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WEBINAR

Innovations in electricity market design for solar and wind integration - Lessons learned from Europe

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Moderated by:
Arina Anisie, IRENA Innovation and Technology Centre

TUESDAY, 20 October 2020 • 16:00 – 17:00 CEST

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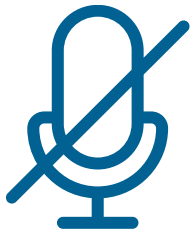

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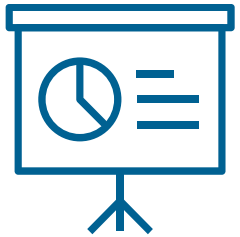
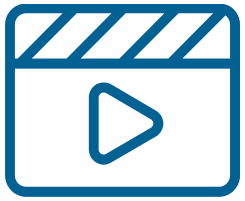
If you have **Questions** to the speaker please use the dedicated **Q&A** tab





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SPEAKERS

Mathieu Fransen
ACER

Elena Ocenic
IRENA

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AGENDA

Innovations in electricity market design for solar and wind integration

Setting the scene:

- **Innovation landscape for a renewable-powered future**, Arina Anisie, IRENA

Presentations:

- **Overview of innovations in electricity market design,** Elena Ocenic, IRENA
- **Insights into the European electricity market,** Mathieu Fransen, ACER

Q&A

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SETTING THE SCENE
Innovation Landscape for a renewable-powered future

Arina Anisie, IRENA

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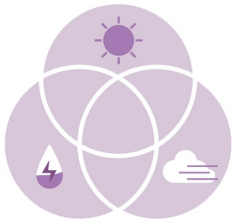
Emerging innovations for the integration of solar and wind power

SYSTEM OPERATION

Operation of a decentralised system

Electrification of end-use sectors

Value complementaries in renewable generation



ENABLING TECHNOLOGIES

Digitalisation

Hydrogen

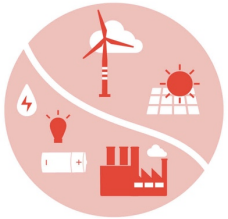
Blockchain

Storage

Electric vehicles

MARKET DESIGN

Encourage flexibility



Empowering consumers

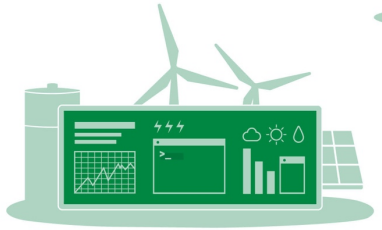
Value spatial complementaries

BUSINESS MODELS

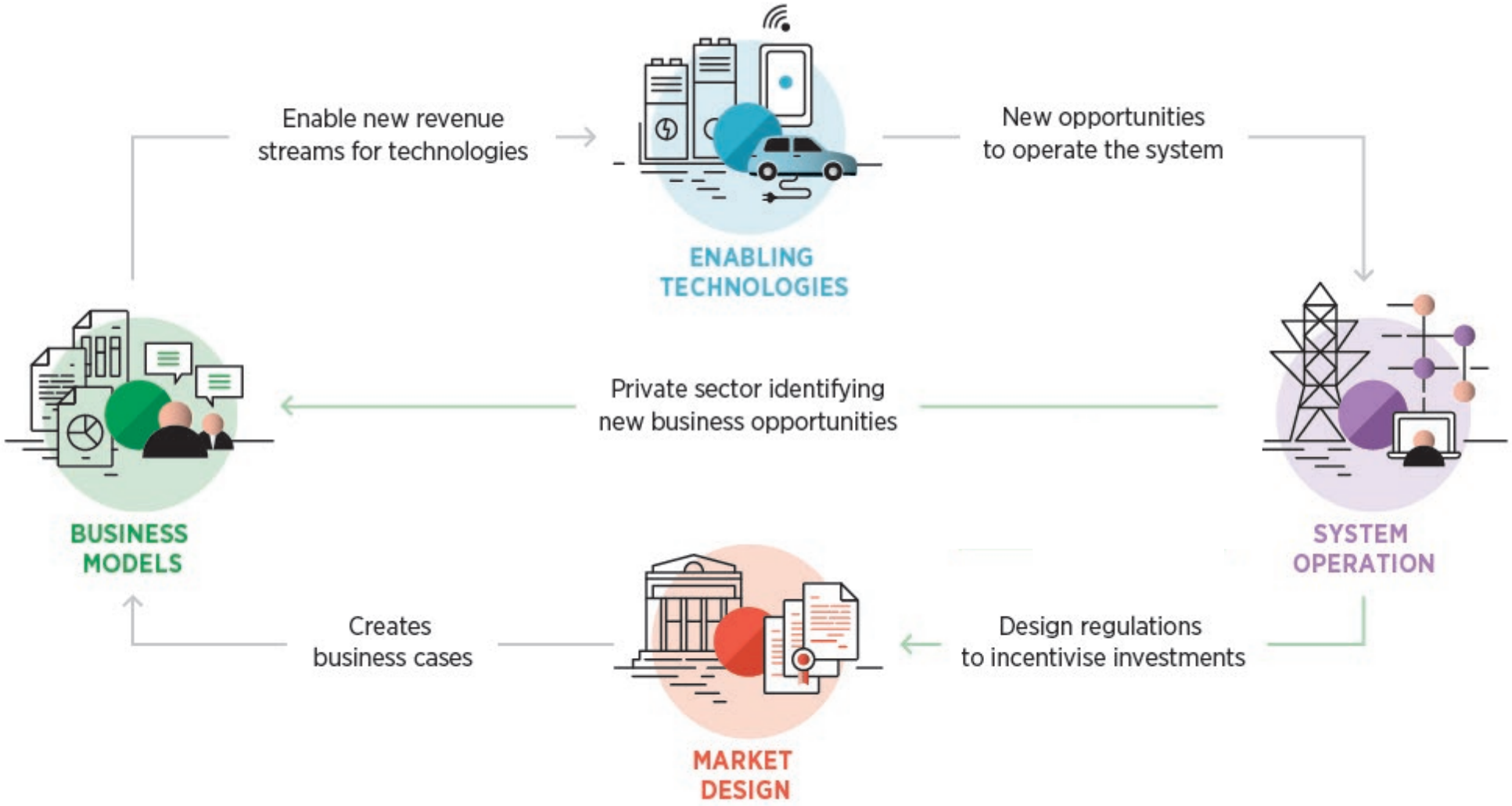
Energy as a service

Peer-to-peer electricity trading

Aggregators



Systemic innovation for an integrated renewable energy system



IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

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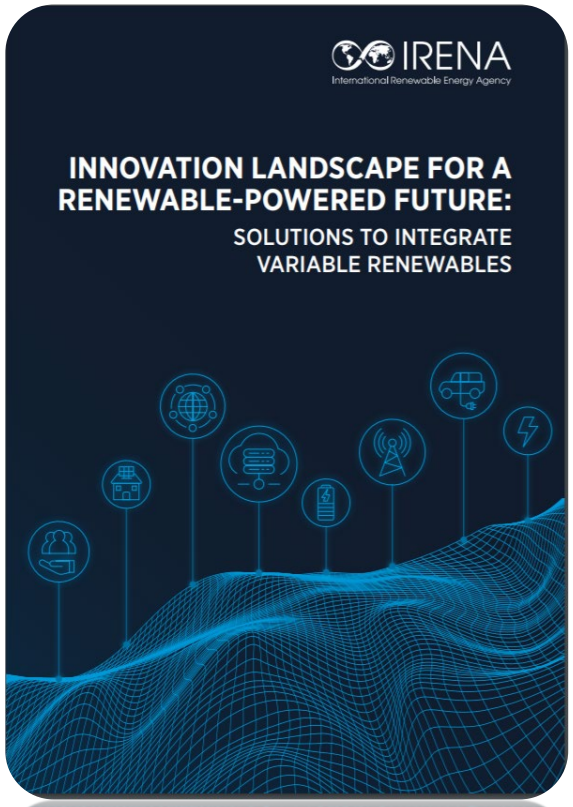
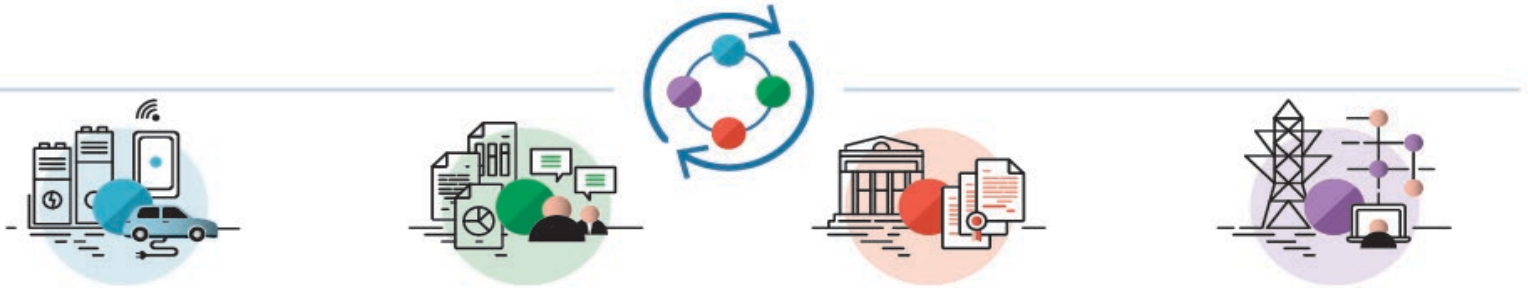
Emerging innovations for wind and solar PV integration



Innovation Landscape Report



ENABLING TECHNOLOGIES

1	Utility-scale batteries
2	Behind-the-meter batteries
3	Electric-vehicle smart charging
4	Renewable power-to-heat
5	Renewable power-to-hydrogen
6	Internet of things
7	Artificial intelligence and big data
8	Blockchain
9	Renewable mini-grids
10	Supergrids
11	Flexibility in conventional power plants

BUSINESS MODELS

12	Aggregators
13	Peer-to-peer electricity trading
14	Energy-as-a-service
15	Community-ownership models
16	Pay-as-you-go models

MARKET DESIGN

17	Increasing time granularity in electricity markets
18	Increasing space granularity in electricity markets
19	Innovative ancillary services
20	Re-designing capacity markets
21	Regional markets
22	Time-of-use tariffs
23	Market integration of distributed energy resources
24	Net billing schemes

SYSTEM OPERATION

25	Future role of distribution system operators
26	Co-operation between transmission and distribution system operators
27	Advanced forecasting of variable renewable power generation
28	Innovative operation of pumped hydropower storage
29	Virtual power lines
30	Dynamic line rating

Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

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30 Innovation Briefs

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https://www.irena.org/publications/2019/Feb/Innovation-landscape-for-a-renewable-powered-future

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Digital Innovation Toolbox

Innovation Toolbox

Innovations

Rapidly integrating solar and wind power to cut emissions and meet key climate goals poses technical and economic challenges.

Innovation Toolbox offers **30 innovations** emerging across four key dimensions: enabling technologies, business models, market design and system operation.

These innovations can be mixed and matched as needed to create solutions. While the combinations could be endless, the Toolbox outlines **11 solutions** as examples of how to achieve system-wide synergies.

Explore the **Innovation Toolbox** based on your own technical, economic or societal requirements:

- Select from the 30 innovations on the left to discover each in more detail.
- Select a solution to see how different innovations can work together.

Access tutorial to learn how to use to the Toolbox.

more

Flexibility solutions

Supply-side: I II

Grid: III IV V

https://www.irena.org/innovation/Toolbox

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Power sector transformation

- Electrification of end-use sectors is an emerging solution to **maintain value and avoid curtailment of VRE**, and help decarbonize other sectors

- The increasing deployment of Distributed Energy Resources (DERs) turns the consumer into an active participant, **fostering demand-side management**.

- Digital technologies enable **faster response, better management of assets, connecting devices, collecting data, monitor and control**

Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

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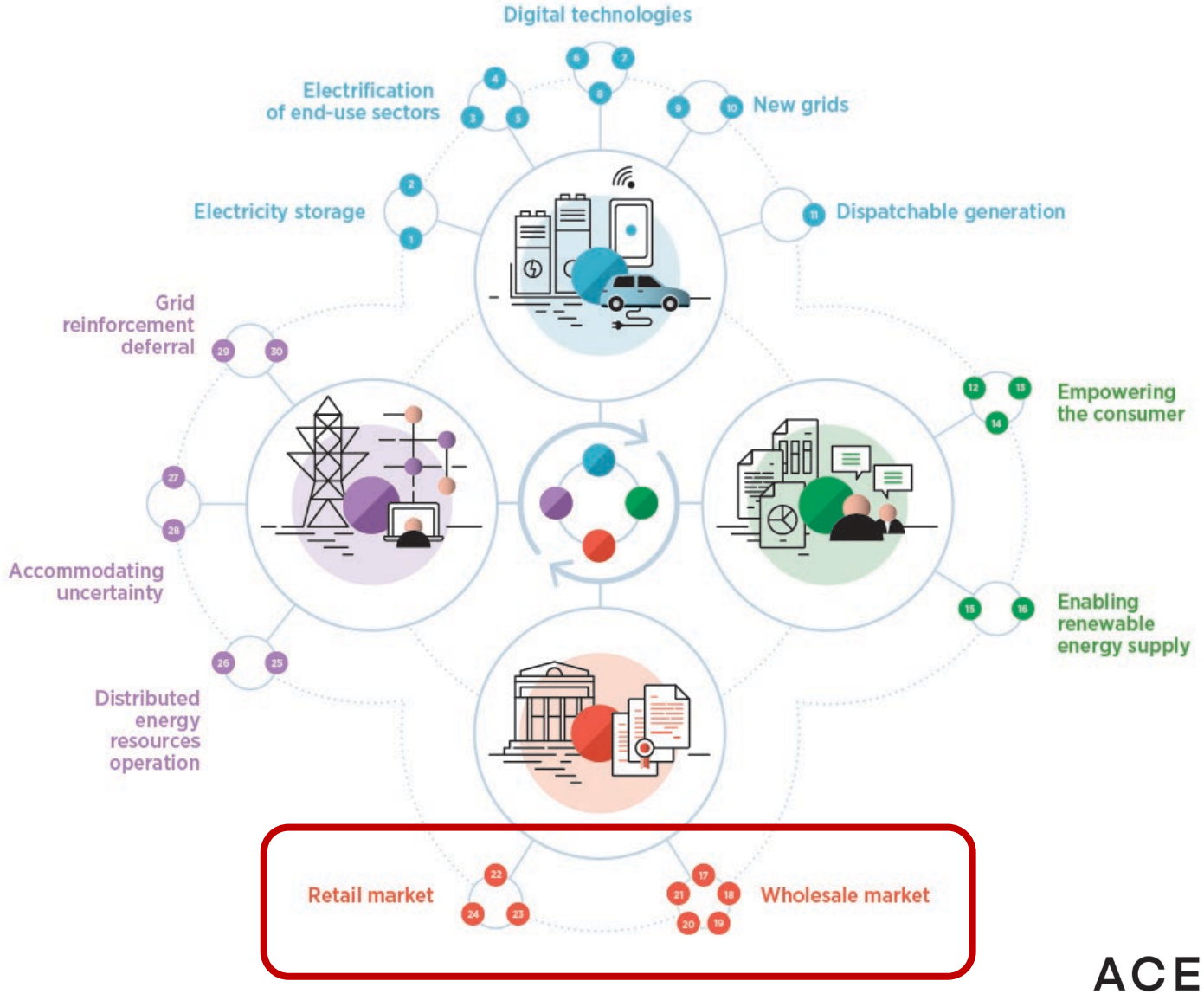
Overview of innovations in electricity market design

Elena Ocenic, IRENA

IRENA's innovation landscape for VRE integration



IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

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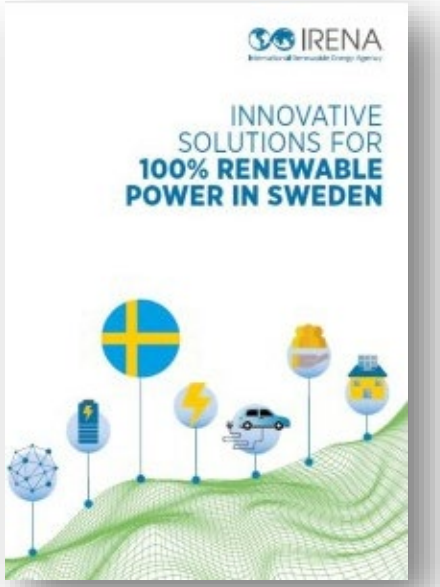
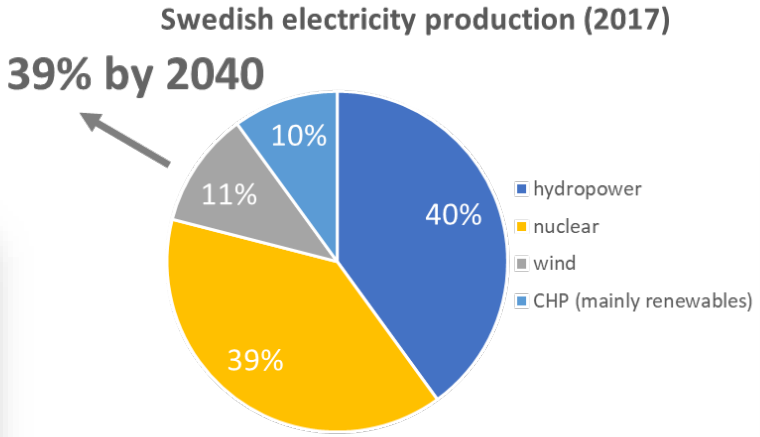
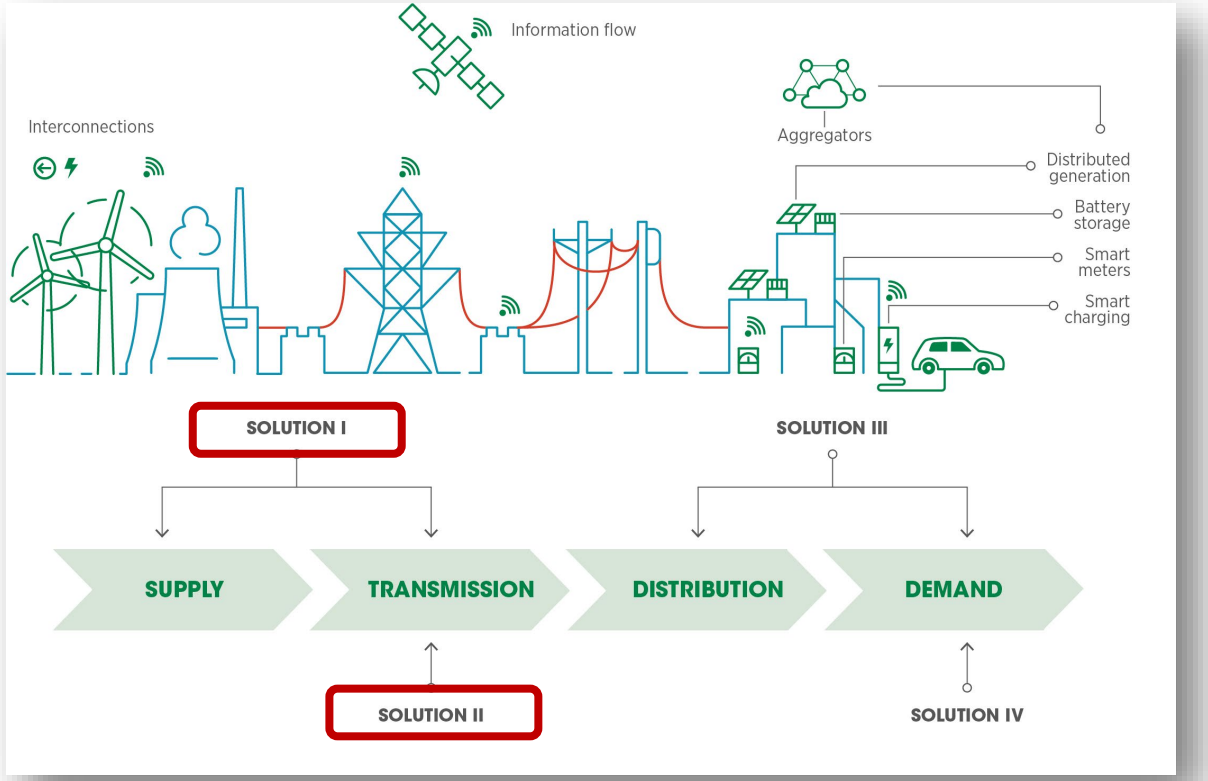
Each solution tackles a power sector segment





Key system operation challenges:

- **Ensuring power system stability**: annual average inertia is expected to decrease from 202 GWs (2020) to 159 GWs (2040);
- **Balancing demand and supply:** greater consumption in the South and significant hydropower generation in the North;
- **Expanding the network:** long lead times for distribution & transmission infrastructure (EUR 15 billion to be invested by 2025).



IRENA (2020), Innovative solutions for 100% renewable power in Sweden

Example of solution combining innovations

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Enabling technologies

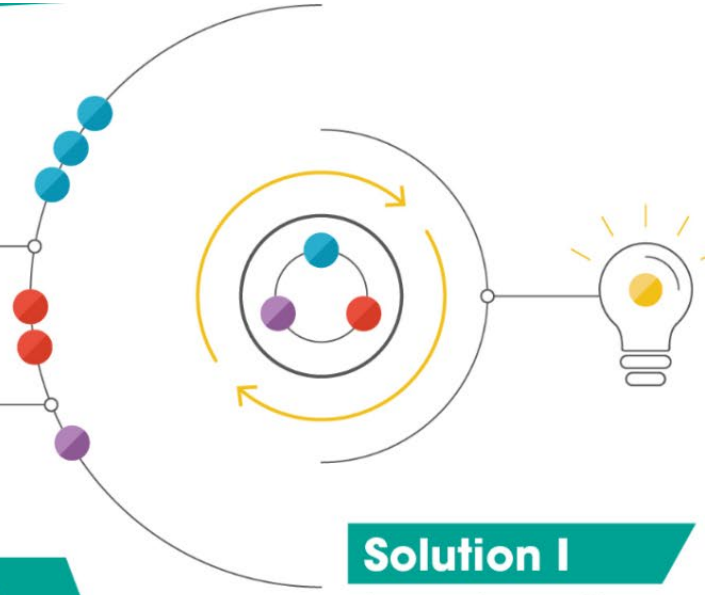
- Utility-scale batteries
- Internet of Things
- Artificial intelligence and big data

Market design

- Increasing time granularity in electricity markets
- Innovative ancillary services

System operation

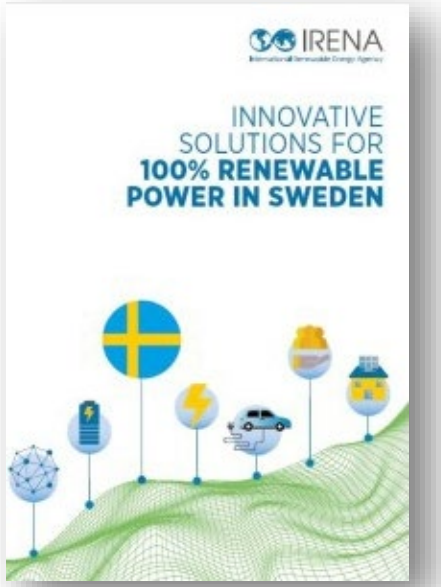
- Advanced weather forecasting of variable renewable power generation



- Provides innovative ancillary services both from conventional and variable renewable energy sources;
- Ensures the security and stability of the power system and the provision of new ancillary services, including frequency and voltage support from VRE sources;
- Enables the provision of such ancillary services with the help of more precise solar and wind power generation forecasts.

Solution I

Innovative ancillary services from both conventional and variable renewable energy sources



Sweden – Battery energy storage system at Forshuvud hydropower plant for better ancillary services

Sweden – VRE participating in the existing ancillary service market

Germany – EWeLiNE, ORKA, ORKA2 and Gridcast projects improving VRE generation forecasts

United States – Flexibility incentivised in California with innovative ancillary services

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Example of solution combining innovations

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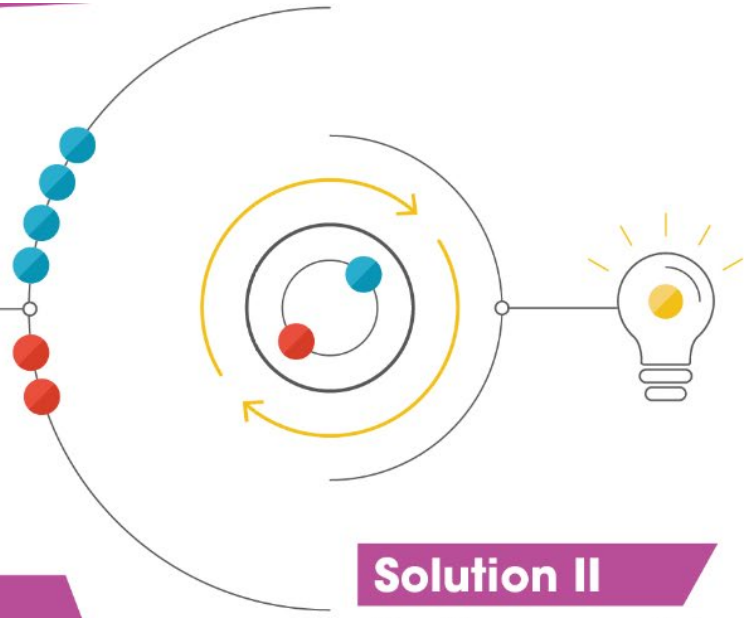
Enabling technologies

- Internet of Things
- Artificial intelligence and big data
- Blockchain
- Supergrids

Market design

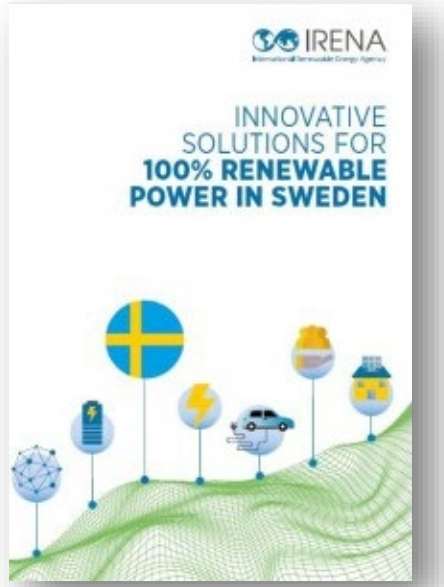
- Increasing time granularity in electricity markets
- Regional markets



Solution II

Pan-European market as flexibility provider with effective collaboration among system operators

- Improves flexibility in the existing pan-European market design;
- Fosters collaboration among system operators in Sweden, the Nordic, Baltic and wider European region;
- Ensures clear and effective division of responsibilities to manage an increasingly complex, decentralised and digitalised power system.



Europe – intraday trading between non-adjacent market areas

Europe – 15- and 30-minute intraday products traded closer to real-time delivery

Denmark – 53% VRE integration thanks to supergrids and regional market

European transmission system operators – pilots for a common balancing market

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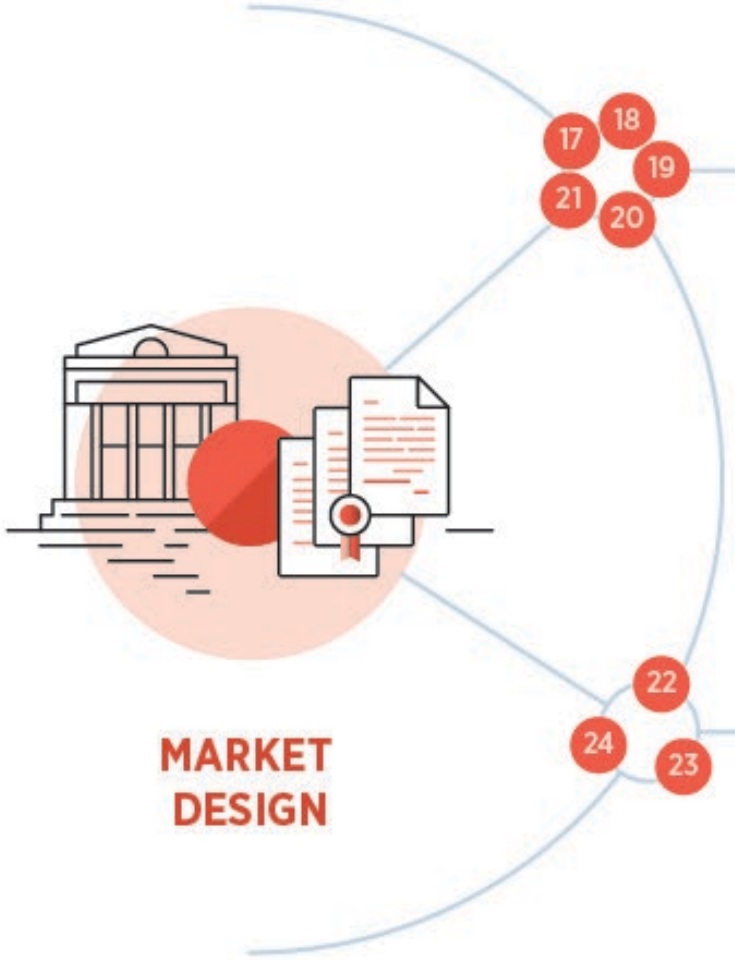
Market design innovations



Wholesale market

- **17** Increasing time granularity in electricity markets
- **18** Increasing space granularity in electricity markets
- **19** Innovative ancillary services
- **20** Re-designing capacity markets
- **21** Regional markets

Retail market

- **22** Time-of-use tariffs
- **23** Market integration of distributed energy resources
- **24** Net billing schemes

IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

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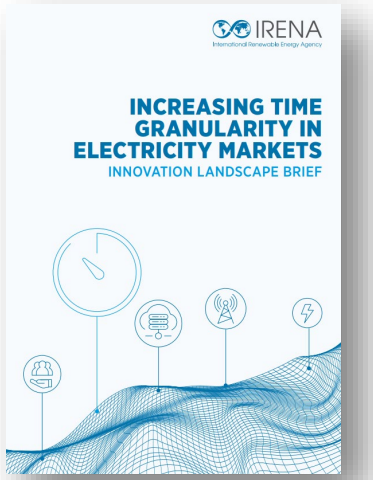
Increasing time granularity in electricity markets



How to internalize the value of flexibility in the market price?

- Reducing the **market time units** (the duration of dispatch);
- Reducing the time span between **trading gate closure** and **physical real-time delivery** of power (the lead time).

1 BENEFITS

Increasing time granularity in electricity markets

Short term:

Improved flexibility in operations through price signals

Long term:

Optimised investments in flexible generation capacity (through granular price signals)

Enable higher shares of VRE in the power system

2 KEY ENABLING FACTORS

- Advanced computational power and optimisation modelling software
- Efficient price formation in well-functioning markets

3 SNAPSHOT

- Shorter market time units are explored in California (United States), Brazil, Germany and other European markets.
- Shorter lead times are proposed in Australia, the Nordic power market in Europe (reduced to 15 minutes), Austria, Belgium and Germany (reduced to 5 minutes).

IRENA (2019), Innovation landscape brief: Increasing time granularity in electricity markets

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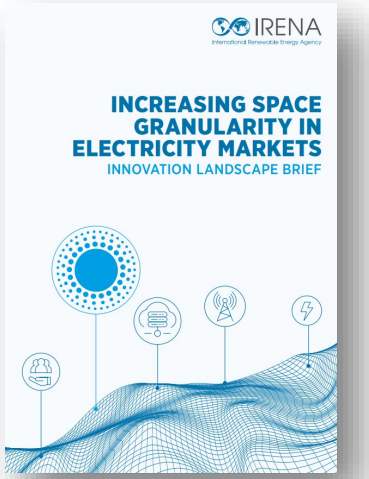
Increasing space granularity in electricity markets (I)

Why?

Zonal and nodal pricing reflect grid congestions. Increasing space granularity in electricity markets can help reduce re-dispatch costs and drive investments where most needed.



1 BENEFITS

Increasing space granularity in electricity markets

Short term:

Avoid costly re-dispatch and incentivise demand response in areas with high prices

Long term:

Optimise network and generation capacity investments through price signals

Incentivise investments in VRE generation in areas with high prices

Incentivise investments in the grid between areas with high price differences

2 KEY ENABLING FACTORS

Advanced computational power and optimisation modelling software

Clear and transparent pricing methodology

IRENA (2019), Innovation landscape brief: Increasing space granularity in electricity markets

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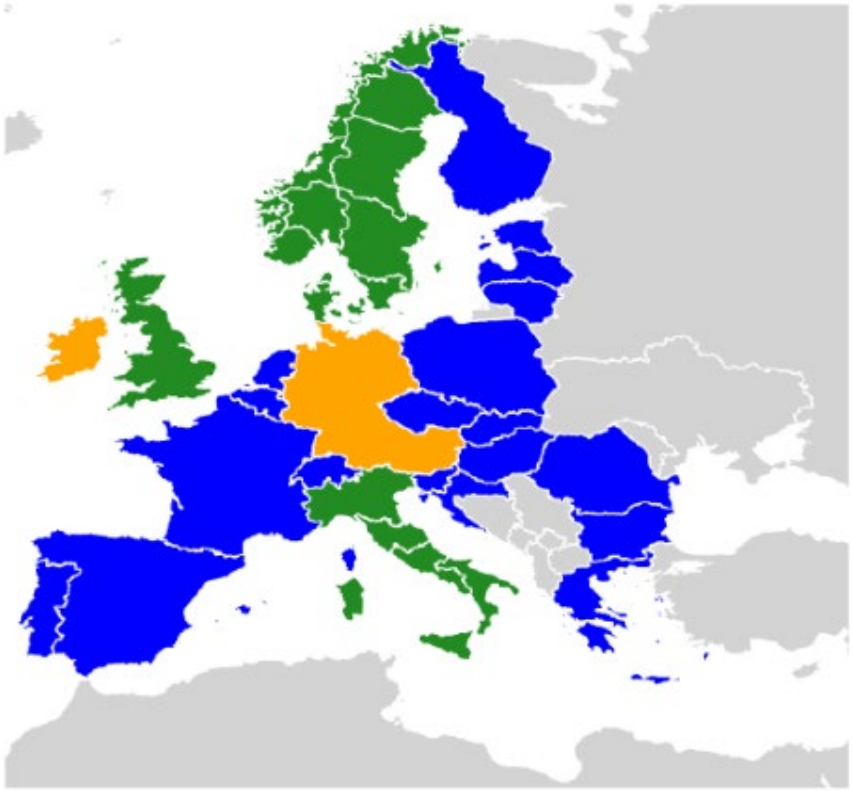
Increasing space granularity in electricity markets (II)

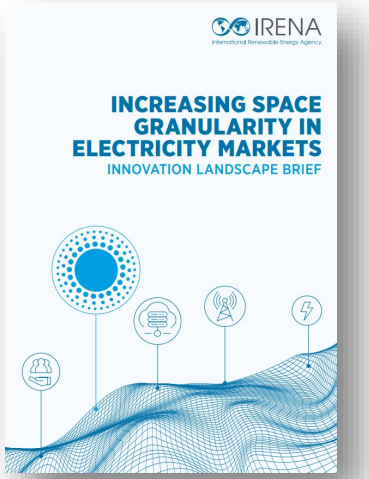
3 SNAPSHOT

- In the US, ERCOT (Texas) has more than 4 000 pricing nodes, while NYISO (Ney York) has 11 zones. This encourages investments in areas with the highest demand and reduces consumption.
- In Europe, some countries divide their national transmission system into more bidding zones: Denmark (2), Italy (6), Norway (5) and Sweden (4).

European bidding zones



Note: Germany and Austria are distinct bidding zones since 2018



IRENA (2019), Innovation landscape brief: Increasing space granularity in electricity markets
IRENA – Energy Community (2018) - Joint Workshop on Grid Integration of Variable Renewable Energy Sources

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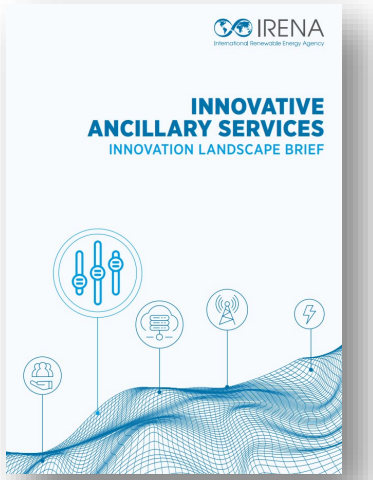
Innovative ancillary services



Why?

Ancillary services are vital to support power system operation. There are two types: **frequency** and **non-frequency** services (voltage control, black start).

3 SNAPSHOT

- Batteries can provide ancillary services in Australia, Belgium, Germany, Netherlands, UK and USA
- Wind power generators can provide balancing services in nine European countries
- A US system operator uses separated ramping products to help the system meet ramping needs
- The exchange of balancing services across borders in Europe is increasing
- Local flexibility markets emerge in Germany and UK, where ancillary services are procured by the DSOs

1 NEW ANCILLARY SERVICE PRODUCTS AND MARKET PARTICIPANTS

New products
- Ramping products
- Fast response frequency reserve

New market participants
- Wind turbines providing inertial response
- Solar PV and batteries providing voltage support
- Distributed energy resources providing frequency and voltage control

→ **Increased flexibility for VRE integration**

2 KEY ENABLING FACTORS

- Defining performance-based products
- Separating capacity and energy products, and contracting periods
- Separating upwards and downwards balancing products

IRENA (2019), Innovation landscape brief: Innovative ancillary services

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Redesigning capacity markets

Why?

Some power systems need a mechanism, like capacity markets, to ensure **generation adequacy** and **security of supply**.

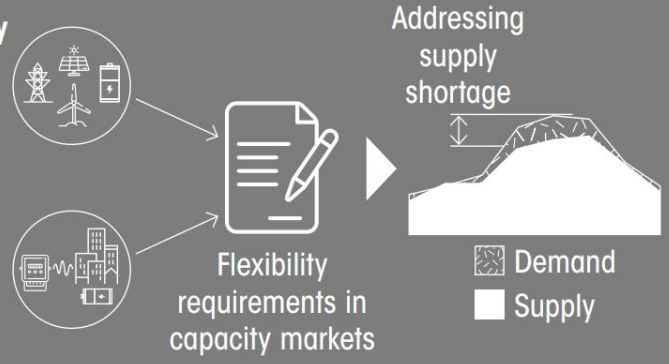
1 KEY INNOVATIONS IN CAPACITY MARKETS

Introducing flexibility requirements to ensure new flexible capacity additions

Allowing new participants in the market, such as storage, interconnections, demand response and VRE resources

Supply-side capacity resource:
- VRE resources
- Battery storage
- Interconnectors

Demand-side capacity resources:
- Demand response



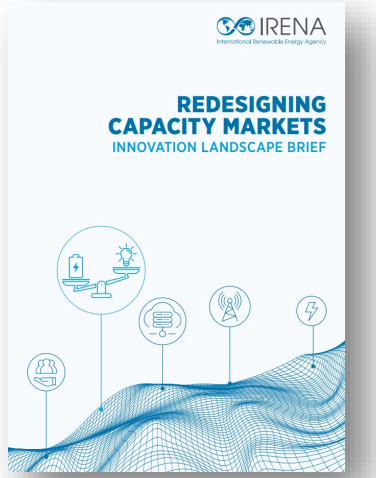
2 KEY ENABLING FACTORS

Adoption of a clear methodology for defining the capacity credit of VRE resources

Deployment advanced metering infrastructure for demand-side participation

3 SNAPSHOT

- Under the French capacity mechanism, consumers with flexible loads can opt to provide **demand response**.
- In Alberta, Canada, the capacity markets require all participants to submit **the ramping capability**.
- In the single electricity market of Ireland and United Kingdom, **interconnectors, renewable energy sources and demand response are allowed** to participate in capacity markets.



IRENA (2019), Innovation landscape brief: Redesigning capacity markets

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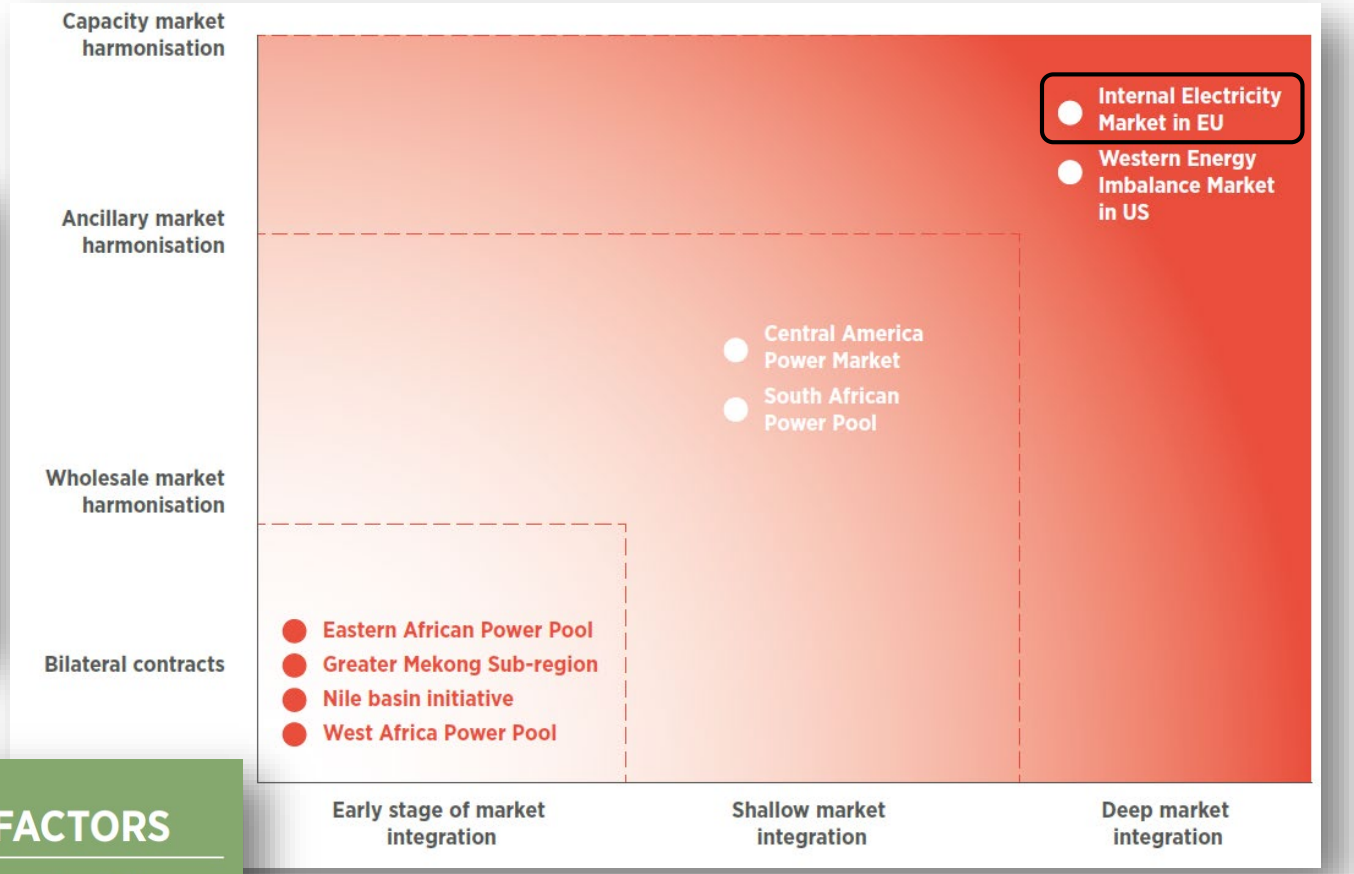
Regional markets

1 HOW IT WORKS

Regional markets require the harmonisation of market rules for electricity to flow freely in response to market-based price signals. The deeper the integration, the more rules needs to be harmonised. There are different stages of market integration:



2 BENEFITS

- Increased flexibility through expanding balancing area
- Advantages of spatial complementarity of VRE generation
- Co-ordinate generation planning
- Reduce system operation cost

3 KEY ENABLING FACTORS

- Physical interconnections with sufficient capacity
- Regional mindset, strong institutional arrangements and governance model
- Robust IT system for market operation

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Insights into the European electricity market

Mathieu Fransen, ACER

Agenda

EU Electricity wholesale market - MMR Key findings at a glance

- Efficient use of cross-zonal capacity

- Maximise cross zonal capacity

- Cost-efficient Security of Supply

Forward looking market design innovations

EU Electricity wholesale market - MMR Key findings at a glance

Objective (CEP)	Target	Indicator	Current level
"Efficient use of the available cross zonal capacity"	**100%**	Efficient use of cross-zonal capacity across all market timeframes	✓ **87%** in the DA timeframe
"Maximise the amount of cross-zonal capacity available for trade"	**70%**	share of capacity of network elements offered for trade	✗ **Often below 20%***
"Ensure security of supply in a cost-efficient manner"	Capacity markets should be implemented only when and where adequacy issues are expected and after removing market distortions		✗ Potential inconsistency between established CMs and expected adequacy issues

**For example, in the CWE region the average capacity available for trade on the weakest network each hour was below 20% for the period 2016-2018*

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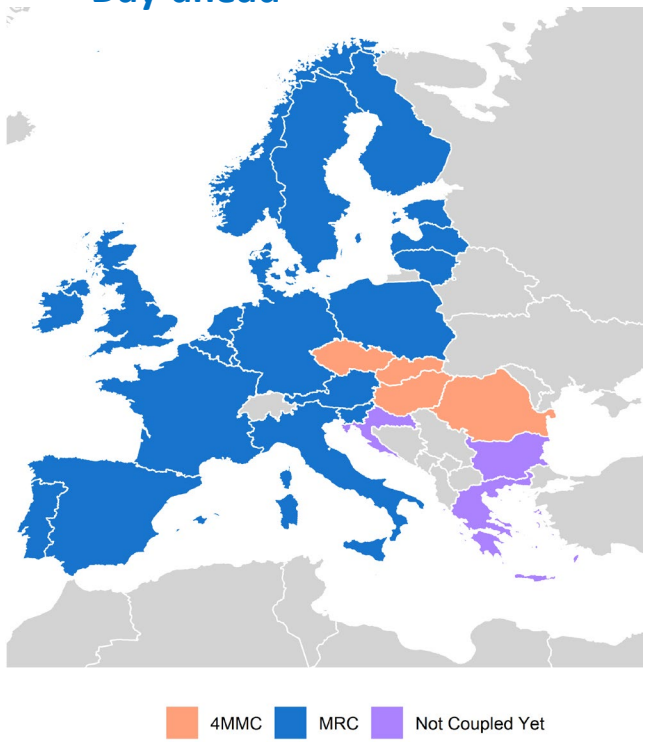
Electricity wholesale : efficient use of cross-zonal capacity

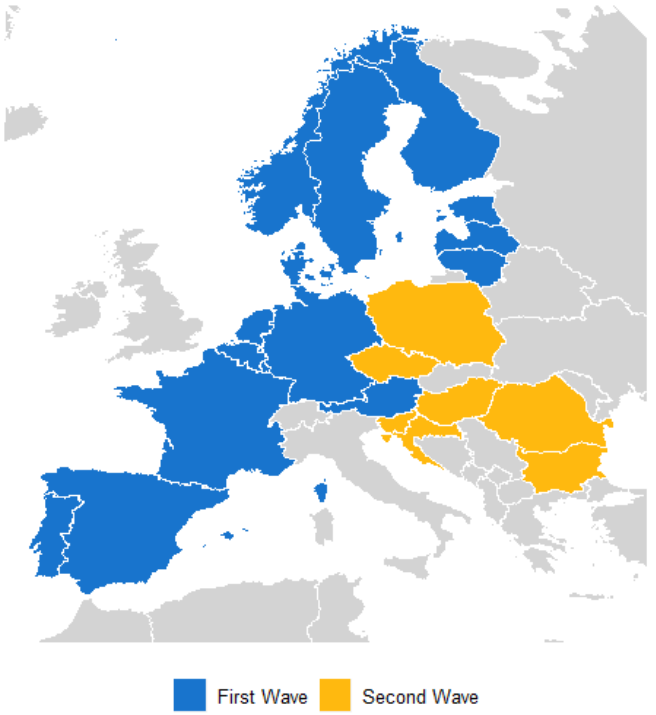
The completion of DA and ID markets integration through market coupling is getting closer…

Implementation status of single DA and ID market coupling (November 2019)

Day-ahead

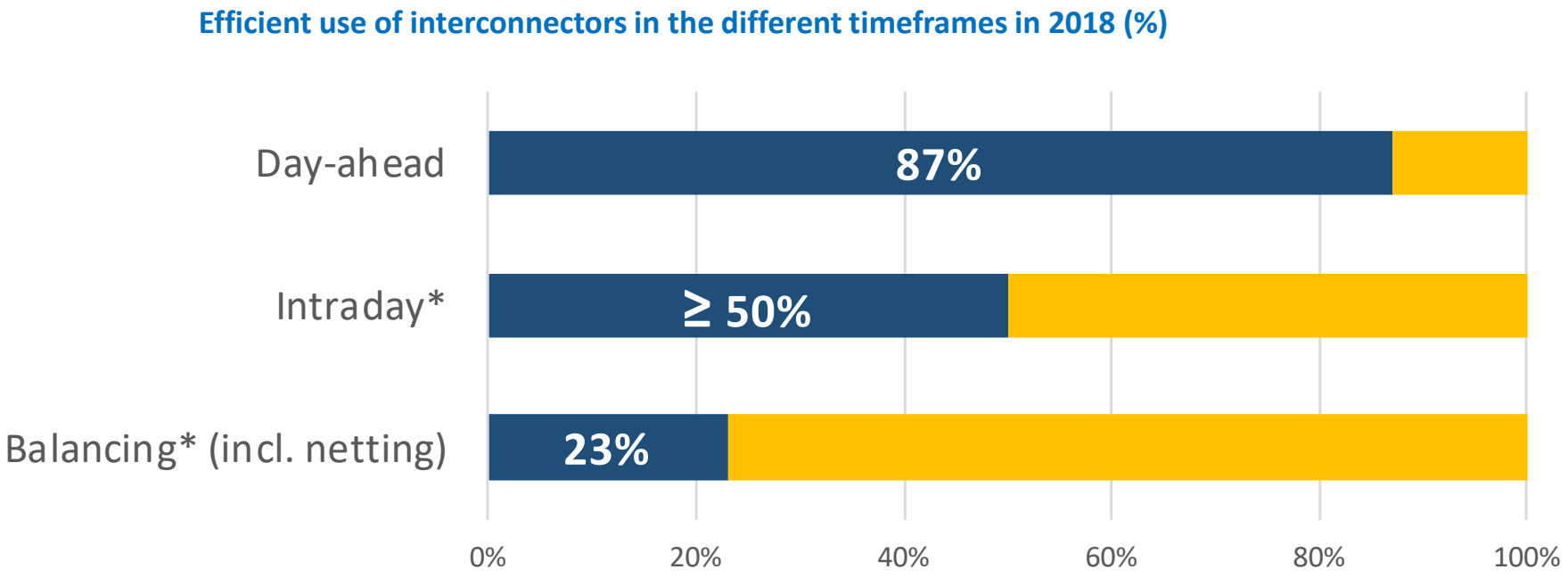


Intraday



Electricity wholesale : efficient use of cross-zonal capacity

..as a result, the (limited) cross-border capacity made available to the market is used very efficiently in the DA timeframe. In the ID and balancing timeframes there is significant room for improvement.



Note: * ID and balancing values are based on a selection of EU borders.

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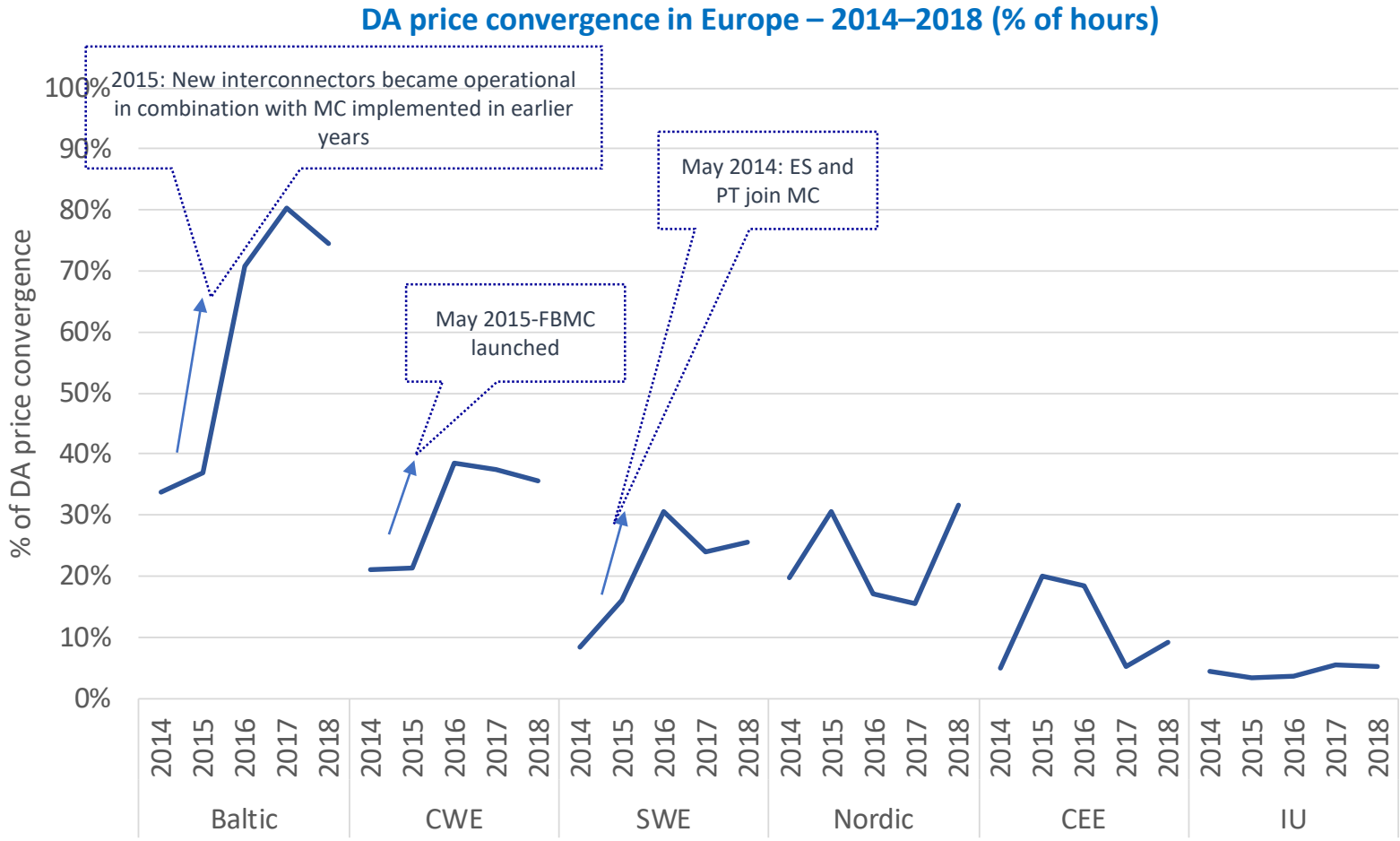
Electricity wholesale : efficient use of cross-zonal capacity

Market coupling contributes to price convergence, although price convergence is not an objective as such



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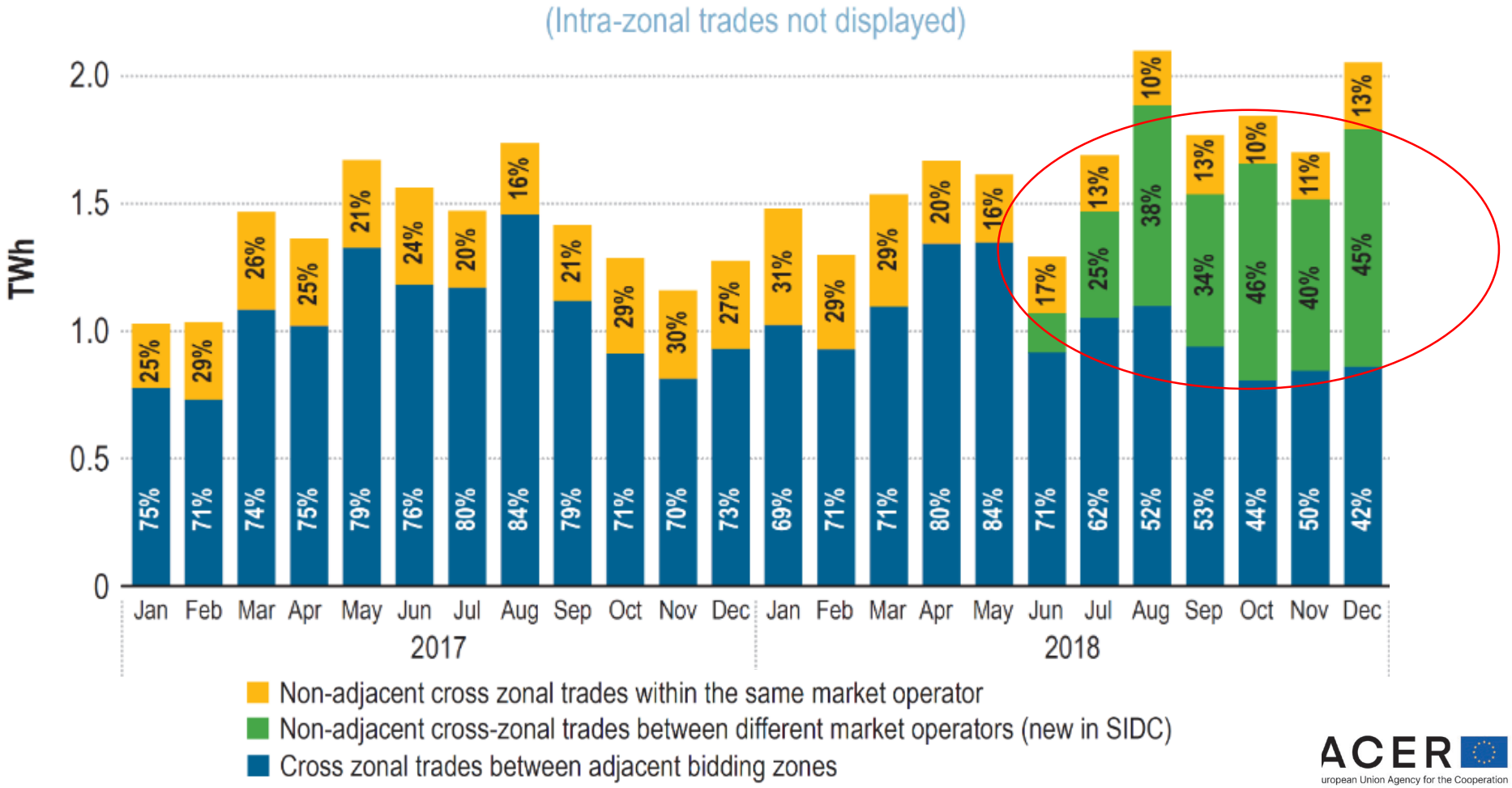
Electricity wholesale : efficient use of cross-zonal capacity

Market coupling brings additional benefits, e.g. increased ID liquidity enabling market participants' access to a larger portfolio of bids and offers to balance their positions

Monthly evolution of the cross-zonal intraday traded volumes for all continuous trading markets 2017–2018 (TWh)



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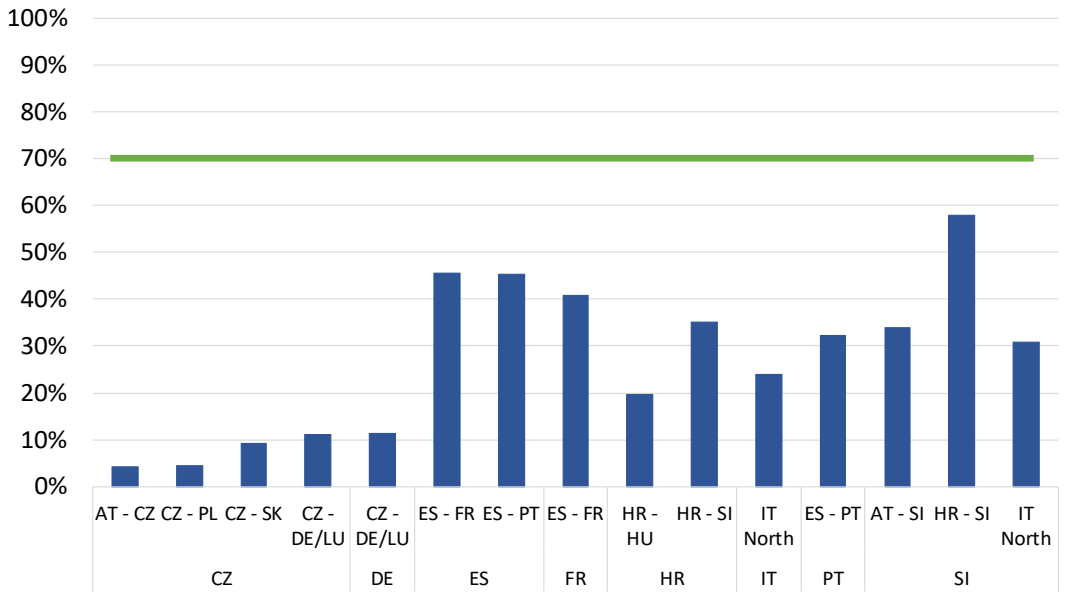
Electricity wholesale markets: maximise cross zonal capacity

- The **calculation of cross-zonal capacity** is crucial for the internal electricity market. It should ensure the efficient management of network congestion, along with the management of remedial actions, network investments and the definition of bidding-zones
- Although some progress was achieved in this area over the years, the level of efficiency, transparency and non-discrimination expected by the European legal and regulatory framework has not fully been reached.
- The recast Electricity Regulation provides a new opportunity to improve congestion management while ensuring a minimum level of cross-zonal capacity (70% target*)
- Following a request from the cross-border committee, **ACER,** in close coordination with the EC, NRAs, TSOs and ENTSO-E, **adopted a Recommendation in August**
- Based **on this Recommendation**, and on ad-hoc data provided by TSOs, the **levels of margin available for cross-zonal trade (MACZT) can be estimated in a harmonised manner.**
- **The monitoring of MACZT estimates the flows induced by cross-zonal trade within the EU** (and with third countries, subject to conditions)

Electricity wholesale markets: maximise cross zonal capacity

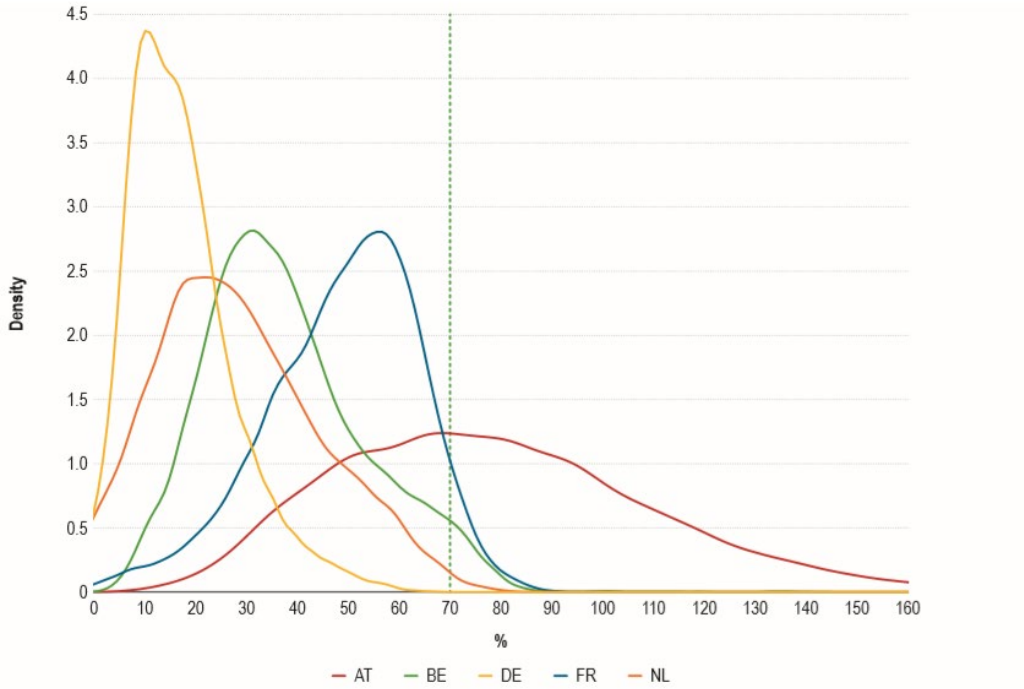
- Increasing the share of physical capacity offered for cross-zonal trade remains a priority: important efforts needed to reach the 70% CEP target

Average relative margin available for cross zonal trade (MACZT) on selected AC bidding-zone borders in Europe – 2016–2018



Note: The average relative MACZT is computed over all declared critical network elements, taking EU bidding-zone borders into account. The margin available for trade on a given border is displayed from the perspective of the two Member States at both sides of the border.
Member States and borders are selected based on the confidence in data, i.e. only borders for which the confidence was sufficient are displayed.

Density function of the lowest hourly relative MACZT of CNECs in the Core (CWE) region, per MS – 2016–2018



Source: ACER calculations based on ENTSO-E/TSOs and Nordpool data.
Note: For each MS, the density describes the relative frequency of the value among all considered values. Part of the density function lies beyond 160% for Austria.

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Electricity wholesale markets: cost-efficient Security of Supply

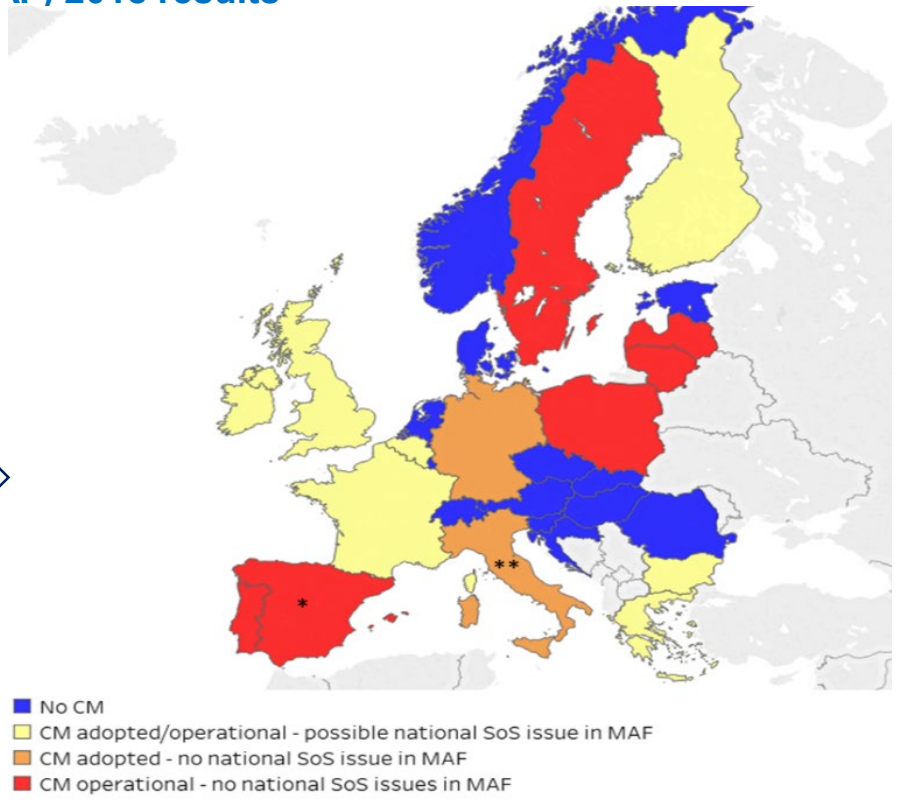
Several Member States have established or plan to establish a Capacity Mechanism, whereas a number of these Member States do not seem to face an adequacy problem in 2020 or 2025

Facts:

- *CMs continued to emerge in Europe (six mechanisms approved by the EC in February 2018).*
- *More than **2.5 billion euros** spent in CMs in Europe in 2018. Costs related to CMs expected to increase in the future.*

- Entso-E's MAF results (2020-2025)
- Conservative reliability standards

Perceived need for Capacity Mechanisms based on the ENTSO-E mid-term adequacy forecast (MAF) 2018 results



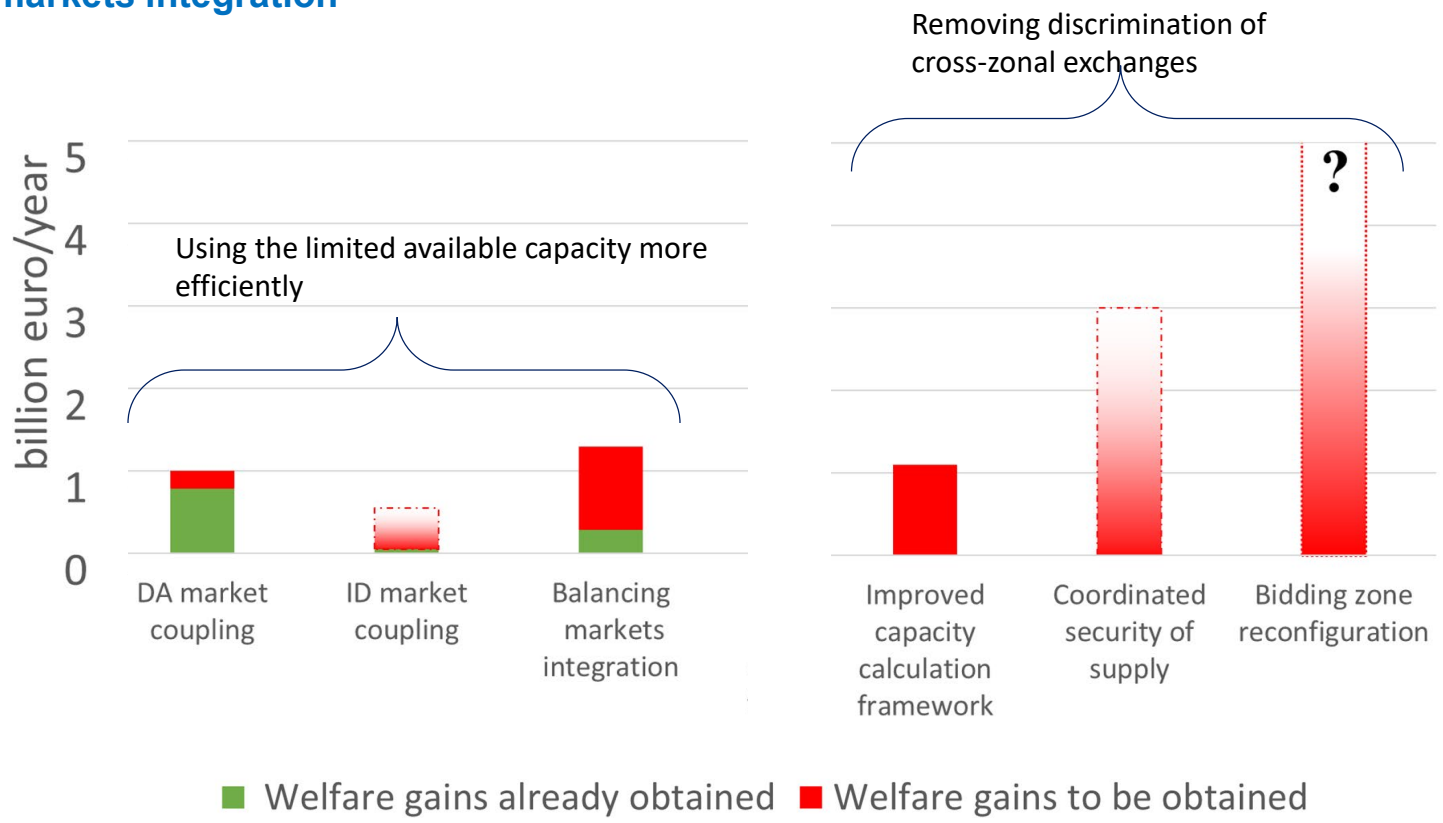
Note: In Spain (*), the CM used to comprise "investment incentives" and "availability payments". The availability payments were removed in June 2018 and the investment incentives only apply to generation capacity installed before 2016. In Italy (**) the analysis suggests potential adequacy issues at the bidding zone level, in Italy-Centre-North and Italy-Sicily, rather than at the national level.

Source: ENTSO-E, NRAs and ACER calculations

Electricity wholesale markets: Additional benefits

The recommendations included in preceding MMRs remain valid: Any step to remove the discrimination of cross-zonal exchanges will bring significant benefits to end-consumers

Social welfare* benefits already obtained and to be obtained from various actions intended to increase EU markets integration



Note: *Gross benefits. The fading color for some categories reflect that the welfare gains are based on third party estimations and/or subject to considerable uncertainty.

Source: ENTSO-E, NRAs, NEMOs, Vulcanus and ACER calculations

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Forward looking – Market design innovations

- **Improve the time granularity in wholesale electricity markets**
  - Markets should align with physics
  - Price formation should ensure relevant prices for electricity in for each timeframe:
    - Make the forward markets more accessible for all and more flexible to changes in bidding zones
    - Day ahead and intraday markets: @15 minute market time unit
    - One real time value of electricity: equal imbalance & balancing energy price
    - Scarcity pricing to improve prices real time scarcity situation
  - Ensure back-propagation of the real time price to all preceding market timeframes

Forward looking – Market design innovations

- **Improve the space granularity in wholesale electricity markets**
  - Markets should align with physics
  - price formation should ensure relevant prices reflecting scarcity of transmission
    - Move to flow-based allocation for Forward, Day Ahead and Intraday markets in meshed networks
    - Align bidding zone borders with structural congestion – allow to offer 70% of physical capacity
    - Introduce ID auctions at frequent intervals in ID markets to price
    - Recalculate available cross zonal capacity regularly up to real time
  - Coordinate energy & ancillary services / balancing markets
    - RCCs/SORs and align market area's bidding zones with system operation zones / LFC Area's
    - Allow to progress at different paces while ensuring interoperability (service provision from DSOs
  - Residual congestions and the need for redispatch should be minimised

Forward looking – Market design innovations

- **Provision of innovative ancillary services by new technologies**
  - Ensure EU-wide optimisation of energy and ancillary services to harness benefits from mutual interdependency.
  - Avoid to create new markets when existing markets can solve the need
    - Ensure interoperability between DSO and TSO grids providing the services
  - Create European balancing markets
    - EU Platforms for the exchange of all the balancing energy products
    - harmonising and integrating dimensioning, procuring and cross-zonal exchanges of balancing capacity
- **Implementation of the intraday trading timeframe and its impact on renewable energy supply**
  - Improve RES operational and investment behaviour
  - Ensure technology-neutrality, e.g. for new entrants: DSR, storage, RES, network development
  - Market facilitation and unbundling: TSOs/DSOs should not own storage in the new world.

Closing

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ACER > EVENTS > MARKET MONITORING REPORT: ACER-CEER JOINT WEBINAR PRESENTING THE KEY FINDINGS

Market Monitoring Report: ACER-CEER joint webinar presenting the key findings

GoToWebinar , 28 October, 2020. From 10:30 AM to 11:45 AM

The Agency for the Cooperation of Energy Regulators (ACER) and the Council of European Energy Regulators (CEER) organise this webinar to present the key findings of their latest Annual Report on the results of monitoring the internal electricity and gas markets [the Market Monitoring Report (MMR)].

You can **register here**

Speakers include ACER Director Christian Zinglersen, CEER President Annegret Groebel, and European Commission's Heads of Unit for Energy, Florian Ermacora and for Consumers, Jan Panek. The webinar will take place between 10.30 and 11.45 CET.

Access the **Agenda**

This year the MMR comprises three volumes analysing Europe's energy markets in 2019: the Gas Wholesale Volume (which you can already access) as well as the Electricity Wholesale Market Volume and the Retail Markets and Consumer Protection volume, both to be published in late October here.

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Q & A
20 min

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Thursday, 22 October 2020 • 15:30 – 18:30 CEST

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