2009	Weeks: 04, 08, 11, 15, 16, 21, 31, 48

CNEC selection process

GOAL

Identify a subset of relevant CNECs in order to reflect the effect of the N-1 security criterion, without endagering the project legal deadline

CNEs selection

- A N-state preliminary simulation has been run
- Among all the 380kV network elements, the most loaded[(1)] ones are identified as CNEs

[(1)]Loaded more than 70% (50% if part of a double circuit line). Cross-border one are included by default.

Contingency identification

- For each selected CNE, most impacting contingencies are identified[(2)]

[(2)]A procedure In line with the "*Methodology for coordinating operational security analysis in accordance with Article 75 of Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation*"

Validation

- TSOs have been asked to check the results and integrate additional CNECs considered relevant (including 220kV elements)

Critical Network Elements

Contingencies

Demand Side Response (DSR) – Explicit vs Implicit

GOAL

Capture the benefits deriving from future Demand Side Response, in line with ACER requirements

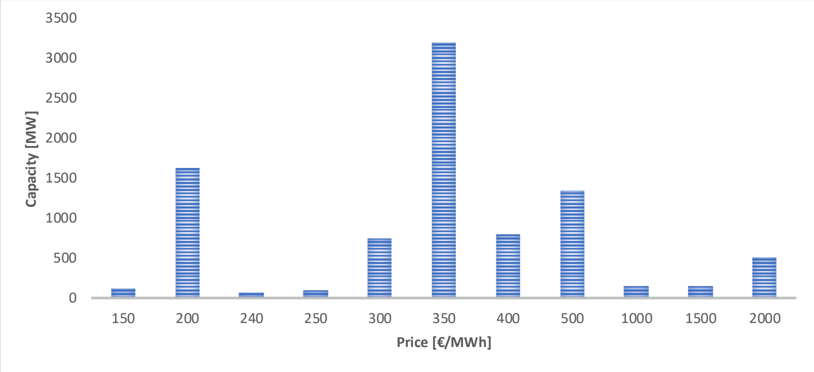
Aspect	Explicit DSR	Implicit DSR
Definition	*It is committed, dispatchable flexibility that can be traded on the different energy markets (wholesale, balancing, system support and reserves markets). This form of Demand-Side Flexibility is often referred to as "incentive driven" demand-side flexibility.*	*It is the consumer's reaction to price signals. Where consumers have the possibility, they can adapt their behaviour (through automation or personal choices) to save on energy expenses. This type of Demand-Side Flexibility is often referred to as "price-based" demand-side flexibility.*
Participation to market segments	***It can potentially participate to all market segments/mechanisms*** *(balancing, ancillary services, etc.)*	*A priori,* ***it does not participate in other market segments or mechanisms (balancing, ancillary services, etc.)***
Visibility/identification of offers	*Individual offers can be often identified.*	• *It may be 'visible' in the wholesale (day-ahead or intraday markets), it may be partly 'hidden', e.g. in the portfolio of vertically integrated companies.* • *Individual offers difficult to identify*
Activation prices	*In theory, activation at any price. In practice, based on TSOs' information, only identifiable at 'relatively' high prices (e.g. 150 euros/MWh or well above)*	*At any price*

Demand Side Response – Modelling approach

Explicit DSR

Set of equivalent generation units bidding at (relatively high) prices

≈8800MW



Implicit DSR

Implicit DSR has been simulated according to **2-step approach**:

1. In a first step, **demand elasticity values have been applied and a simplified zonal yearly simulation has been run** (activating the Plexos Cournot competition model). The scope of this step is to derive demand slope and intercept to be adopted in the final simulations.

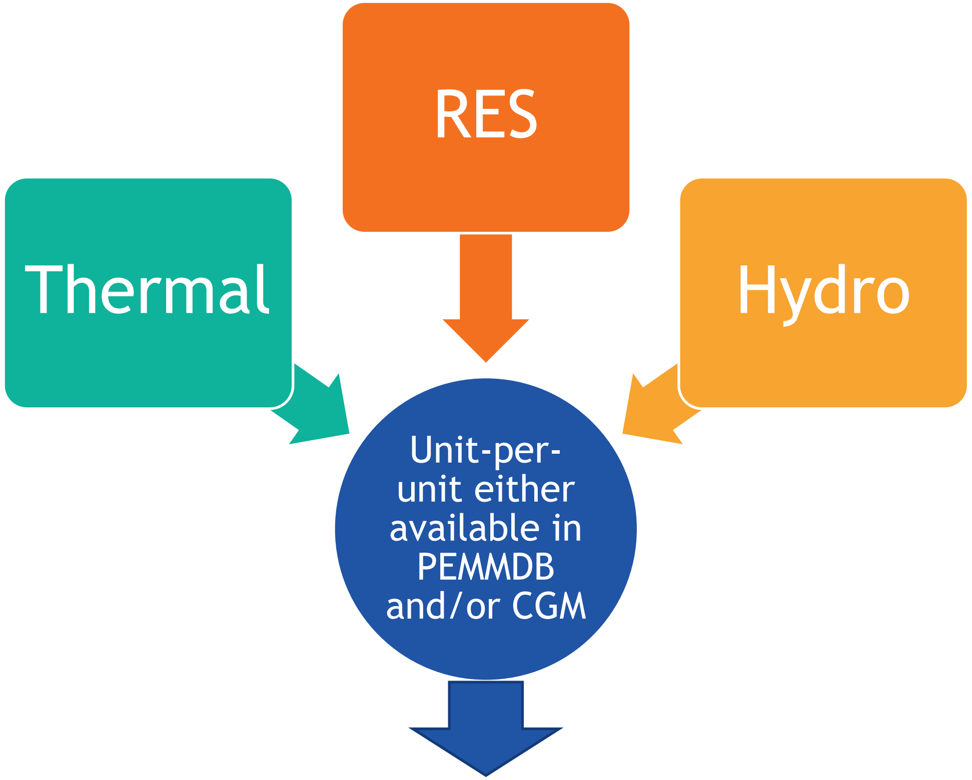
2. In the second step, **computed hourly demand slope and intercept parameters are assigned to each (existing) Bidding Zone and adopted in the final LMP simulations**.

Demand elasticity values are the main input for assessing implicit DSR parameters: on the basis of the relevant literature*, **a standard value of -0.08 has been adopted for all the countries** (against the -0.2 provided as a reference in the ACER methodology), **except for Germany for which a -0.05 value has been adopted** on the basis of a study which conducted a specific assessment on demand elasticity for Germany.

**Paper list:*
Csereklyei, Z. (2020). Price and income elasticities of residential and industrial electricity demand in the European Union. Energy Policy, 137, 111079
Knaut, A (2017). "When Are Consumers Responding to Electricity Prices? An Hourly Pattern of Demand Elasticity", Chapter 4 in Essays on the integration of renewables in electricity markets. PhD Thesis. University of Cologne
Hirth, L., Khanna, T., Ruhnau, O. (2022). The (very) short-term price elasticity of German electricity demand. ZBW - Leibniz Information Centre for Economics, Kiel, Hamburg

Nodal allocation of generation and load

GOAL: to run a nodal simulation → need to split to a nodal level.
For year 2025 we have zonal information from TYNDP and MAF.



Load

- Load forecast at BZ level;
- Nodal split as TYNDP*;
- Scaling to match 2025 demand.

Hydro

- Generation unit-per-unit information;
- Natural Inflow, hydro constraints, and storage capacity proportional to gen. capacity.

*assumption that the repartition is the same throughout the year

Full alignment between PEMMDB and CGM was necessary and achieved in order to have nodal data base in both formats and to run simulations. Furthermore, nodal splitting methodologies had to be developed and applied.

Simulation process

The LMP simulation chain (CE & Ireland) - Main workstream

Mainworkstream

Locational Marginal Prices according to the **optimal dispatch** of the available resources (generation units and DSR) **given the network**

Outage Plan

- **Planned maintenances for thermal generation units** are allocated to minimize the impacts on reserve margins
- The «PASA» model available in the Plexos software has been adopted for this scope

CNEC selection

- CNE selection base on flows coming from **n-0 nodal market simulation**
- Identification of most impacting contingencies for identified CNEs*», obtaining the **initial CNEC list**
- The list is validated by TSOs

Final N-1 simulation chain

- **Implicit Demand Side Response** parameters computation (slope and intercept).
- **Weekly storage targets** are derived running a yearly mid-term simulation. Afterwards, **daily targets for storages** are defined over the weekly time-horizon running a mid-term optimization, considering weekly initial and end values fixed
- The **final n-1 nodal market simulation** is performed, considering all the relevant features (e.g. DSR implicit and explicit, final CNEC list, storage targets).

* In line with the "*Methodology for coordinating operational security analysis in accordance with Article 75 of Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation*"

The LMP simulation chain (CE & Ireland) - TRA workstream

TRA workstream

Locational Marginal Prices according to the ***optimal dispatch*** *of the available resources (generation units and DSR) and* ***optimizing the network configuration*** *applying Topological Remedial Actions*

⚠ Time intensive → Applied only on 3 most congested weeks representative for all regions

Identification of TRAs

- For a subset of (3) selected weeks, **TSOs identified relevant topological remedial actions** (TRAs) to be applied in order to relieve detected congestions in the "Final N-1 simulation“, like:
  - Opening/closing lines
  - Opening/closing busbar couplers (and changing line connection configurations)

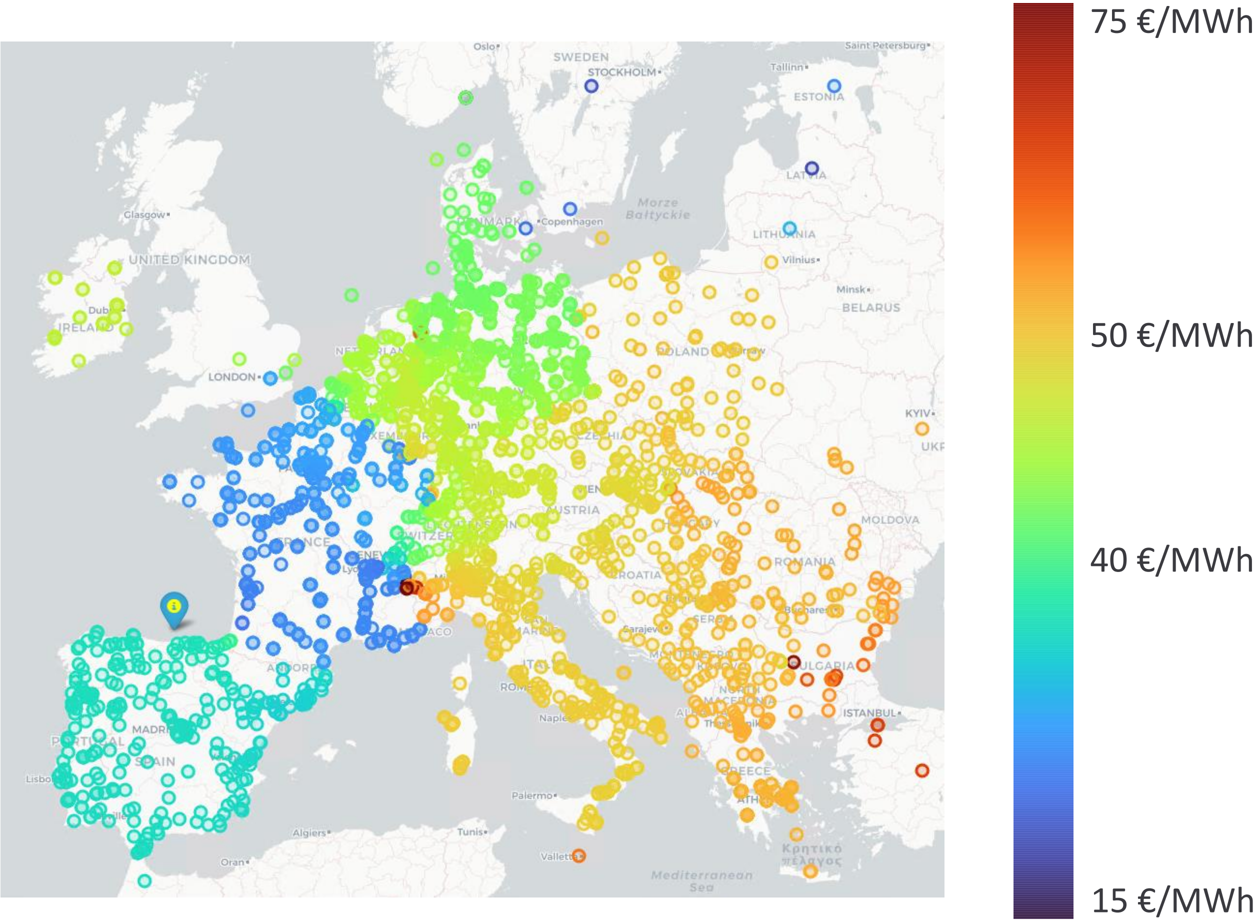
TRAs simulation

- The **final n-1 nodal market simulation chain** is re-run on the three selected weeks, considering all the relevant features (e.g. DSR implicit and explicit, final CNEC list, storage targets) and also topological remedial actions.

LMP simulation results

LMP simulation results - average LMPs (all scenarios)

Average LMPs across all 24 simulated weeks



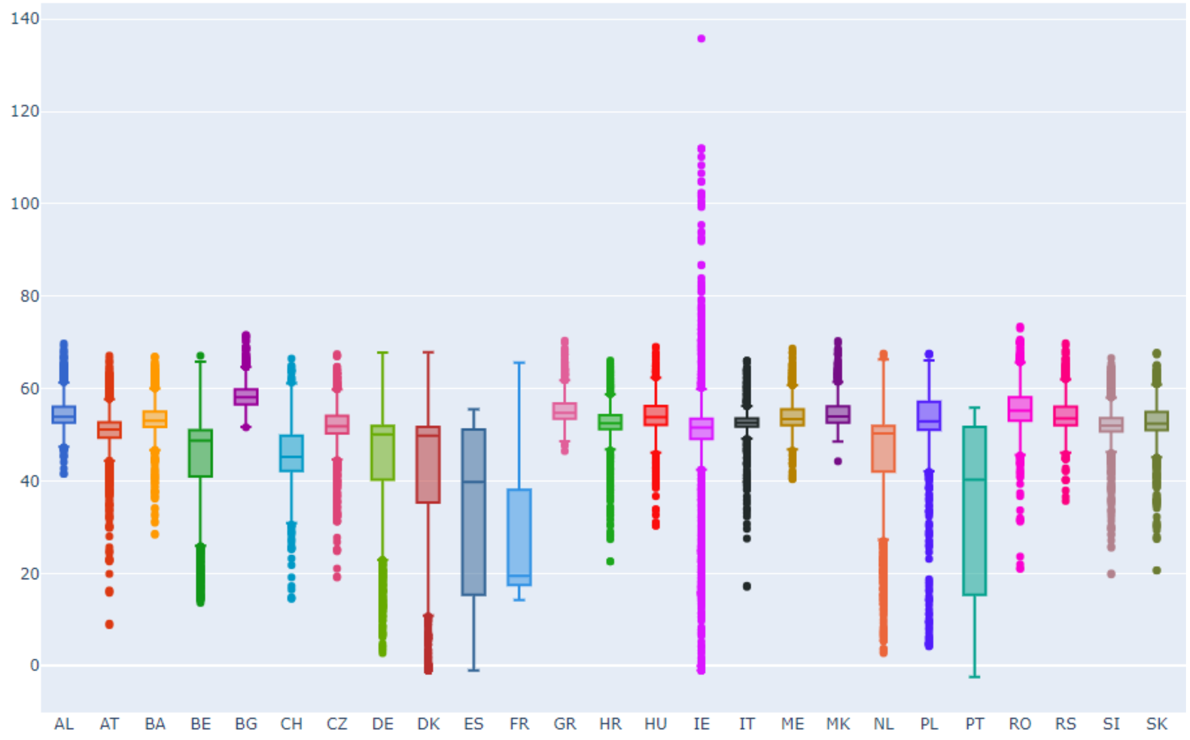
Hourly price differentials can disappear from aggregation over time. Therefore, average price differentials do not tell the whole story, as price differentials may be very different across hours.

- From an overall picture, average nodal prices are in resonable range.
- Average price differences occur mainly on country borders.
- Average price differences visibile also within country borders.

LMP simulation results - main workstream

Analysis of nodal prices time variation

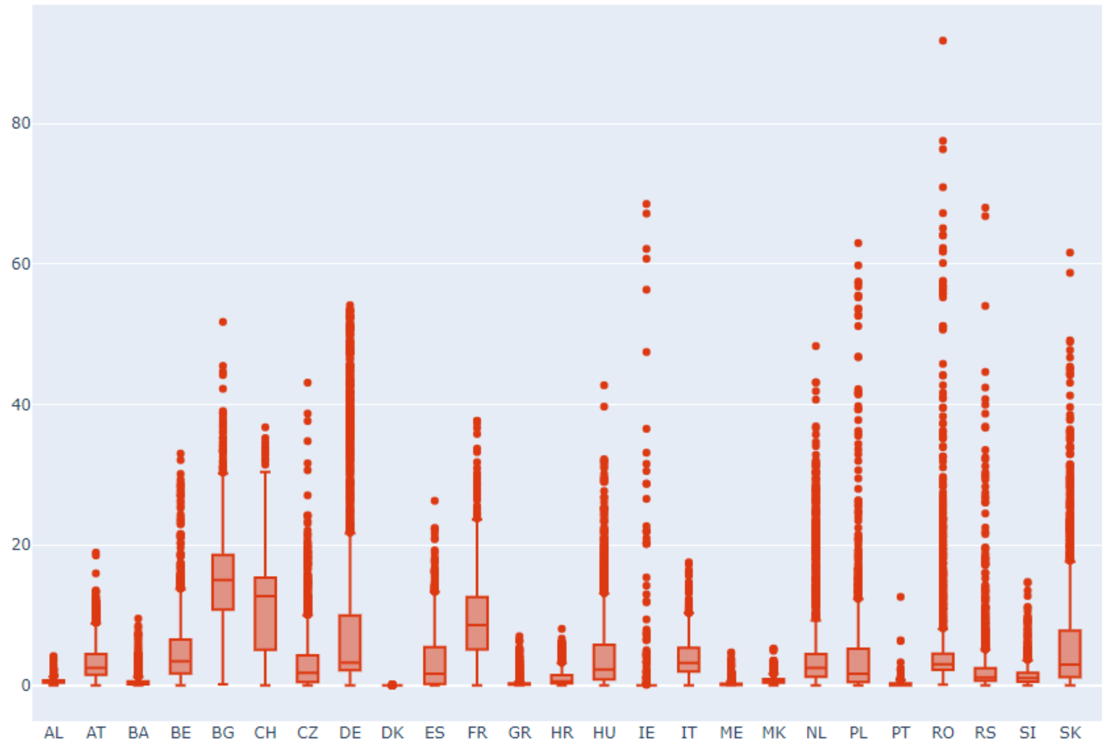
Hourly avarage prices per country [€/MWh]



Graph shows volatility of average prices in a country

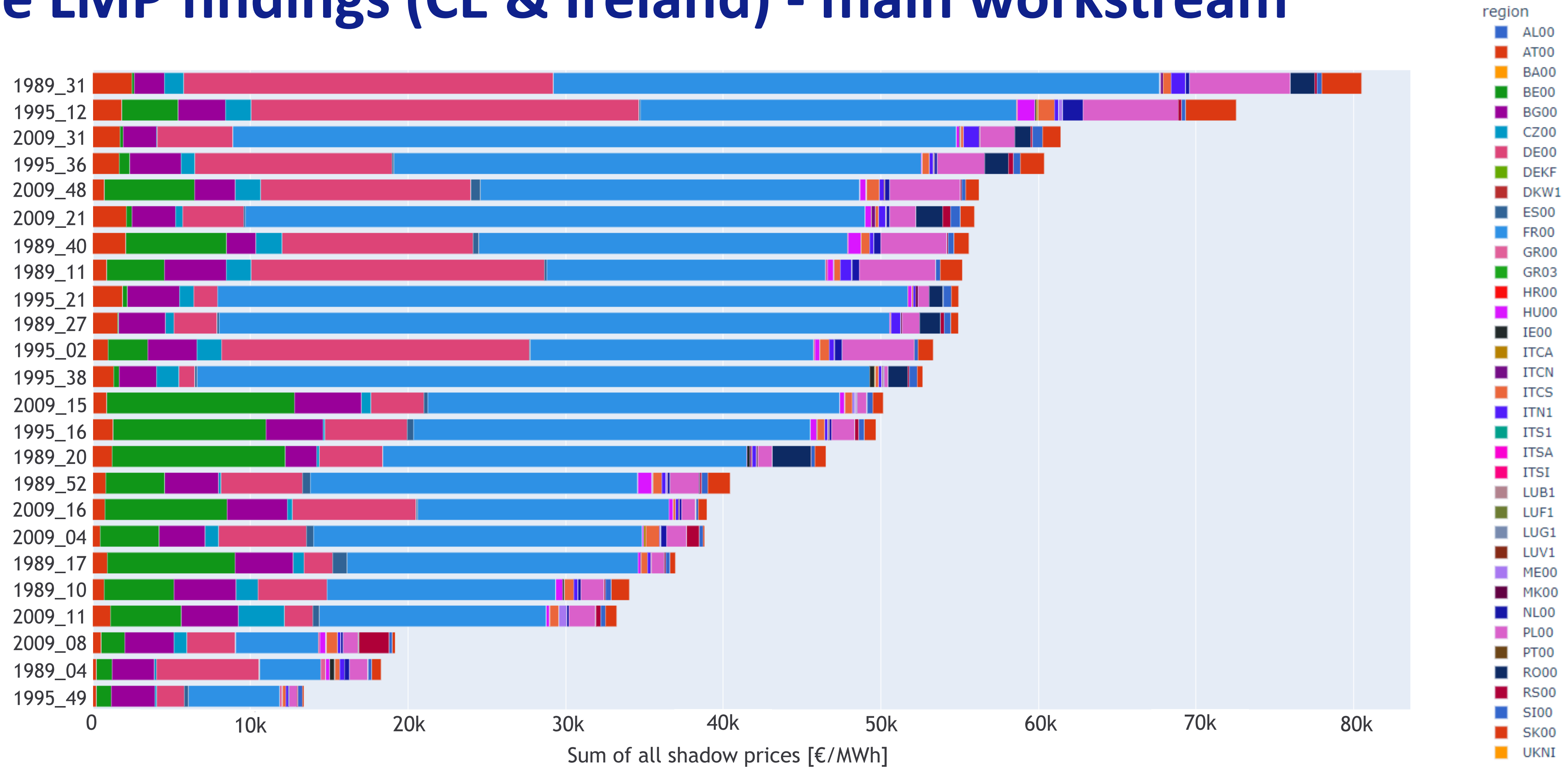
Analysis of nodal prices geographical variation

Hourly intraregional price spread for p05 - p95 [€/MWh]



Graph shows volatility of absolute difference between the 5th & the 95th percentile of the hourly nodal prices in a country

The LMP findings (CE & Ireland) - main workstream



Amount of congested elements across geographical area depends on climatic conditions

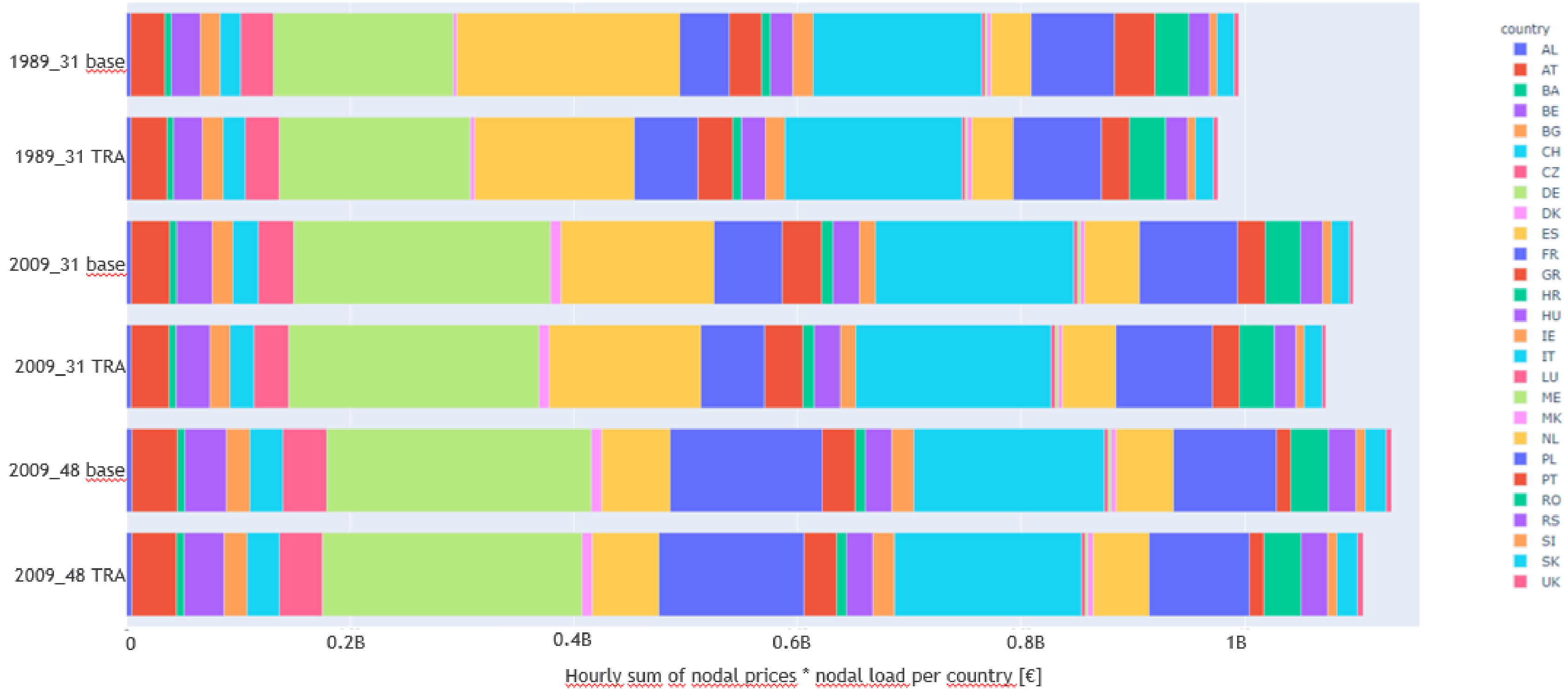
The LMP findings (CE & Ireland) - ex-post workstream

Weeks considered in the ex-post workstream:

- **Climate week 1989_31** → most congested for all the synchronous area
- **Climate week 2009_31** → most representative for CW1 & most congested for FR
- **Climate week 2009_48** → most congested for SWE

Topological remedial actions were applied for:

- **France** for all the 3 weeks
- **Czech Republic** for the climate weeks 1989_31 & 2009_31
- **Spain** and **Portugal** for climate week 2009_48

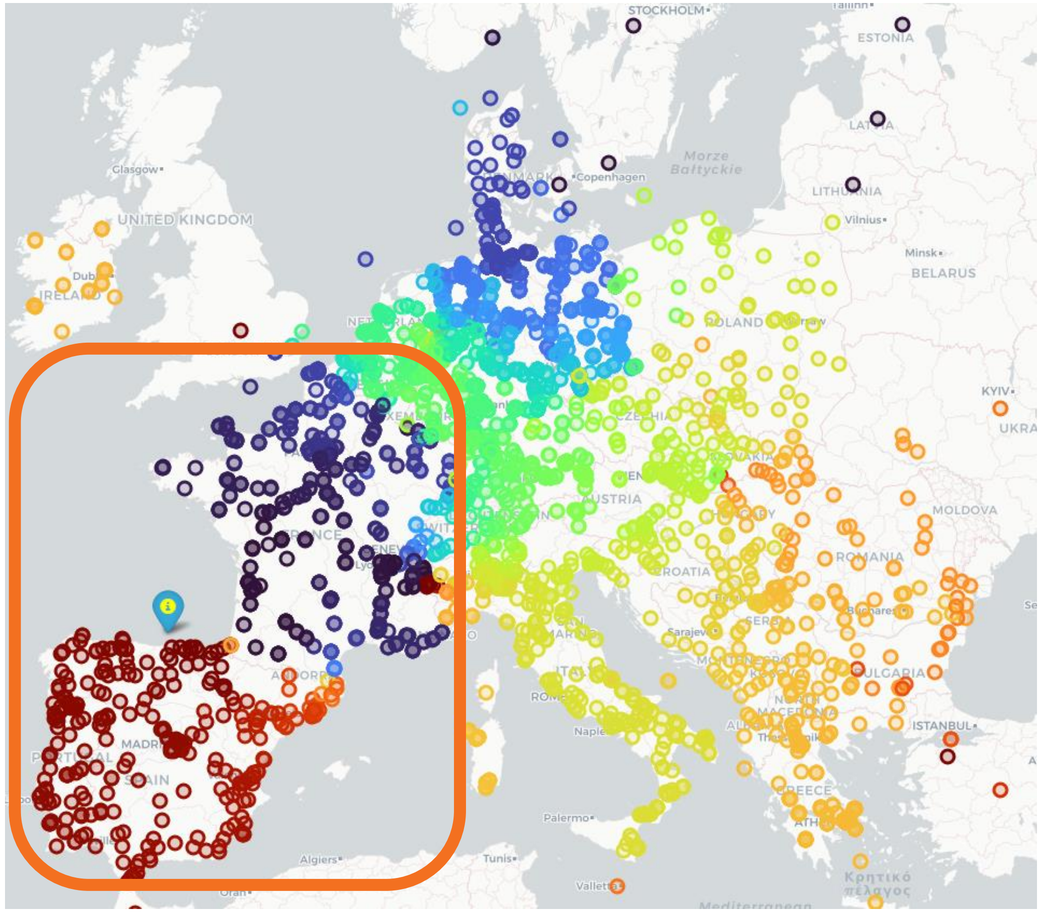


Application of topological remedial actions leads to an overall reduction of weighted nodal prices in all three weeks simulated

Nodal prices with and without TRAs 1989 w31

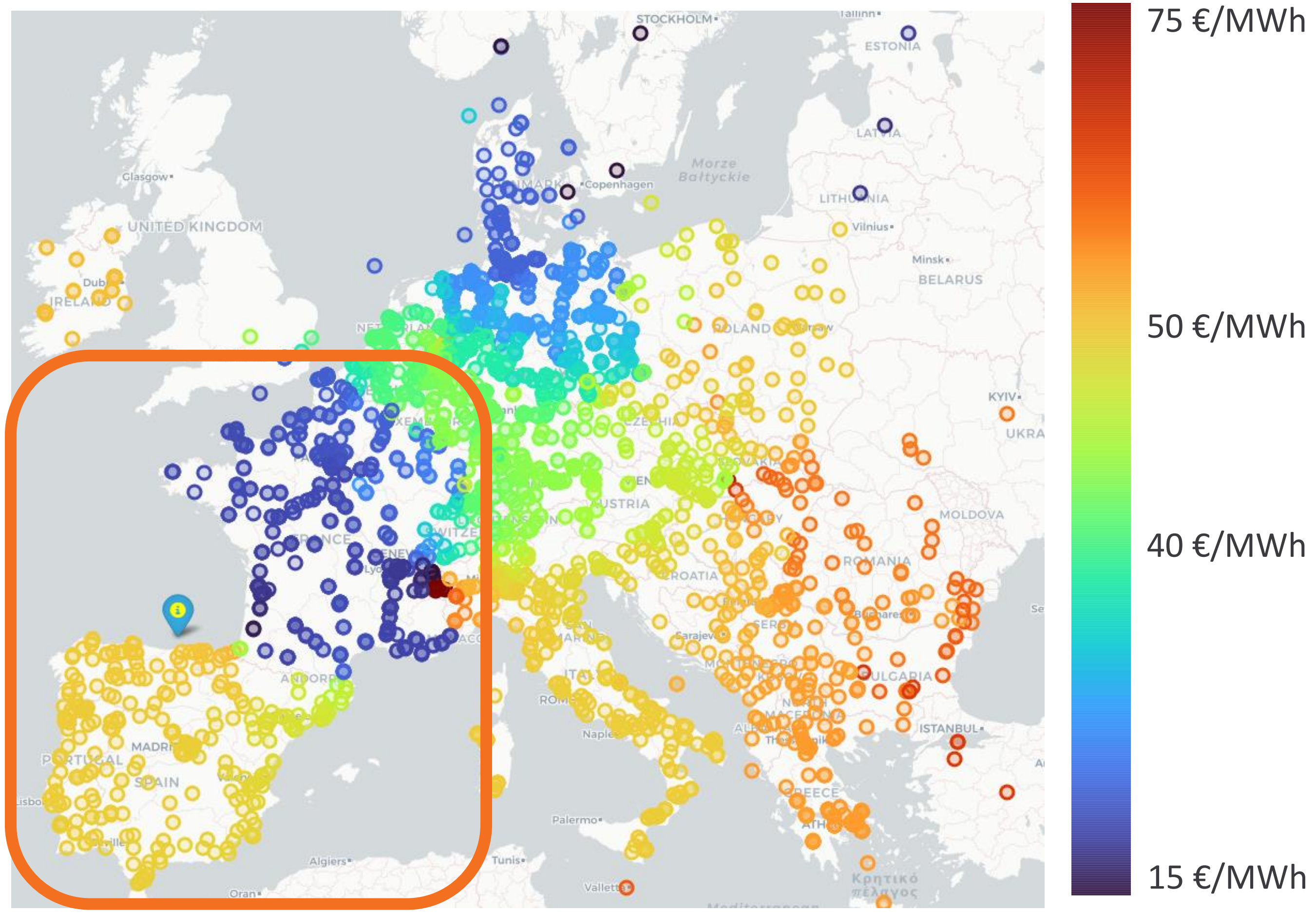
Hourly price differentials can disappear from aggregation over time. Therefore, average price differentials do not tell the whole story, as price differentials may be very different across hours.

Overall average nodal prices without TRAs* [€/MWh]



* All network elements >= 380kV are visualized

Overall average nodal prices with TRAs* [€/MWh]



* All network elements >= 380kV are visualized

TRA leads to lower average prices in ES & PT, higher prices in FR

entsoe

The LMP findings (CE & Ireland) - sensitivity runs (without TRAs)

Case relative to base run	CO_2 price of 90 EUR/t*	Higher fuel prices**
Hourly average price per country	↑	↑
Intraregional price spreads	↑	↑
Average hourly sum of shadow prices	↑	↑
Hourly shadow price sum distribution	↑	↑
Conclusion	Some new lines with shadow prices detected	Some new lines with shadow prices detected

* *instead of 40 €/t used for the main workstream*

** *main CO2 and fuel price assumptions*

Fuel / CO2	Main simulations (€/GJ)	Sensitivity run (€/GJ)
Gas	5.57	26.39
Hard coal	2.30	2.68
Oil	10.6-12.9	12.9-15.8
Lignite	1.4-3.1	1,6-3.6
CO2	40	90

From the additional sensitivity runs performed it can be concluded that simulation results are sensitive to input data assumptions

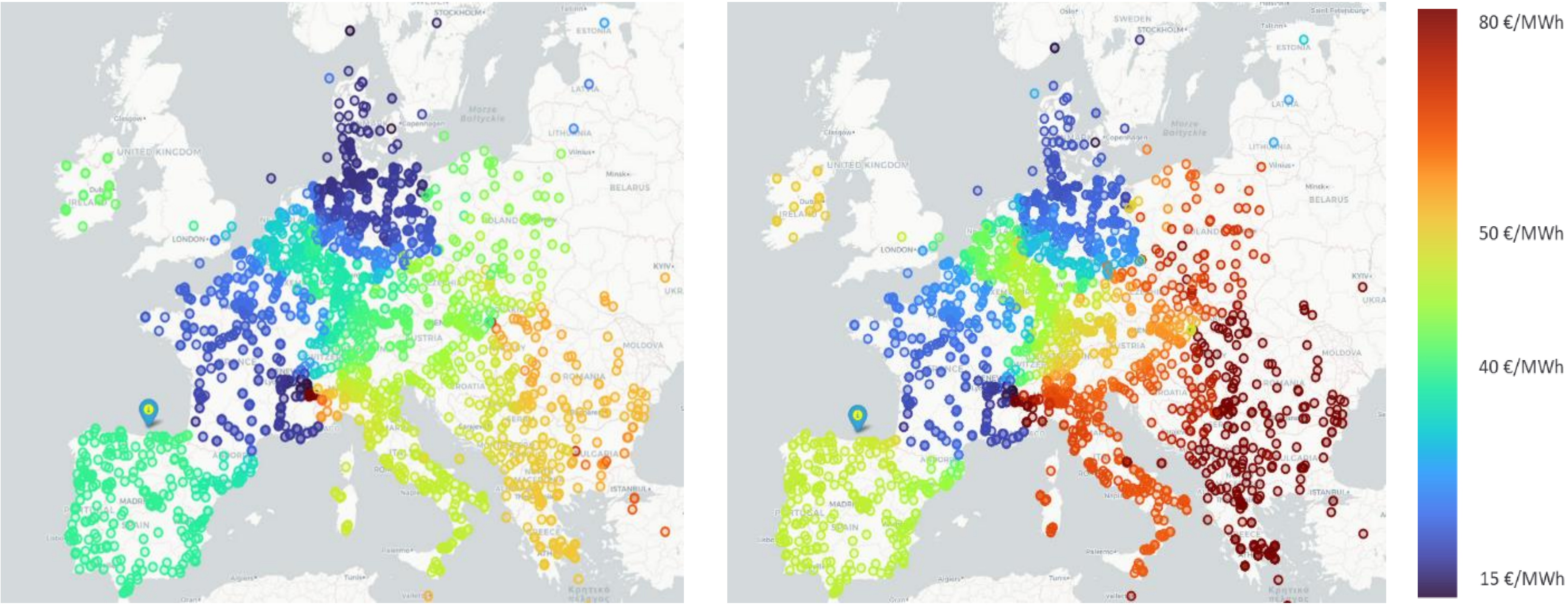
Visualisation of sensitivity analyses 1995w12

S4 – CO_2 price of 90 EUR/t

Hourly price differentials can disappear from aggregation over time. Therefore, average price differentials do not tell the whole story, as price differentials may be very different across hours.

Overall average nodal prices BASE* [40 €/t]

Overall average nodal prices NEW price* [90 €/t]



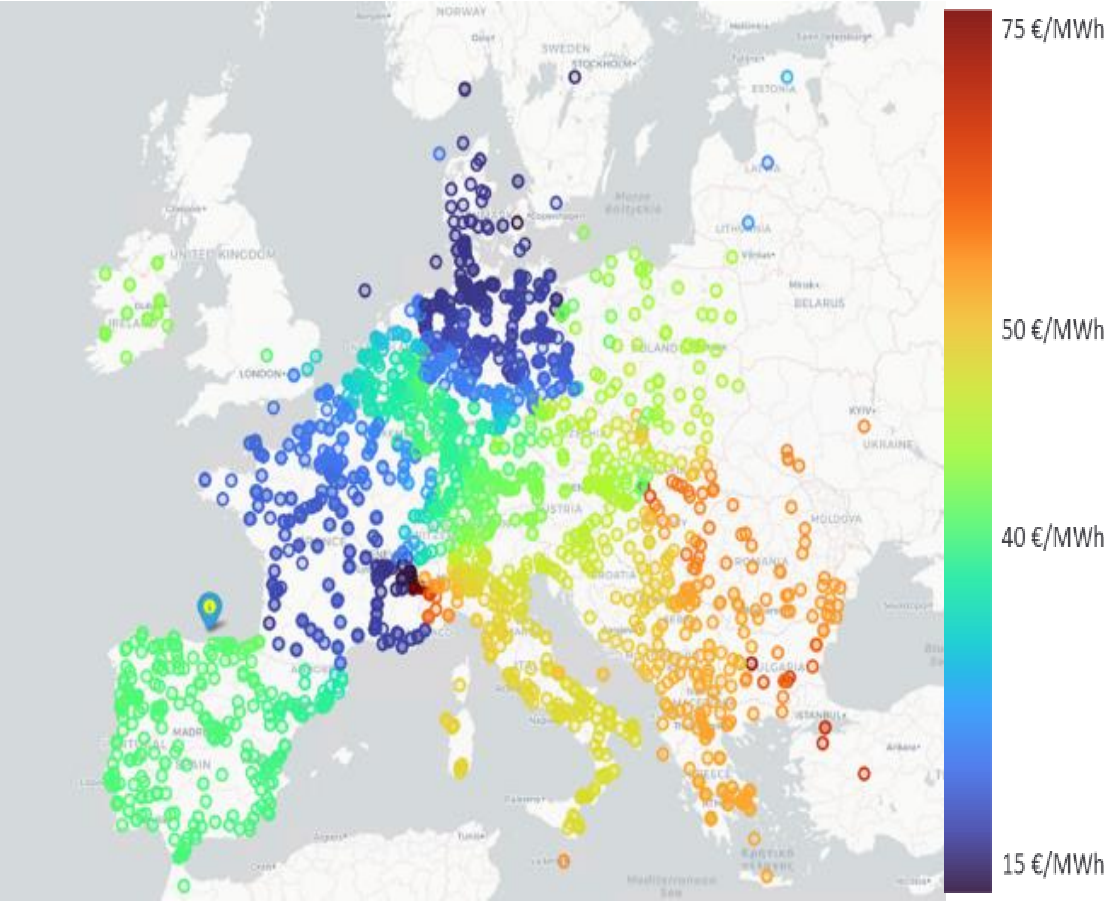
* All network elements >= 380kV are visualized

Visualisation of sensitivity analyses 1995w12

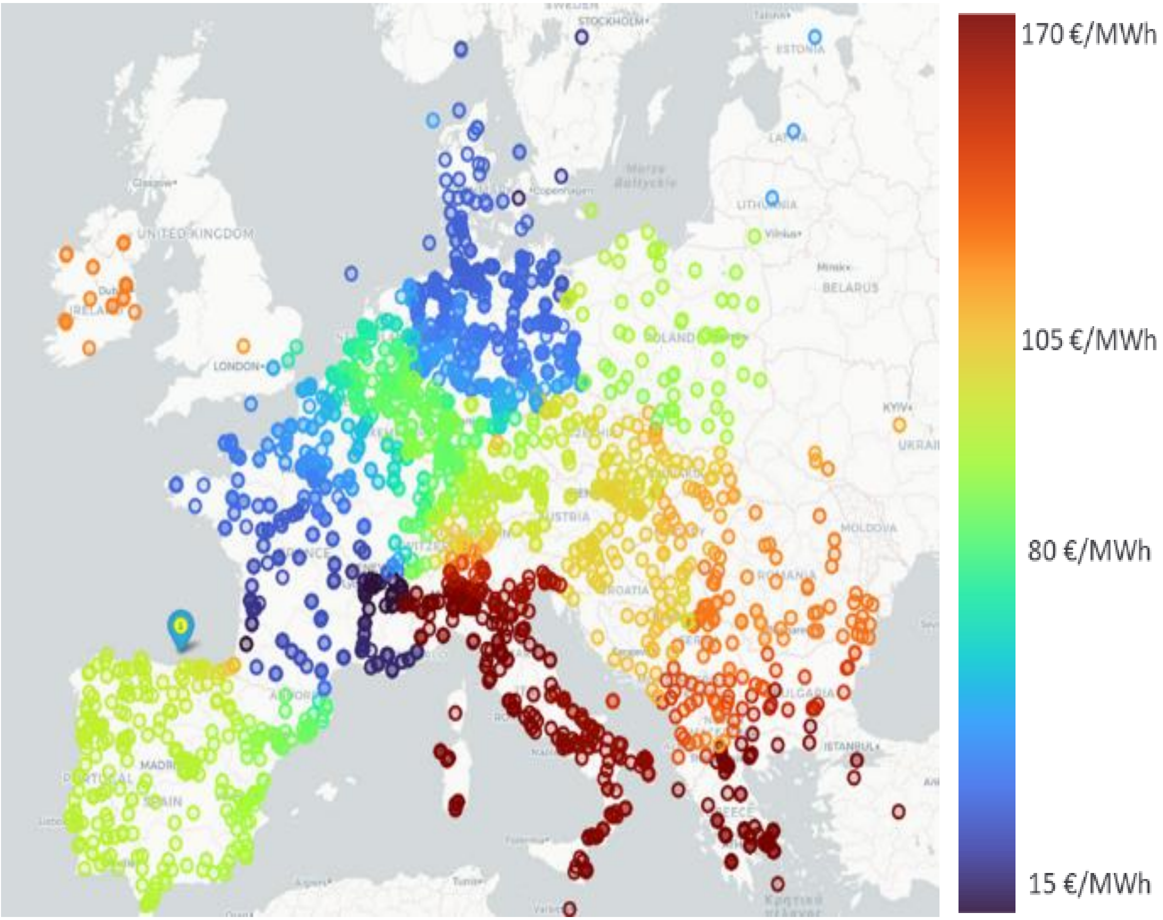
S5 – CO_2 price of 90 EUR/t + increased fuel prices

Fuel / CO2	Main simulations (€/GJ)	Sensitivity run (€/GJ)
Gas	5.57	26.39
Hard coal	2.30	2.68
Oil	10.6-12.9	12.9-15.8
Lignite	1.4-3.1	1,6-3.6
CO2	40	90

Overall average nodal prices BASE*



Overall average nodal prices NEW fuel prices*



* All network elements >= 380kV are visualized

Hourly price differentials can disappear from aggregation over time. Therefore, average price differentials do not tell the whole story, as price differentials may be very different across hours.

Technical complexity

Technical complexity

Integration of non-nodal countries

Bugs and infeasibilities in the simulations

Format integration. Different data sources.

Mapping PSSE to CGM

Enormous Computational power needed: Longer runtimes than expected

Adequate modelling of hydro units

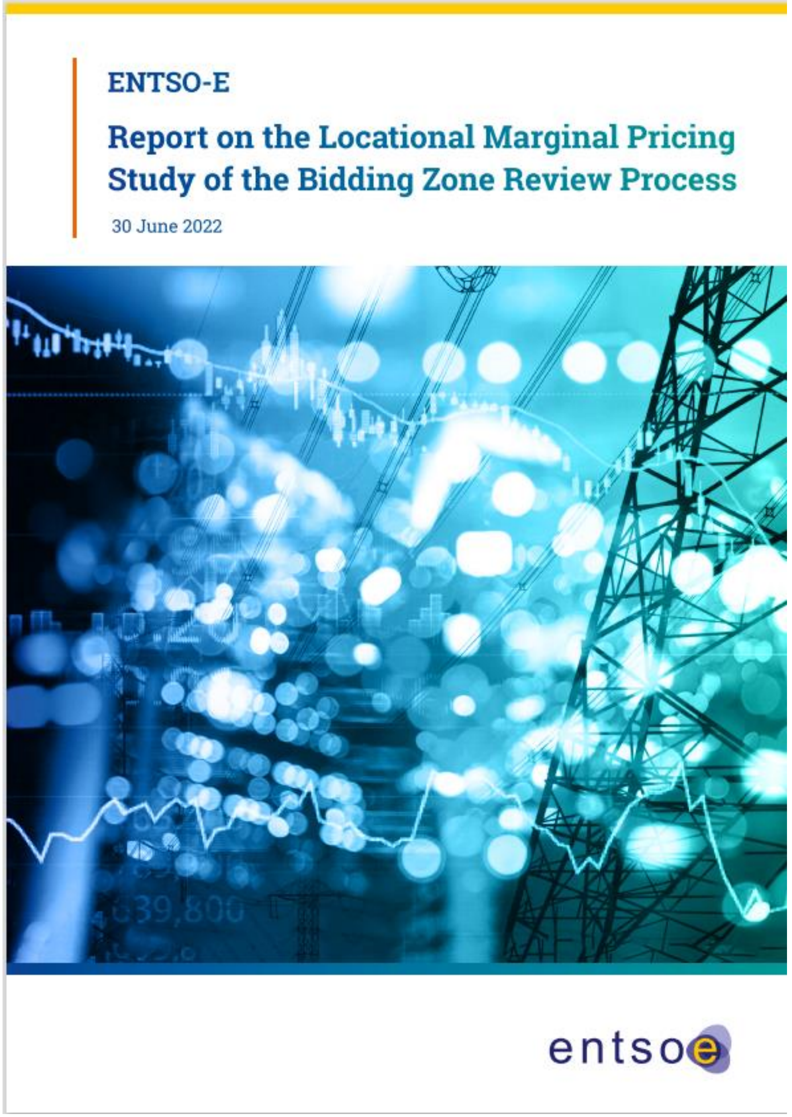
Development of tools for analysing the quality of simulation results

New methodologies developed:

- Climate years and weeks selection
- CNEC selection
- Implicit DSR modelling
- Nodal allocation of generation and load

LMP report

LMP report



[ENTSO-E publishes its report on Locational Marginal Pricing Study of Bidding Zone Review Process (entsoe.eu)]

- Report describes work done in the context of the LMP project. Among others:
  - Legal background
  - Input data, methodologies and tools developed
  - Simulation results

- Pending: LMP input and output data publication

Summary and overview

ENTSO-E LMP project was triggered by ACER in order to have a well-founded input for defining alternative Bidding Zone configurations. Nordic TSOs in parallel also carried out LMP simulations.

Significant part of the work consisted of preparing the database, developing new methodologies according to requirements set by ACER and setting up a large-scale european Nodal Pricing model.

First time that a running nodal Plexos model (for Continental Europe and Ireland) was developed and used for regulatory process within ENTSO-E.

Additional sensitivity runs have been performed in order to proove the validity of methodological assumptions as well as to understand the impact of current commodity price developments on the LMP simulation results.

ENTSO-E LMP work can be used as basis for future studies outside the ENTSO-E community (LMP report is published, data publication pending).

AOB (15 min)

- ACER decision on alternative configurations
- Public Workshop on the 16 September
- Next meeting CG on the 13 October

ENTSO-E Mission Statement

Who we are

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the **association for the cooperation of the European transmission system operators (TSOs)**. The 42 member TSOs, representing 35 countries, are responsible for the secure and coordinated operation of Europe's electricity system, the largest interconnected electrical grid in the world. In addition to its core, historical role in technical cooperation, ENTSO-E is also the common voice of TSOs.

ENTSO-E **brings together the unique expertise of TSOs for the benefit of European citizens** by keeping the lights on, enabling the energy transition, and promoting the completion and optimal functioning of the internal electricity market, including via the fulfilment of the mandates given to ENTSO-E based on EU legislation.

Our mission

ENTSO-E and its members, as the European TSO community, fulfil a common mission: Ensuring the **security of the interconnected power system in all time frames at pan-European level and the optimal functioning and development of the European interconnected electricity markets**, while enabling the integration of electricity generated from renewable energy sources and of emerging technologies.

Our vision

ENTSO-E plays a central role in enabling Europe to become the first **climate-neutral continent by 2050** by creating a system that is secure, sustainable and affordable, and that integrates the expected amount of renewable energy, thereby offering an essential contribution to the European Green Deal. This endeavour requires sector integration and close cooperation among all actors.

Europe is moving towards a sustainable, digitalised, integrated and electrified energy system with a combination of centralised and distributed resources. ENTSO-E acts to ensure that this energy system **keeps consumers at its centre** and is operated and developed with **climate objectives** and **social welfare** in mind.

ENTSO-E is committed to use its unique expertise and system-wide view – supported by a responsibility to maintain the system's security – to deliver a comprehensive roadmap of how a climate-neutral Europe looks.

ENTSO-E Mission Statement

Our values

ENTSO-E acts in solidarity as a community of TSOs united by a shared responsibility.

As the professional association of independent and neutral regulated entities acting under a clear legal mandate, ENTSO-E serves the interests of society by optimising social welfare in its dimensions of safety, economy, environment, and performance.

ENTSO-E is committed to working with the highest technical rigour as well as developing sustainable and innovative responses to prepare for the future and overcoming the challenges of keeping the power system secure in a climate-neutral Europe. In all its activities, ENTSO-E acts with transparency and in a trustworthy dialogue with legislative and regulatory decision makers and stakeholders.

Our contibutions

ENTSO-E **supports the cooperation** among its members at European and regional levels. Over the past decades, TSOs have undertaken initiatives to increase their cooperation in network planning, operation and market integration, thereby successfully contributing to meeting EU climate and energy targets.

To carry out its **legally mandated tasks**, ENTSO-E's key responsibilities include the following:

- Development and implementation of standards, network codes, platforms and tools to ensure secure system and market operation as well as integration of renewable energy;
- Assessment of the adequacy of the system in different timeframes;
- Coordination of the planning and development of infrastructures at the European level (Ten-Year Network Development Plans, TYNDPs);
- Coordination of research, development and innovation activities of TSOs;
- Development of platforms to enable the transparent sharing of data with market participants.

ENTSO-E supports its members in **the implementation and monitoring** of the agreed common rules.

ENTSO-E is the common voice of European TSOs and provides expert contributions and a constructive view to energy debates to support policymakers in making informed decisions.

Our values define who we are, what we stand for and how we behave.
We all play a part in bringing them to life.

EXCELLENCE

We deliver to the highest standardss. We provide an environment in which people can develop to their full potential.

TRUST

We trust each other, we are transparent and we empower people. We respect diversity.

INTEGRITY

We act in the interest of ENTSO-E

TEAM

We care about people. We work transversal and we support each other. We celebrate success.

FUTURE THINKING

We are a learning organisation. We explore new paths and solutions.

We are ENTSO-E