

AFRY
ÅF PÖYRY

Visión mercado vinculante y mercado intradiario

27 de octubre de 2022

JAVIER REVUELTA

Agenda

1. AFRY
2. History of the Spanish market
3. Current Intraday and Ancillary Services
4. Challenges and outlook
5. Discussion on MEM proposal



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ÅF and Pöyry joined forces in 2019 under the new brand AFRY to become a leading international engineering, design and advisory company

The AFRY story

- ÅF was founded in 1895 and Pöyry in 1958
- In February 2019, ÅF and Pöyry merged to become an international engineering, design and advisory company which is listed on the stock market in Stockholm
- The new common brand AFRY was launched in November 2019
- Annual revenue in 2019: ~1.9 bnEUR (~20 bnSEK)
- Almost 17,000 employees worldwide
- Locally present, globally connected: 50+ countries
- Projects in more than 100 countries
- Serving 25% of Fortune 500

AFRY divisions



Engineering & Solutions

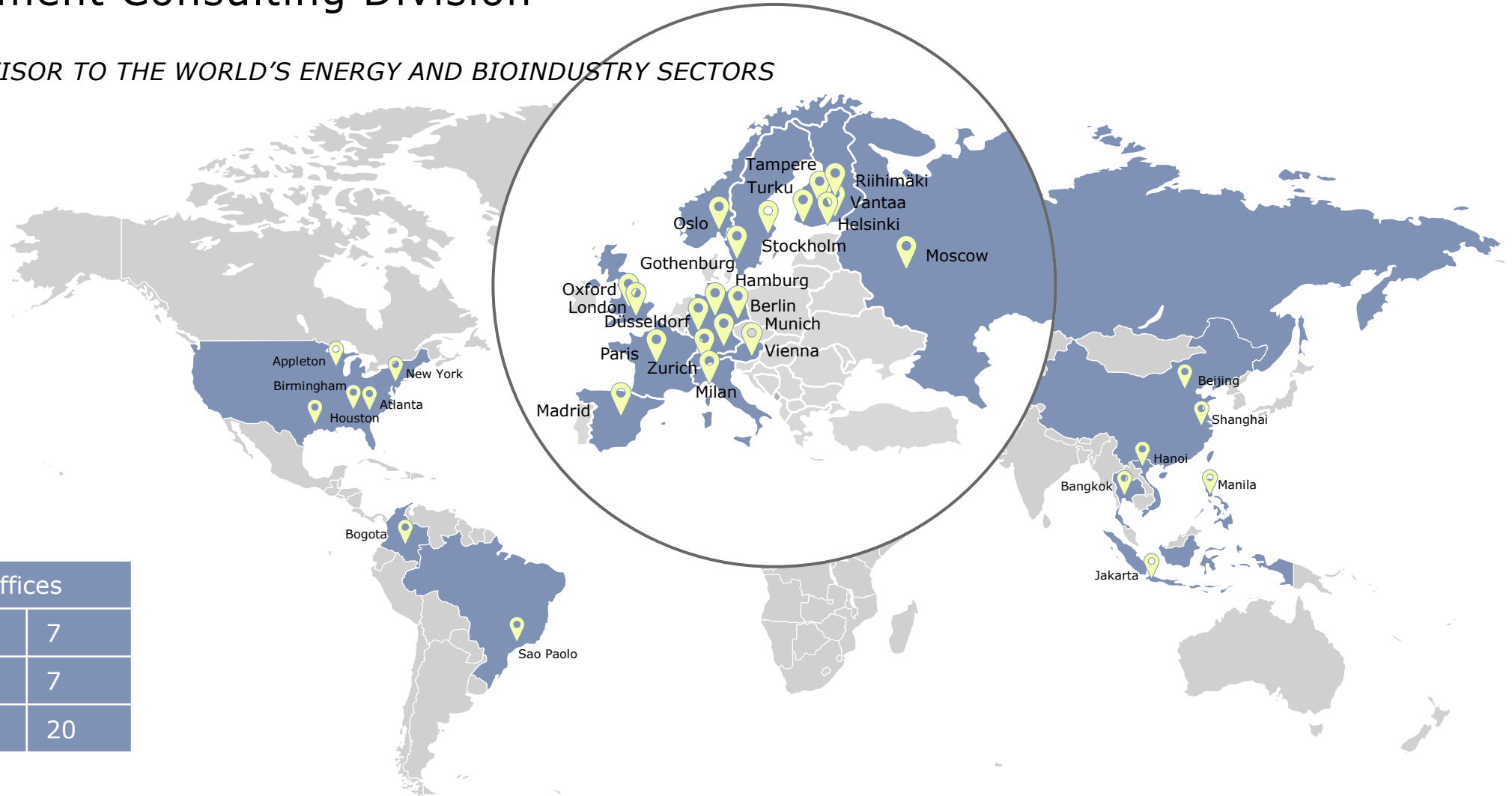
Consulting

Energy	Infrastructure	Process Industries	Industrial & Digital Solutions	Management Consulting
<ul style="list-style-type: none"> - Networks - Renewable energies & hydro - Nuclear - Thermal generation 	<ul style="list-style-type: none"> - Transport - Buildings - Water - Environment 	<ul style="list-style-type: none"> - Chemistry - Stationery & packaging - Mining & metals - Biotechnology 	<ul style="list-style-type: none"> - Advanced automation & IoT - Artificial intelligence - Software - Automotive R&D 	<ul style="list-style-type: none"> - Market analysis - Strategic advice - Transaction services - Operational excellence

GLOBAL PRESENCE

Management Consulting Division

LEADING ADVISOR TO THE WORLD'S ENERGY AND BIOINDUSTRY SECTORS



>500 FTE

Number of offices	
Americas	7
Asia	7
Europe	20

Our Energy Management Consulting team offers a wide range of services along the entire industry value chain

Energy consulting – service areas

Strategic advice



We support companies in the power and gas markets to evaluate opportunities and define growth strategies.

Transaction services



We help asset owners, investors and financiers to evaluate infrastructure and energy companies (due diligence).

Operational excellence



We support clients to improve performance through reorganisation, optimisation and transformation.

Market analysis



We assist companies in assessing market developments and government institutions in market design.

Expertise & value chain coverage



Power & Heat Generation

- Thermal generation
- Renewable generation
- Hydro power & storage
- Waste to energy
- District heating
- PPAs

Gas & Oil

- E&P
- Oil midstream
- Gas storage
- Gas transportation
- (Small scale) LNG
- Long term contracts
- Hydrogen
- Carbon capture & storage/ utilisation

Networks

- Transmission
- Distribution
- Smart grids & metering
- EV infrastructure
- System operation
- Market operation

Customer Solutions

- Retail sales/ customer service
- Decentralised business models
- Decentralised generation & storage
- Energy efficiency
- E-mobility services

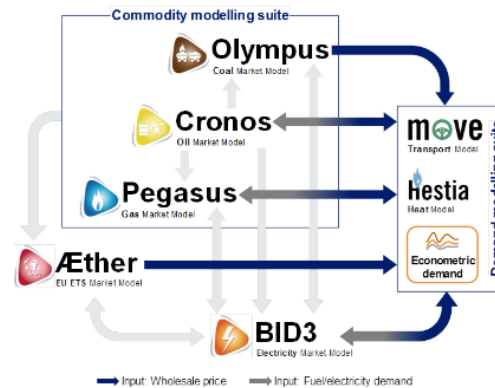
AFRY market reports present the outputs of our detailed modelling, which use our modelling suite designed to analyse the energy decarbonisation challenge

PAN-EUROPEAN MODELLING



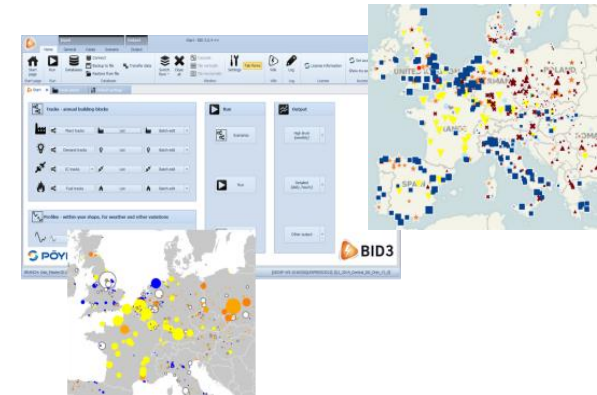
- **All countries are modelled simultaneously** in the same level of detail by considering the interconnection capacity and the flows between modelled countries.
- **Pan-European** analyses of interactions on the electricity and CO2 markets and global analyses of interactions on gas, oil and coal markets.

MODELLING PLATFORM



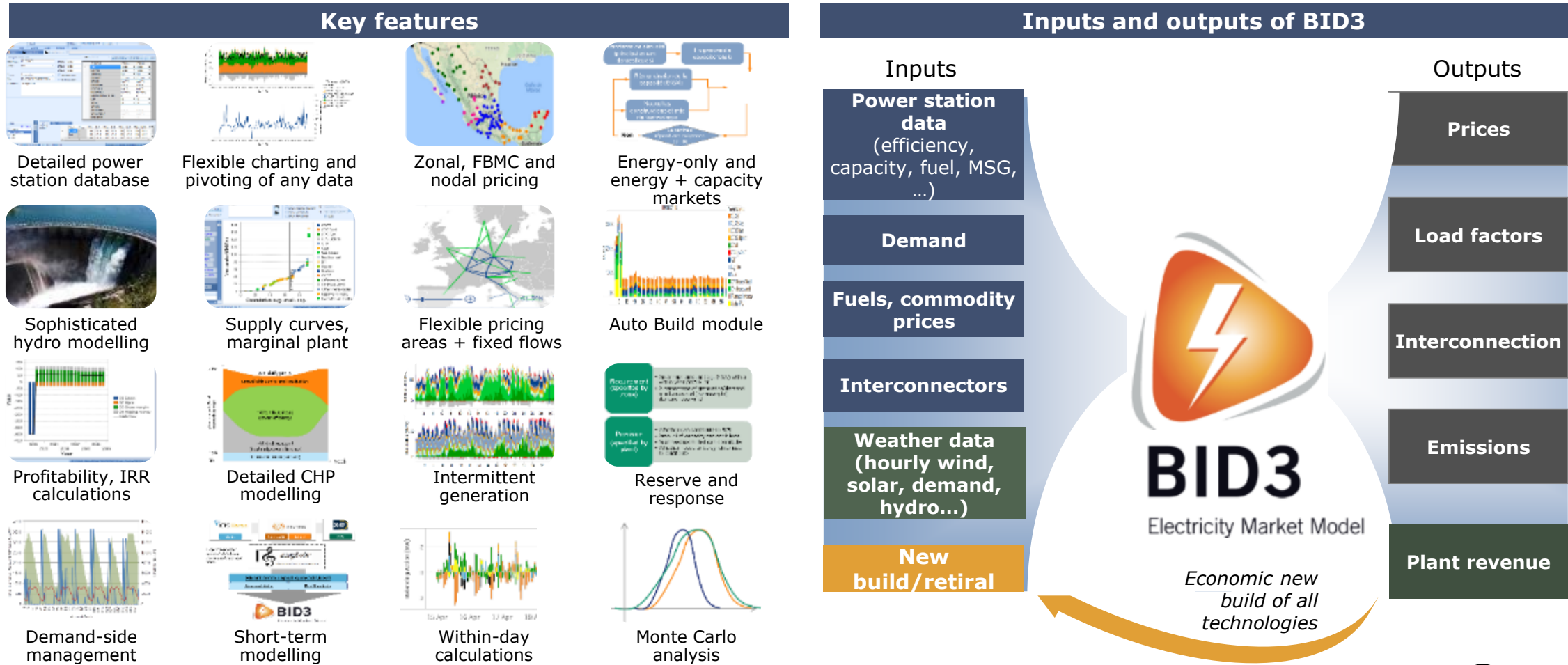
- Designed to meet the **analytical needs** of our clients, BID3 lies at the heart of our modelling suite working in an **iterative manner** with all our commodity and demand models.
- **Internally developed** suite of models (and sub-models) covering Europe and global commodities.
- Used **by utilities, regulators and TSOs** across Europe.

LIVE DATABASE OF MARKET INFORMATION



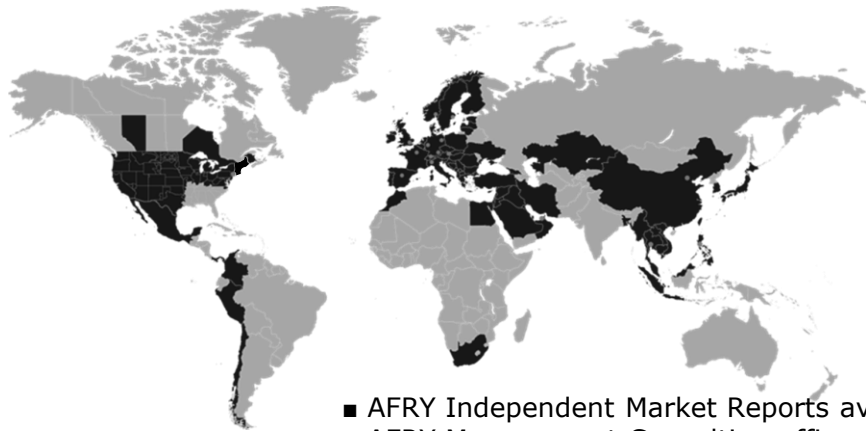
- A wealth of information and data feed into the modelling process.
- Our experts maintain on an ongoing basis a **live database of market information**, such as characteristics of every generation units in Europe, weather-related data, interconnections, technology costs, etc.

Our market model BID3 incl. all adjacent modules allow the quantitative evaluation of decentralization developments on power markets

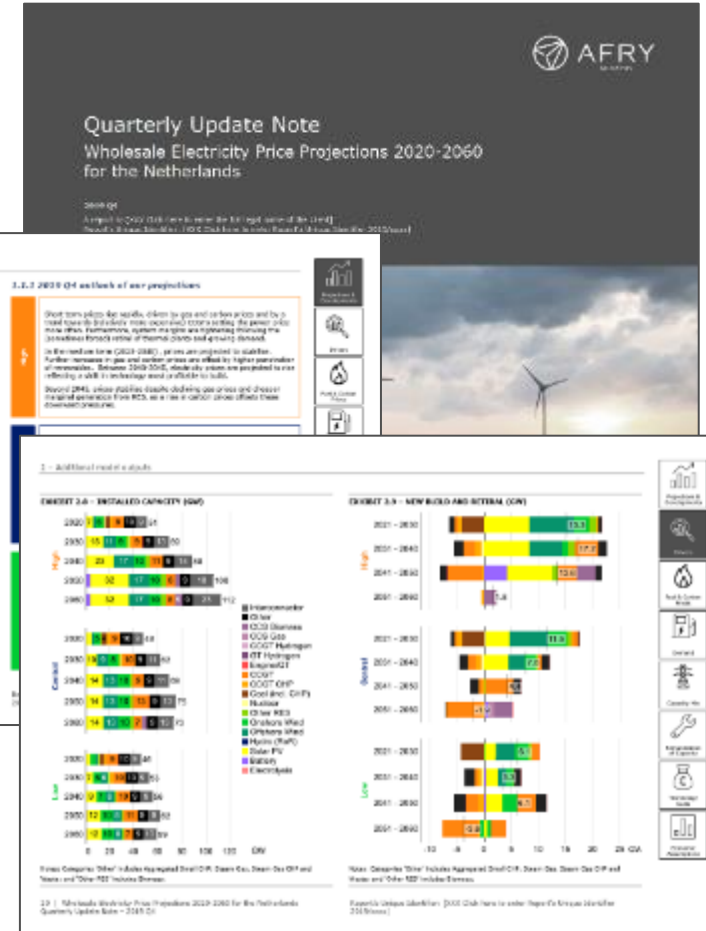


Our quarterly updated reports contain information on the latest market developments and trends impacting the overall energy market developments

- AFRY’s market reports are relied upon by utilities, banks, funds and independent players
- Reports provide a comprehensive review of the market background including regulation and stakeholders, historical characteristics and trends
- Projections on an annual basis out to 2060 for three scenarios
- Our detailed regional, country and technology reports include:
 - Scenario price projections to 2060
 - Industry structure and key players
 - Demand and supply dynamics
 - Government policy and regulation
 - **Spanish NECP scenario and projections of system costs**



■ AFRY Independent Market Reports available
 ● AFRY Management Consulting offices



Visit www.AFRY.com/pimr for more information

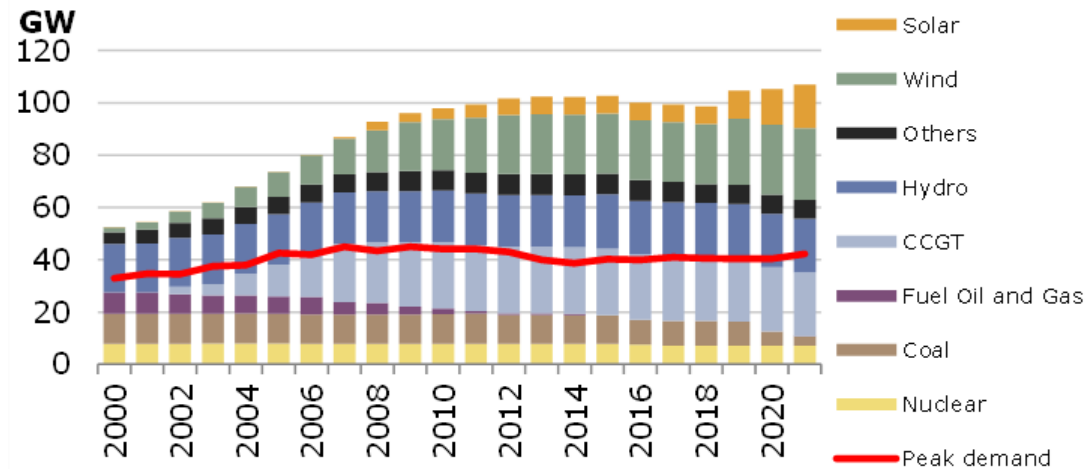
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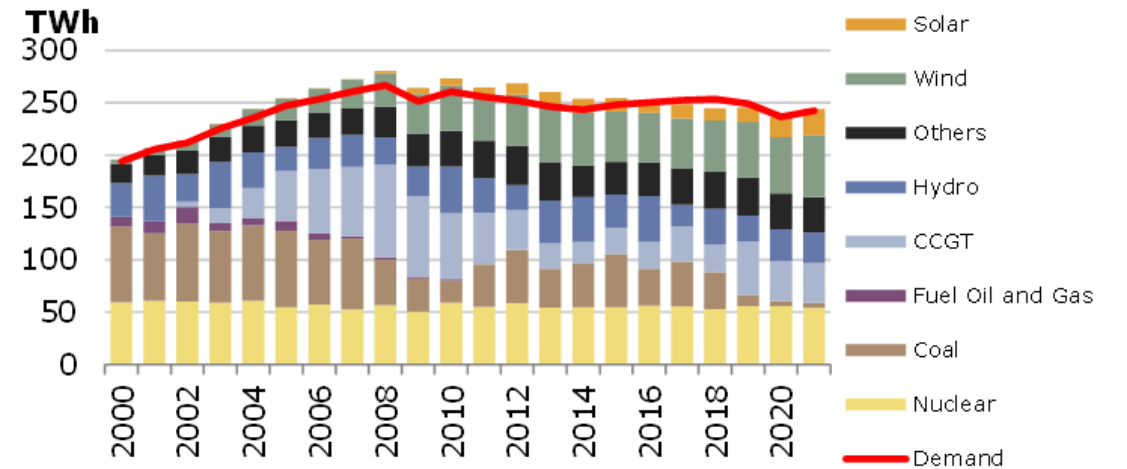


Renewable penetration in mainland Spain has reached 48.4% in 2021

CAPACITY MIX IN THE SPANISH MARKET



GENERATION IN THE SPANISH MARKET

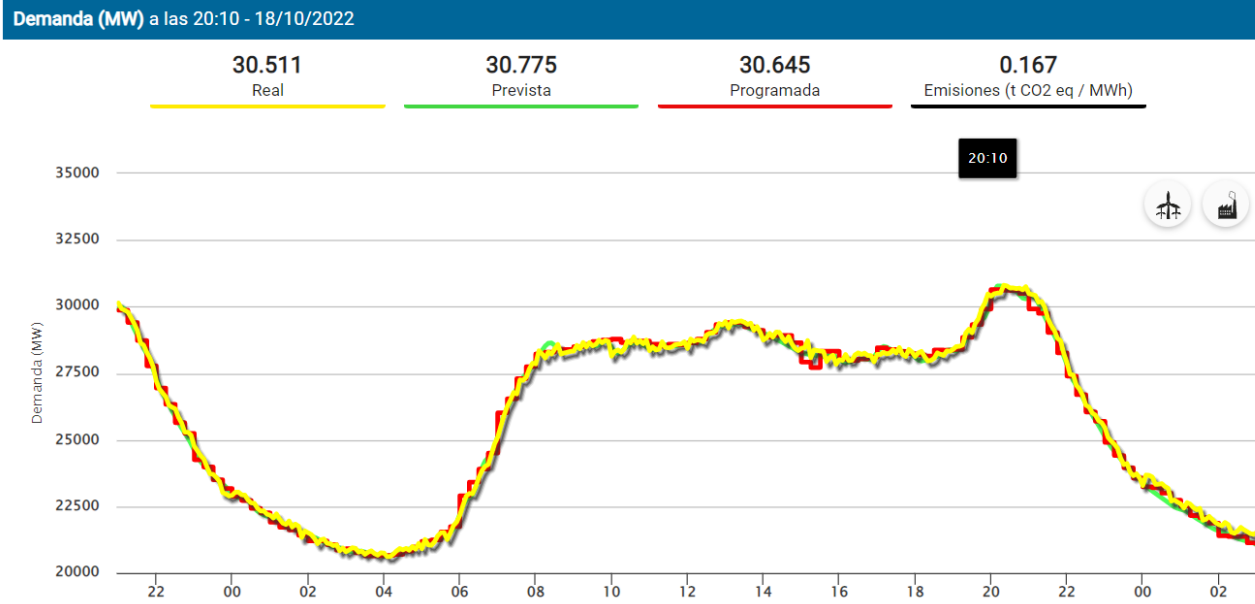


- Towards full coal decommissioning
- Flat CCGTs
- Rising wind and solar PV
- NECP seeks 40GW PV + 49GW Wind by 2030

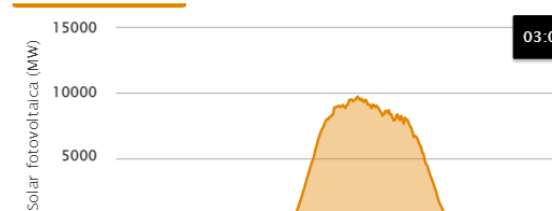
- 48.4% RES-Electricity in 2021 (NECP seeks 78% by 2030)
- Little coal back in merit order
- 2021 average hydro year (slightly dry), 2022 extremely dry

Volatiles RES and demand imply high flexibility requirements to hydro and CCGTs

HOURLY DEMAND AND GENERATION IN THE SPANISH MARKET



Solar fotovoltaica 6



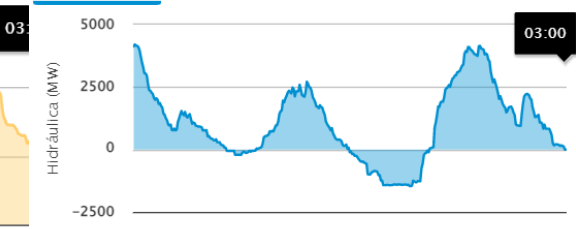
Eólica 10.204



Ciclo combinado 5.675



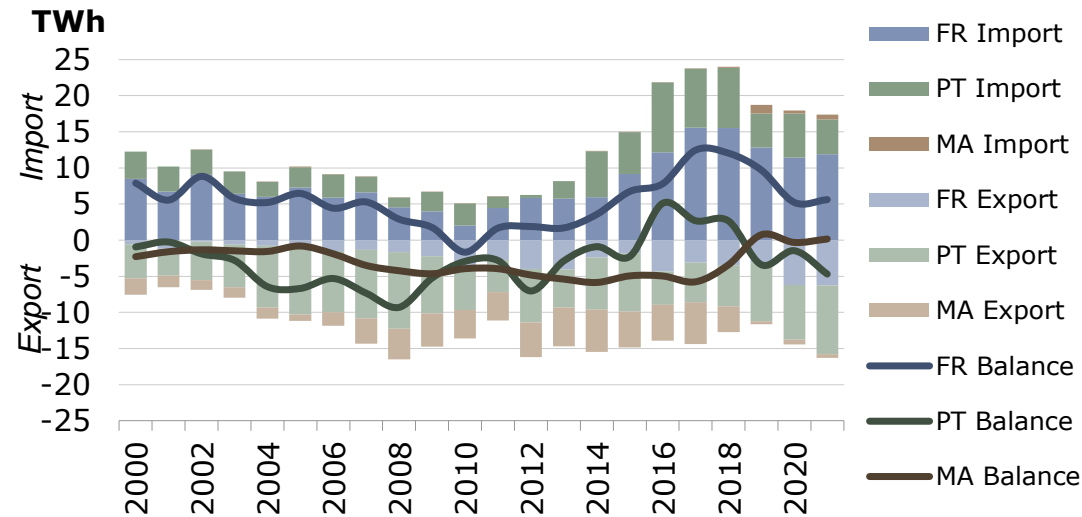
Hidráulica 126



SPANISH INTERCONNECTIONS

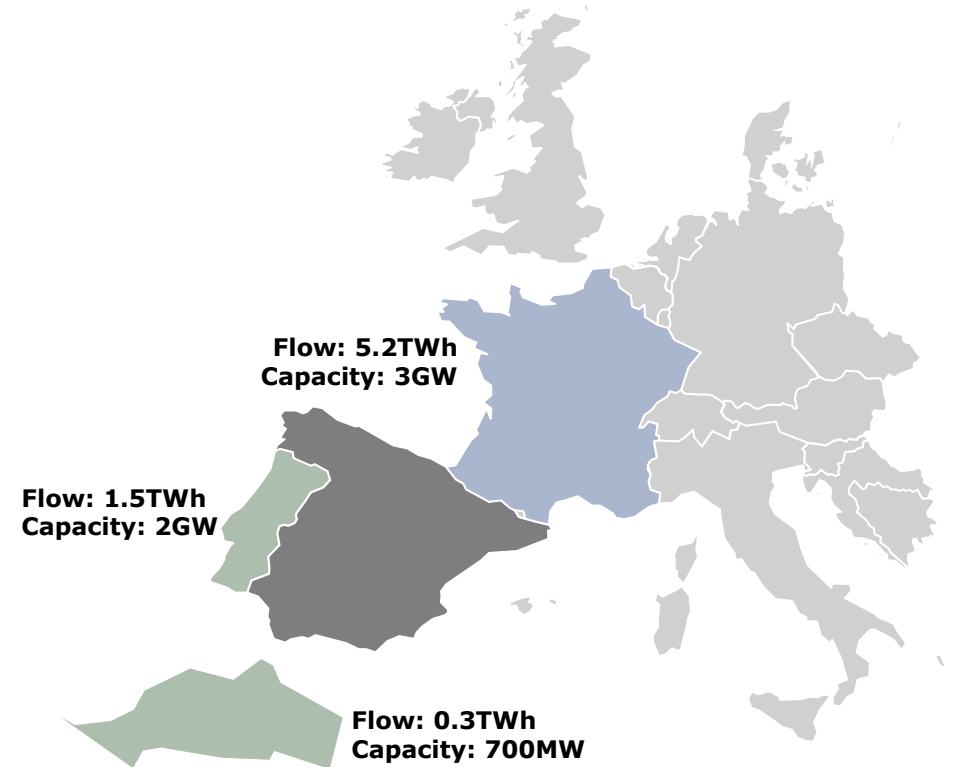
Spain is an electric island, generally a net importer from France and net exporter to Portugal and Morocco

MONTHLY IC FLOWS (TWH)



2020 ANNUAL IC NET FLOWS (TWH) & CAPACITY LEVELS (GW)

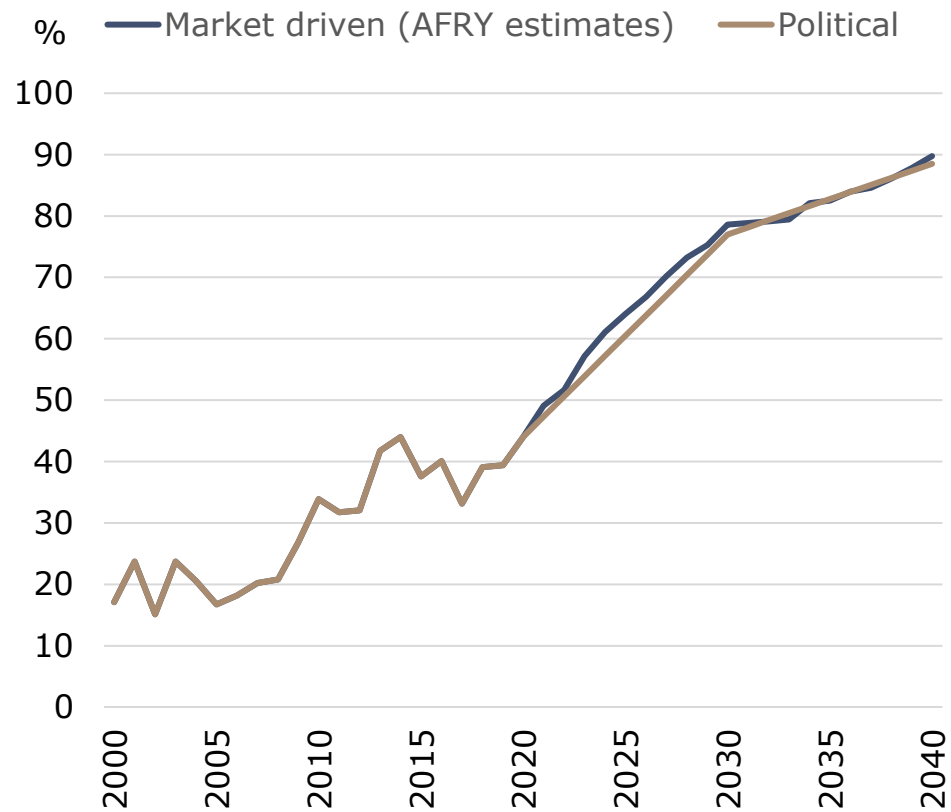
Spain is a net importer (blue) Spain is a net exporter (green)



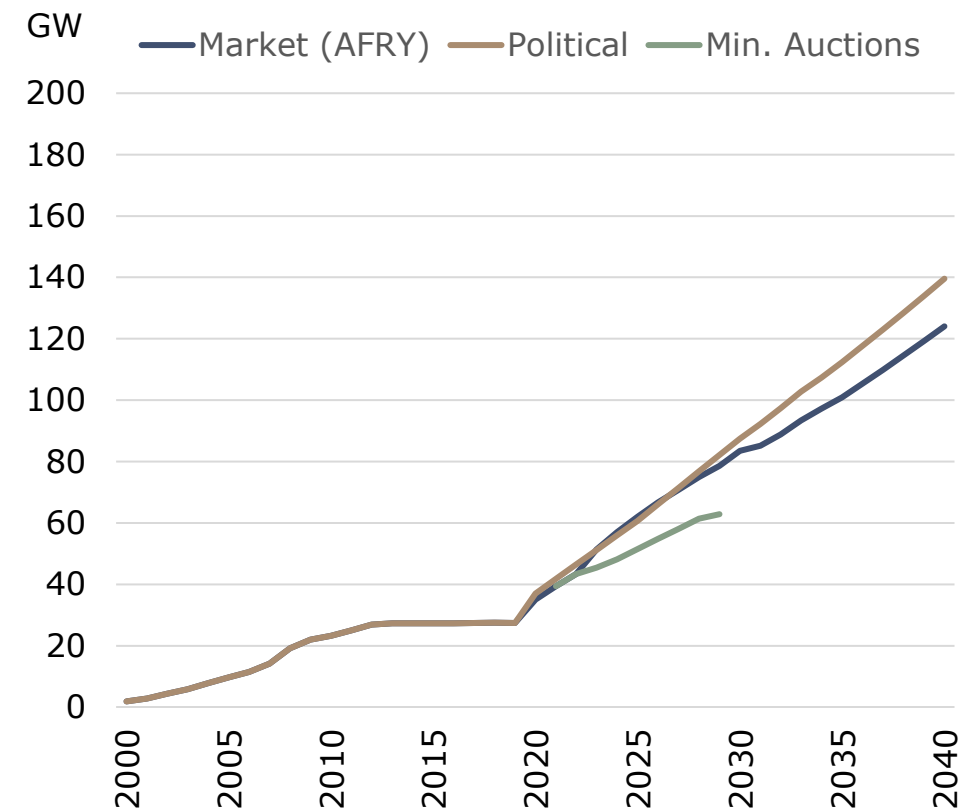
Sources: REE & AFRY

High RES political ambition, and even higher investment appetite

RES PENETRATION IN SPAIN (MAINLAND)



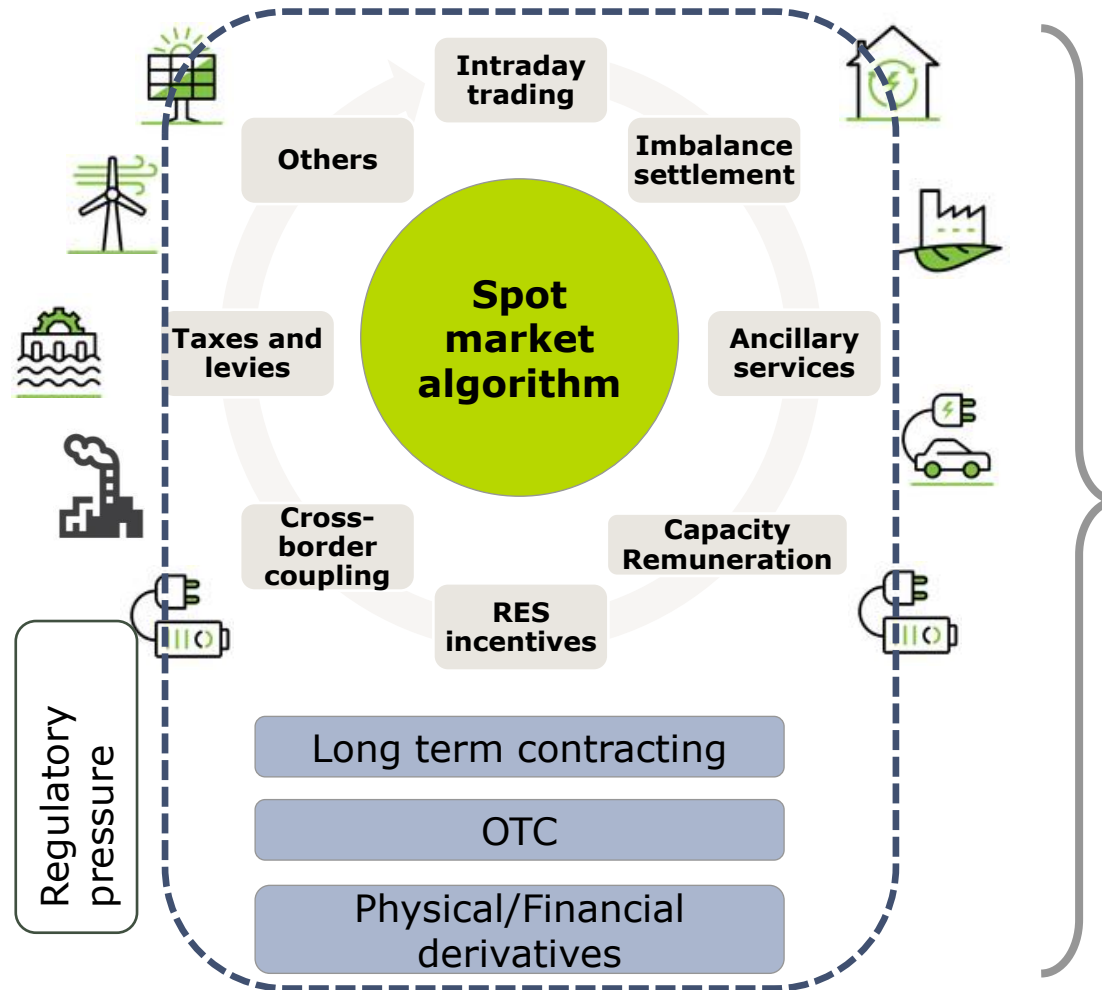
WIND + SOLAR PV CAPACITY IN SPAIN (MAINLAND)



Political is over generation vs. Market driven is over demand

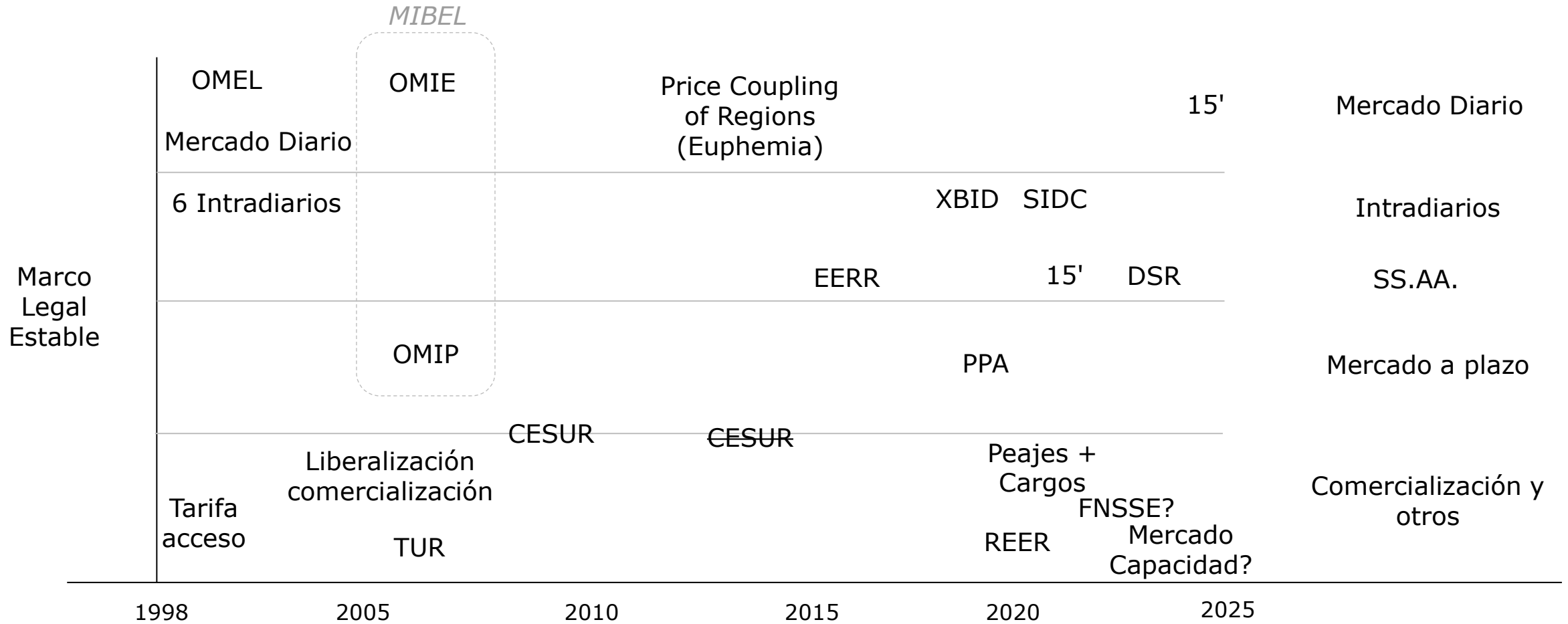
AN ELECTRICITY MARKET IS A SET OF INTERDEPENDENT BUILDING BLOCKS

Wider elements of an electricity market

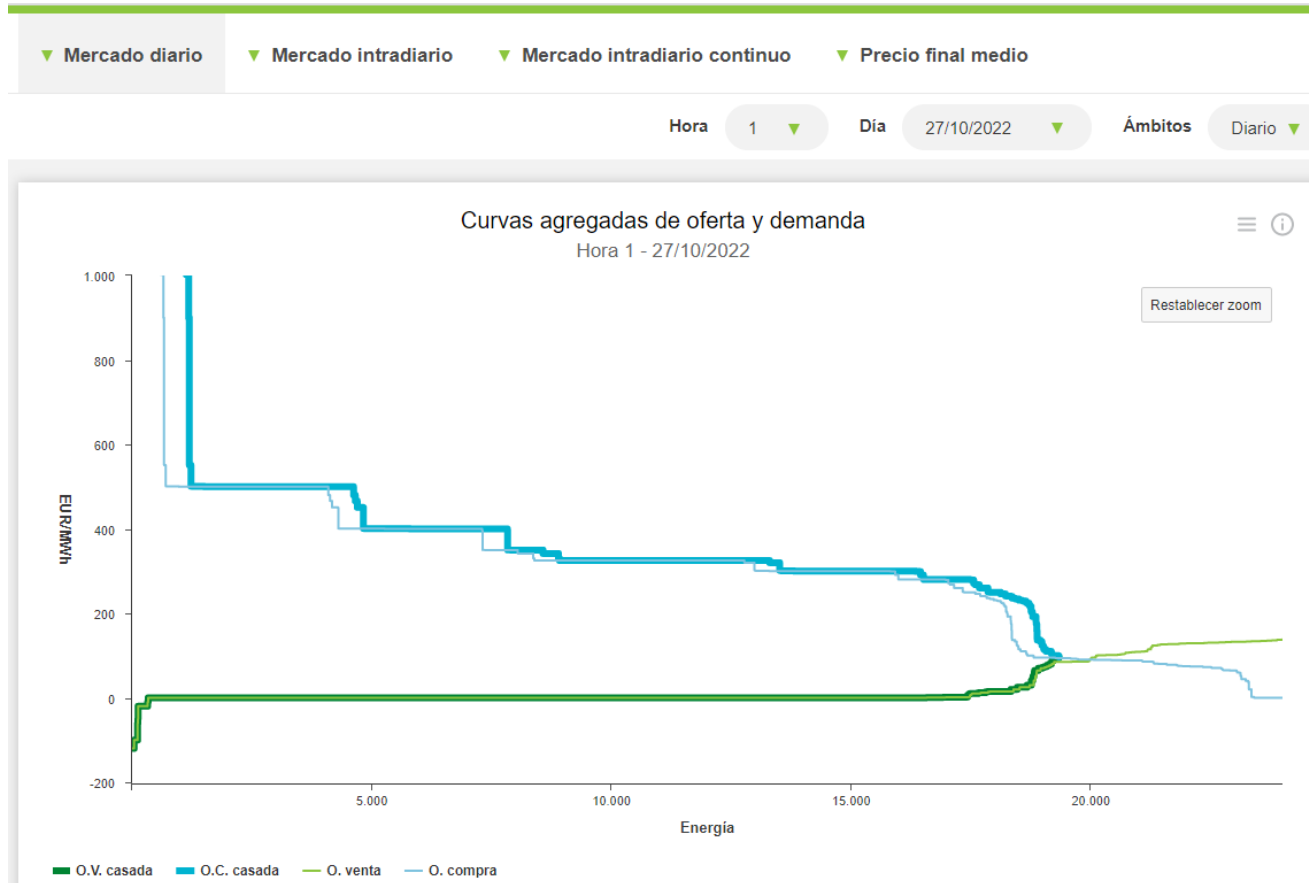


- Schedule of plants
- Short term price signals to demand and service providers
- Long term price signals for investment / decommissioning decisions

The Spanish market has evolved since its creation in 1998



The Spanish market has evolved since its creation in 1998



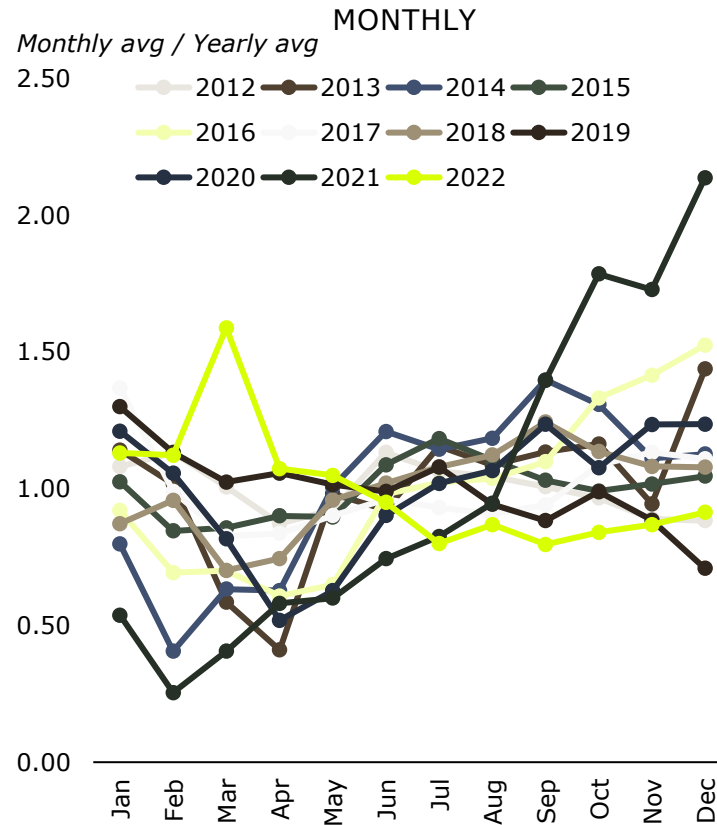
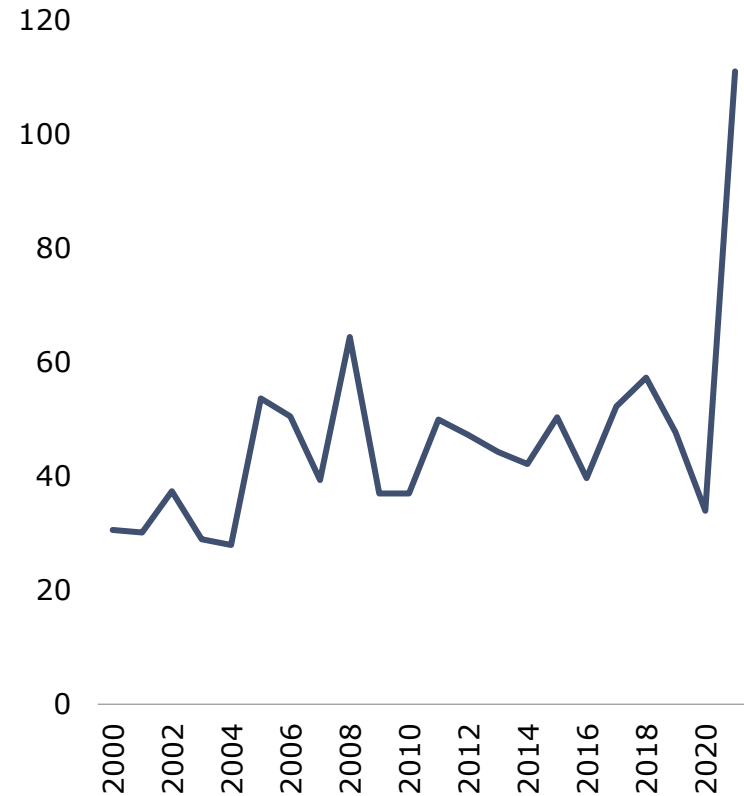
- Sophistication of daily market algorithm to include additional constraints
 - ramp rates
 - mínimo time ON
 - mínimo daily income to couple 24 hours
- Price caps
 - [0;180] to [-500;3.000] €/MWh

Wholesale price volatility has increased over the last years as a result of the increasing renewable penetration

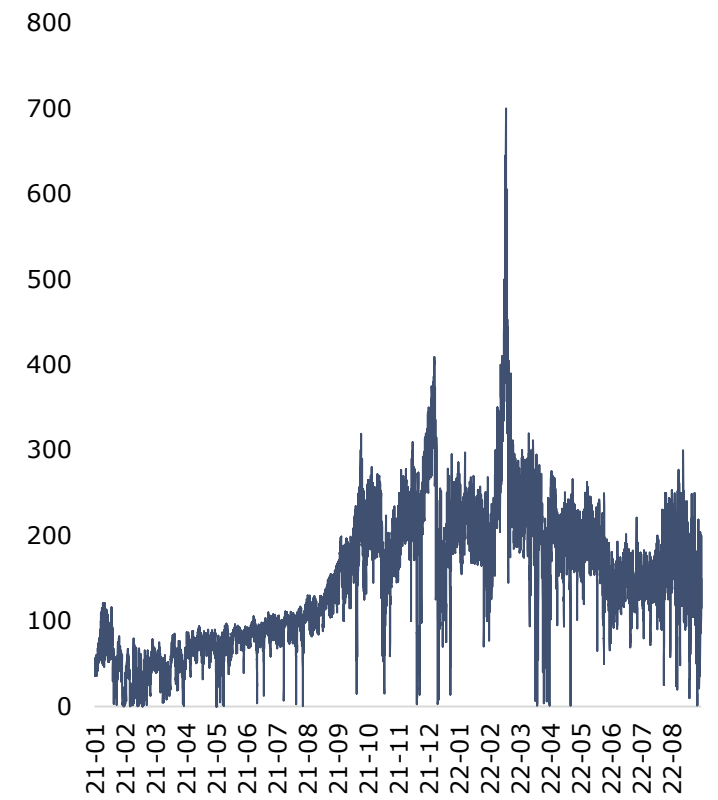
WHOLESALE PRICE EVOLUTION

€/MWh, nominal

ANNUAL



HOURLY

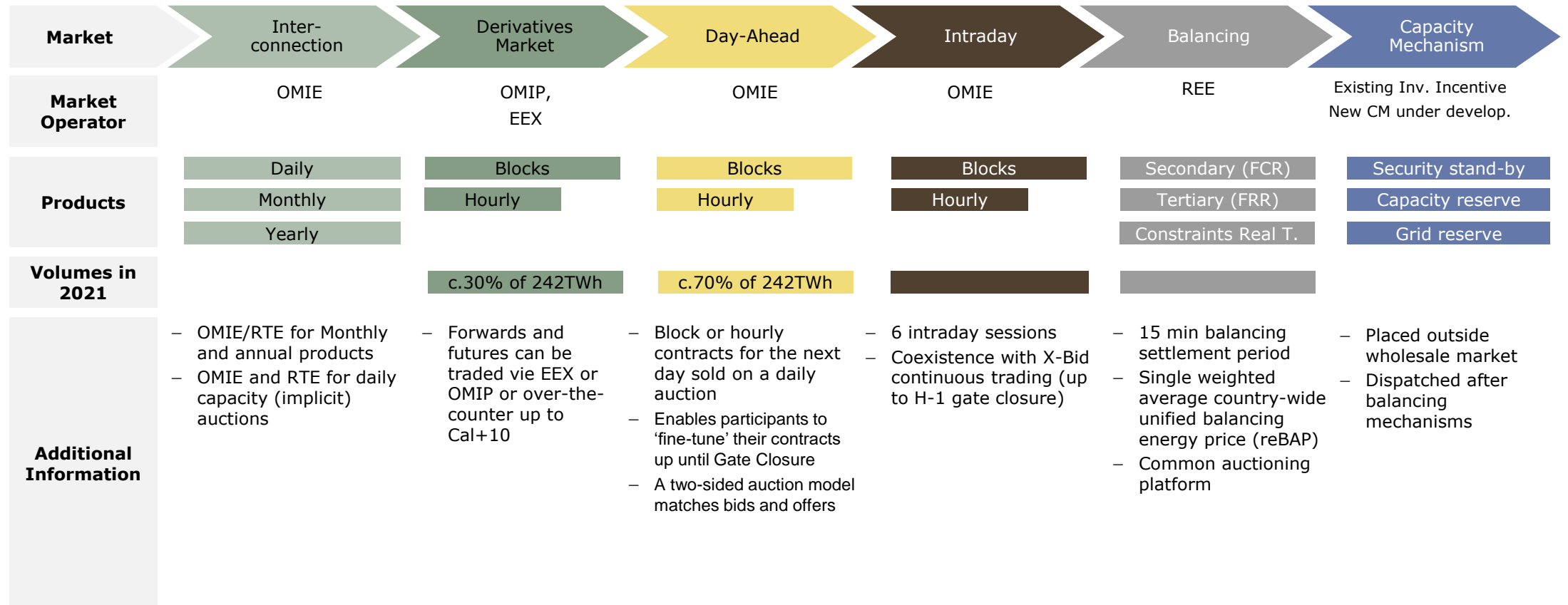


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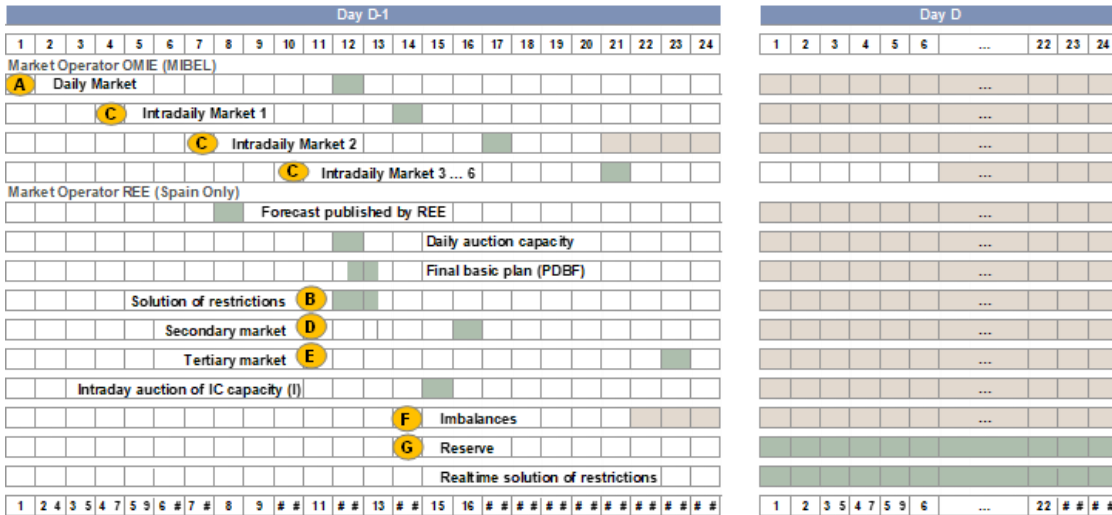


The Spanish electricity market design is integrated with the Portuguese in the MIBEL and coupled with Europe through Euphemia and capacity auctions



The Spanish market is composed of several sessions managed by OMIE and Ancillary Services managed by the TSO, REE

TIMINGS



- Day-ahead session: Programa Base de Casación (**PBC**)
- PBC + OTC: Prgrama Base de Funcionamiento (**PBF**)
- PBF + Technical Constraints: Programa Viable Provisional (**PVP**)
- Intraday sessions: Programa Final Horario 1, 2, 3..., 6
- including reserves procurement: **P48**

MARKET PROCEDURES

- Daily market**
 - Day-Ahead (OMIE) price for each hour (SMP)
 - Product of bids and offers by generators and suppliers
 - Price set at intersection of supply and demand
- Technical constraints**
 - System Operator (REE) assesses grid constraints (i.e. overloads and voltages) on a daily basis after the day-ahead market session + OTC
 - Adjusts the unconstrained market schedule (PBF) into a viable schedule (PVP)
- Intraday markets**
 - Intraday market (OMIE) allows players to adjust their offers made in the daily market in 6 sessions
 - This is now compatible with the XBID continuous trading platform
- Secondary reserve**
 - System Operator (REE) buys short response (<100s) balancing services to balance the system in real time, under governance of the central AGC
 - Remunerates capacity (daily auction in €/MWh/h), and €/MWh if utilised
- Tertiary reserve**
 - System Operator (REE) occasionally buys/sells slower reserve (15 min) to regenerate Secondary Reserve if necessary. €/MWh hourly marginal pricing.
 - Mandatory bids for energy only, set marginal price for Secondary and Tertiary
- Deviation management**
 - System Operator (REE) buys or sells energy to balance the system, whenever forecasts for the next 2-4 hours suggest a short/long market that cannot be managed only with Secondary and Tertiary
- Reserve capacity**
 - Aimed at ensuring enough spinning reserve in thermal units to cope with ramp rates and potential errors in demand and renewable energy production
 - Created after 2013, previously part of the Technical Constraints analysis. Cancelled in 2019, back to Technical C.



The purpose of the ancillary services is to ensure that quality and security requirements are met in the delicate supply/demand electricity balance

DEFINITION

- After the day-ahead and intraday markets take place, schedules may lead to infeasibilities in the network, such as overflows or under/over voltages; then the Spanish TSO (REE) conducts a security analysis aiming at solving these constraints
- The resultant schedule PBF (PBC + OTC) needs to be adjusted 'inserting' some units and 'removing' some other units in order to eliminate the infeasibilities. Additionally, ahead of real time some imbalances may be foreseen between generation scheduled by the agents and demand forecasted. Finally, in real time, the instantaneous balancing of supply and demand requires that the manageable generation follows exactly the small supply/demand imbalances through the frequency control loops and operational reserves
- The different ancillary services existing in the Spanish market and obligation of providing these services are shown in the top-right table. The compulsory services are not currently remunerated while the ones required by the Spanish Transmission System Operator (TSO) are market-based
- In Spain, all of these services are managed by the TSO, REE

ANCILLARY SERVICES

Compulsory services	System operator services
<ul style="list-style-type: none">– Primary regulation– Voltage control	<ul style="list-style-type: none">– Constraints management– Additional upward reserve capacity*– Secondary regulation (band and energy)– Tertiary regulation– Imbalance management – Current European Replacement reserve– Service restoration (black-start capability)

* Upward Reserve Capacity suspended in 2019

Market description, timings and suitability for a storage-based business plan

Market	Description	Clearing	Responsible	Market Gate Closure Time
Day-ahead	Wholesale market. Participation is compulsory for generators	Marginal price	OMIE	11:00 D-1
Intraday auctions	Market participants are allowed to adjust their positions in 6 intraday auctions	Marginal price	OMIE	3/4 hours before gate closure
Continuous intraday (XBID)	Market participants are allowed to adjust their positions closer to real time	Continuous trading	OMIE	1h before real time
DA¹ TTRR² Phase I	Additional production needed for the secure functioning of the electricity system	Pay as bid	REE	1h after DA results
DA TTRR Phase II	Change in DA schedule to re-establish the generation/supply equilibrium. Generators normally pay to the TSO ³ for the energy that is reduced	Pay as bid	REE	1h after DA results
Primary reserve	Mandatory regulation with response $t < 30s$	Non-remunerated	REE	Real time
Secondary band	Availability to provide secondary reserve through the effective provision of secondary energy. Only the units approved by the TSO can participate	Marginal price	REE	19:45 D-1
Secondary activation	Regulation with response $30s < t < 300s$	Same price as regulating reserve	REE	Real time
Regulating reserve	The TSO shall use regulating reserve to reconstitute the secondary reserve. Response $t > 300s$. Participation is compulsory	Marginal price	REE	20:00 D-1, updated until 10min after the XBID closure
Replacement reserves	The TSO use replacement reserves to settle imbalances after the last intraday session before real time, avoiding using tertiary reserves	Marginal price	REE	20:00 D-1, updated until 10min after the XBID closure
Real time TTRR	During real time operation, the TSO might need to contract regulating reserve offers out of the merit order due to technical restrictions	Pay as bid	REE	Real time

Notes: 1) Day-Ahead (DA); 2) Technical Restrictions (TTRR); 3) Transmission System Operator (TSO)

Market requirements for the participation in ancillary services of the awarded hybrid facilities

CURRENT REQUIREMENTS FOR THE DIFFERENT MARKETS

Market	Bid period opening	Bid period closure	Clearing period	Min. response time	Max. response time	Applicability
Bilateral contracts	Unlimited	D-1	As agreed in the supply contract	As agreed in the supply contract	As agreed in the supply contract	Unitary
Day-ahead	At 10:30 Day-ahead information is published by the TSO	12:00 CET on D-1	Not after 13:00 CET on D-1	00:00 CET on D	23:59 CET on D	Unitary
Constraints market	12:00 CET on D-1	15 min after PDBF* publication on D-1	Not after 14:45 CET on D-1	Depends on the TSO requirements	Until TSO consideration	Unitary
Secondary reserve	Not after 14:45 CET on D-1	75 min after PDVP** publication on D-1	Not after 16:30 CET on D-1	30 sec	15 min	Regulation zones
Tertiary reserve	Not after 21:00 CET on D-1	Before 23:00 CET on D-1	After 23:00 CET on D-1	15 min	120 min	Unitary
Intraday	14:00 CET on D-1 17:00 CET on D-1 21:00 CET on D-1 01:00 CET on D 04:00 CET on D 09:00 CET on D	15:00 CET on D-1 17:50 CET on D-1 21:50 CET on D-1 01:50 CET on D 04:50 CET on D 09:50 CET on D	15:27 CET on D-1 18:17 CET on D-1 22:17 CET on D-1 02:17 CET on D 05:17 CET on D 10:17 CET on D	00:00 CET on D 21:00 CET on D-1 01:00 CET on D 05:00 CET on D 08:00 CET on D 13:00 CET on D	23:59 CET on D 23:59 CET on D 23:59 CET on D 23:59 CET on D 23:59 CET on D 23:59 CET on D	Unitary
Replacement market	End of hourly period on D-1	One minute before hourly period	15 min periods	Less than 30 min	30 min	Unitary

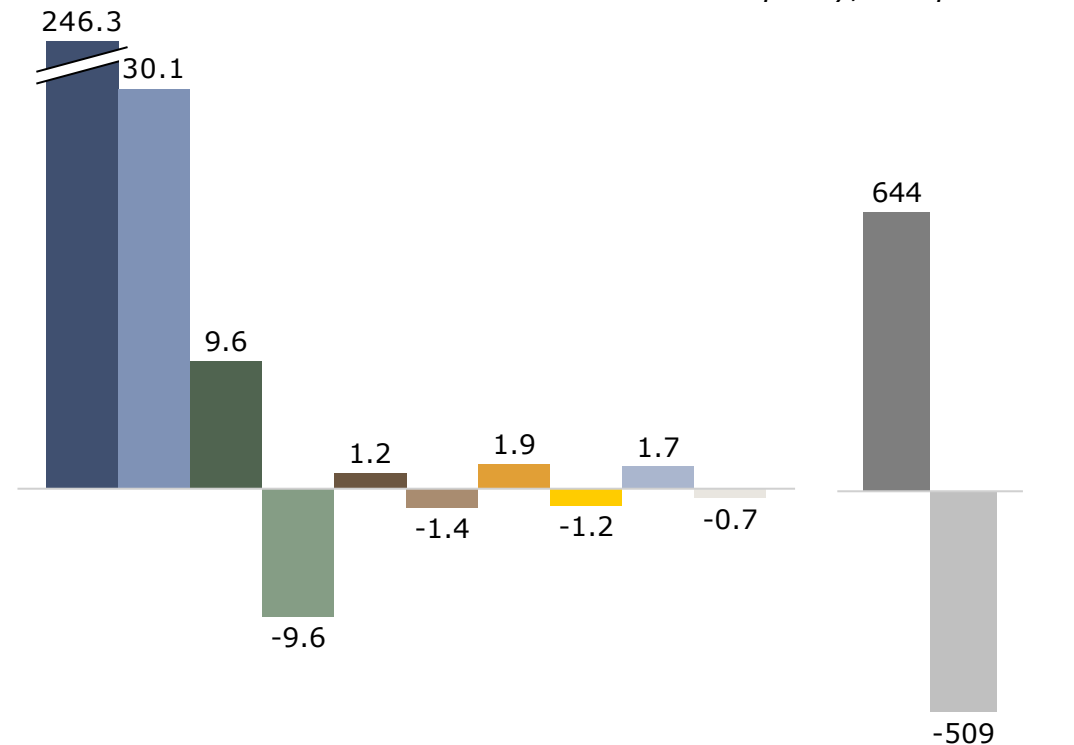
*PDBF: Programa Diario Base de Funcionamiento (must be published up to 30 min after PDBC (Programa Diario Base de Casación)). **PDVP: Programa Diario Viable Provisional (must be published up to 75 min after PDBF publication)
Source: OMIE, AFRY

Historical volumes and prices in the Spanish markets for the 2016-2020 period

AVERAGE VOLUMES PER MARKET, 2016-2020

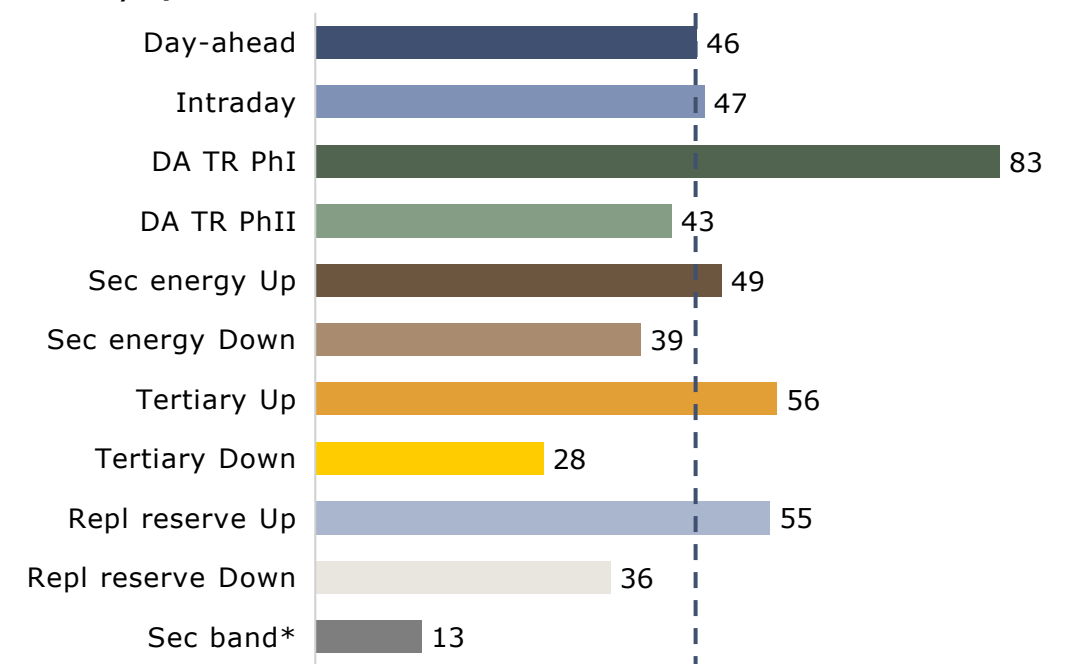
Energy volumes, TWh

Capacity, MW per hour



AVERAGE MARKET PRICES, 2016-2020

Prices, €/MWh



■ Day-ahead
 ■ DA TR PhI
 ■ Sec energy Up
 ■ Tertiary Up
 ■ Repl reserve Up
 ■ Sec band Up
■ Intraday
 ■ DA TR PhII
 ■ Sec energy Down
 ■ Tertiary Down
 ■ Repl reserve Down
 ■ Sec band Down

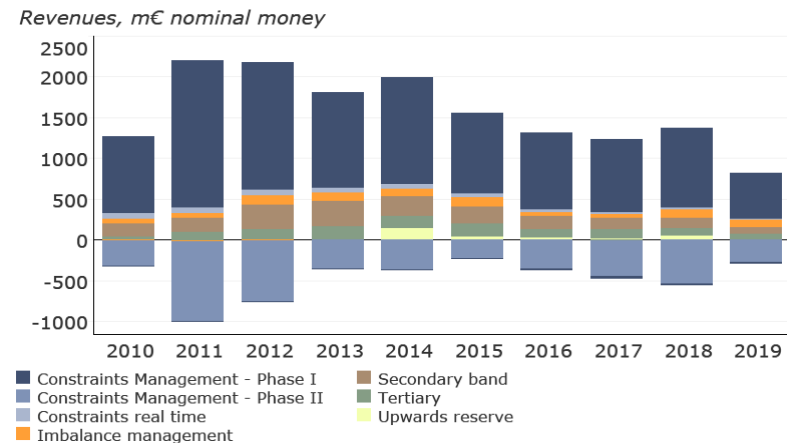
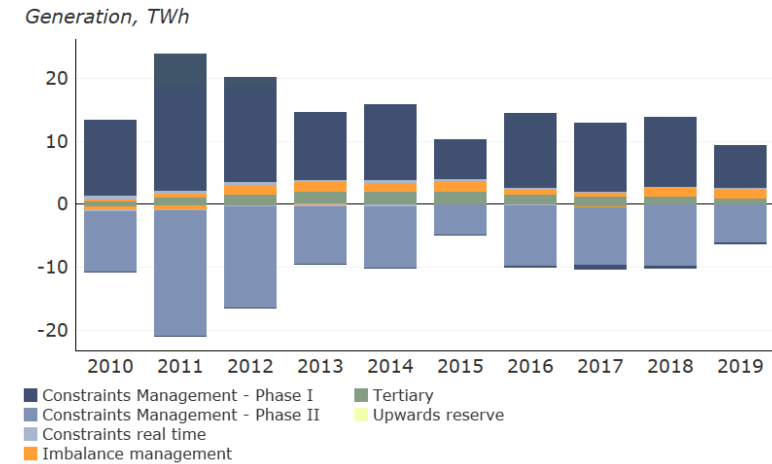
Note: *Secondary band prices are in €/MW. Source: REE

Phase I of constraints management has been the ancillary services market with higher revenues and energy dispatch in the Spanish market

ANCILLARY SERVICES – HISTORICAL RESULTS

- Ancillary services historical revenues in the Spanish market show that constraints management – phase I is the most relevant market in the system, followed by constraints management – phase II. These markets solve technical constraints that appear in the Spanish electricity system, such as overflows, over-voltages or under-voltages; so they play a key role in the ancillary services balance
- The revenues of almost all the ancillary services markets have decrease during the last decade, mainly due to technical improvements in the Spanish network, the improvement in the demand and intermittent forecasts and the commissioning of new interconnections with France and Portugal
- Energy and revenues follow similar trajectories; generation does not show secondary band dispatched as this market dispatches headroom or MW and not energy; however, the costs for the system are shown in the revenues chart

HISTORICAL ENERGY VOLUMES AND REVENUES



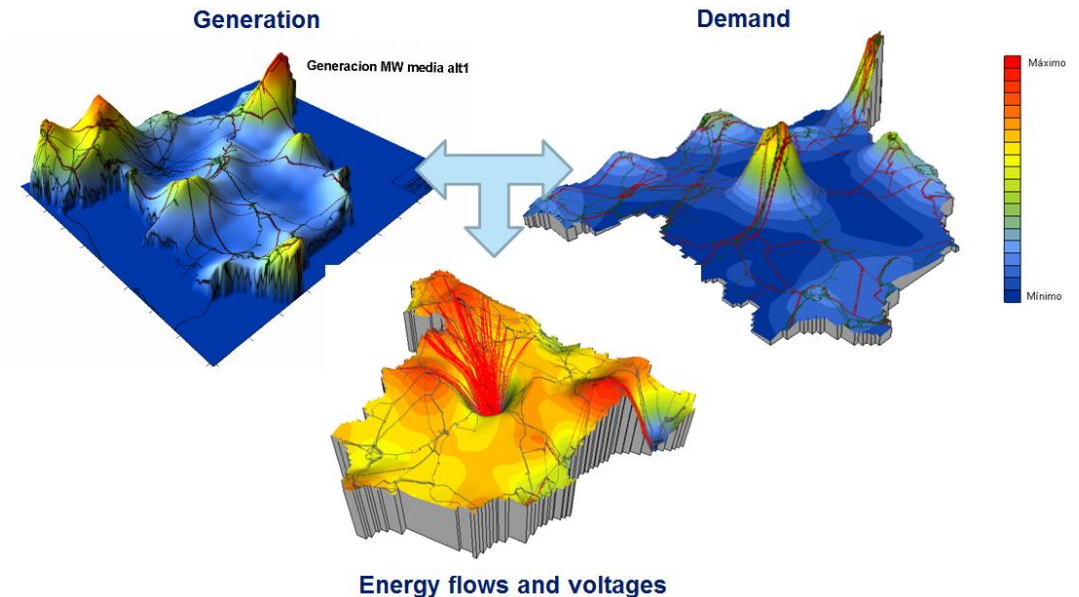
Constraints management market aims to solve the network constraints by increasing/decreasing generation/demand where needed

CONSTRAINT MANAGEMENT

- Neither day-ahead nor intraday markets take into account network constraints. These are evaluated by the TSO after the day-ahead and intraday market sessions have been cleared
- Typical profiles show that electricity demand is mainly concentrated in the central area of the Iberian Peninsula, on the Eastern coast and in the North, whereas generation is more widely distributed, but still clustered in only a few areas. This asymmetric distribution of generation and electricity demand can lead to three different problems in the transmission network:
 - **Overflows in the power lines:** the flows of energy resulting from the day-ahead or intraday schedule exceed the capacity limits of the power lines. This is the case for power flowing from Northwest (Galicia) to the Centre of Spain (Madrid)
 - **Over-voltages:** as a result of a surplus in net generation, which generates high reactive power, voltage in certain nodes can be higher than the threshold established in the Spanish Grid Code. This is the case for the southern part of Cataluña
 - **Under-voltages:** as a result of a deficit in net generation, voltage in certain nodes can be lower than the threshold established in the Spanish Grid Code. This is the case of the centre of Spain (Madrid) or the Basque Country

Sources: REE and AFRY

VOLTAGE AND LOAD PROFILES AFTER THE DAY-AHEAD MARKET



Constraints management market aims to solve the network constraints by increasing/decreasing generation/demand where needed

CONSTRAINT MANAGEMENT

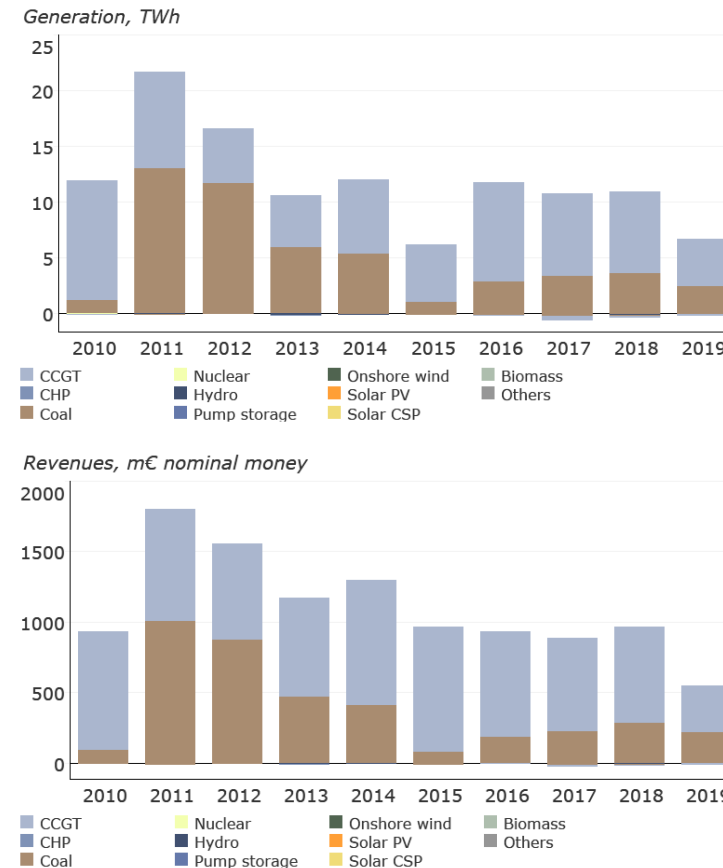
- As a result, after the day-ahead and intraday market sessions, the TSO runs a load flow model, checks grid problems, and manages these constraints so that the resulting new generation schedule is technically feasible with respect to grid constraints and the quality of supply that can be guaranteed. To manage the constraints, the TSO can act as follows:
 - increase generation (or decrease demand); or
 - decrease generation (or increase demand)
- As the Spanish network is well meshed, REE looks at the best option to minimise the overall cost of solving all constraints. To do so, after the day-ahead market, the TSO organises a 'restrictions or constraints management market' to which generators and consumers can submit their specific bids to solve potential network constraints. This market is divided into two phases: Phase I aims at solving the physical constraint, and by doing so Phase I procedure creates a mismatch between the previously cleared supply and demand that needs to be rebalanced in Phase II

Phase I of constraints market is organised to solve the constraints after the day-ahead market

PHASE I – CONSTRAINTS MANAGEMENT

- The constraints management market Phase I is a market organised so that REE, the TSO, can solve the technical constraints (e.g. under/over voltages or congestion of power lines) appearing in the network after the day-ahead market clearing
- This is a pay-as-bid market with no cap in prices, in which a generator competes against their local peers in order to solve the constraints in the region. A low level of competition could have an upwards effect in the revenues collected in this market
- The volume of energy required in Phase I to solve constraints has decreased in the last decade as shown in the figures on the right. This decrease could be the result of technical improvements in the network and the commissioning of new interconnection with France
- This market is dominated by thermal generation (mainly CCGTs), as it typically requires continuous generation support during periods between 8 and 24h. Hydro is normally utilised by the TSO to solve real-time constraints and thus has a low dispatchability in this market

HISTORICAL ENERGY VOLUMES AND REVENUES IN PHASE I



Phase II of constraints market is organised to balance the generation after the dispatch in the constraints management (phase I) market

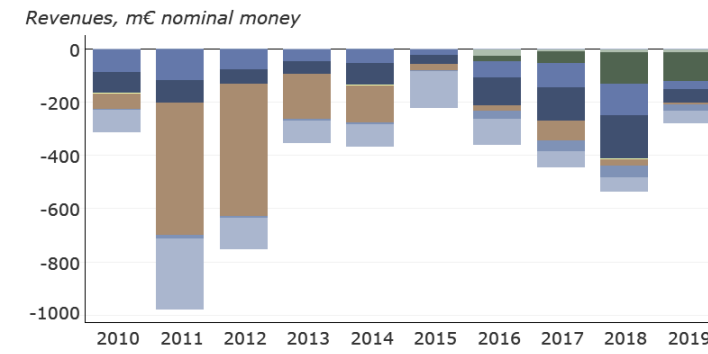
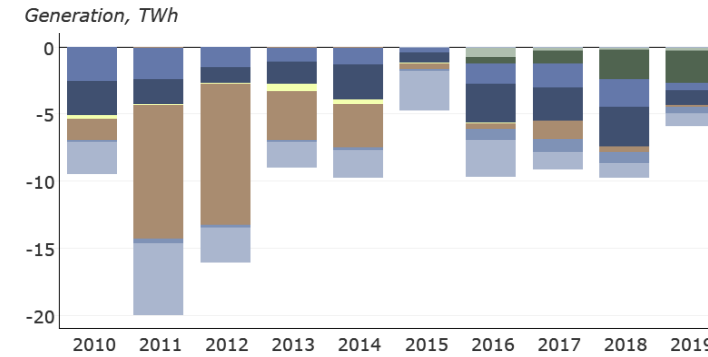
- After the constraints management (phase I) market, REE typically has increased generation from some selected power plants located in specific places of the Spanish network to solve the technical constraints. As a result, after phase I market, generation is typically higher than demand breaking the fundamental balance of electricity markets
- The first principle of the operation of an electricity system is that generation equals demand at all times in order to maintain the frequency and stability of the system. Thus, in phase II, the TSO reduces generation (or increases consumption) from power units willing to do it; in this way, the TSO matches generation and demand again. This equilibrium is reached at a system level, and not at a zonal level like the constraints management (phase I) market
- This is a pay-as-bid market, and typically prices are at a negative premium if compared to the day-ahead prices. As a result, a power unit could potentially be dispatched in the day-ahead market and unwind its position in phase II, collecting some revenues without even generating. This is shown through an example below:
 - **Day-ahead dispatch:** 100MW at €50/MWh. Revenues: €5,000
 - **Constraints** management (phase II) dispatch: -100MW at €40/MWh. Costs: €4,000
 - **Final position:** 0MW, collecting €1,000 in revenues
- Since 2016, renewables have been allowed to participate in the ancillary services markets if they comply with the technical requirements of each service

Historically, energy volumes and revenues have decreased in the last decade, and renewable sources have played an important role during 2019

PHASE II – CONSTRAINTS MANAGEMENT

- Historical results included in figures on the right show energy volumes and revenues of Constraints management Phase II market to reach the equilibrium, after Phase I. This equilibrium, as stated before, usually means decreasing energy since after Phase I generation is typically higher than demand
- As for Phase I, Phase II volumes have decreased in the last decade as a result of the technical improvements in the network and the commissioning of new interconnection with France
- This market is showing an increasing competitiveness over the last years, as a result of the participation of more technologies in this market all the while thermal has decreased its participation due to its lower dispatchability in the day-ahead market
- Historical graphs also show the entry of renewable sources, mainly onshore wind, in this market from 2016

HISTORICAL ENERGY VOLUMES AND REVENUES IN PHASE II



Additional upward reserve aims at obtaining additional upward reserve capacity that may be required in the PVP for future system changes

ADDITIONAL UPWARD RESERVE

- After REE has solved all the constraints and possible contingencies (Phase I) and has again restored the balance between generation and demand (Phase II), it publishes a 'feasible' schedule, which incorporates the technical adjustments made to the day-ahead market schedule. This schedule is called the provisional viable daily schedule (Programa Viable Provisional, PVP)
- Additional upward reserve is a service that aims at obtaining additional upward reserve capacity that may be required in the PVP to ensure sufficient headroom to cope with future system changes. It is a way of ensuring that the system will have available reserves online to respond to changes. This market was launched in 2012; before, this need of spinning reserves was part of the Constraints process, which partly explains that the volumes of the constraints market decreased from 2012 onwards, and some of these volumes shifted to the new ancillary service
- Additional reserves can only be provided by thermal power plants with certain features that must comply with the TSO requirements, i.e. coal power plants and CCGTs
- Pay-as-clear market. Units cleared in this market have the obligation to be able to provide the capacity offered to the TSO if needed in the different ancillary services through dispatch at least at minimum stable generation
- **This market stopped operating at the end of 2019** and has been **integrated in the constraints management** process; in any case, the technical requirements requested by the TSO to participate in this market made it only possible to compete to CCGTs and coal power plants

Reserve energy provides rapid access to generation, or demand reductions, to accommodate demand/generation failures and restore frequency response

SECONDARY BAND AND REGULATION (RESERVE PROVISION)

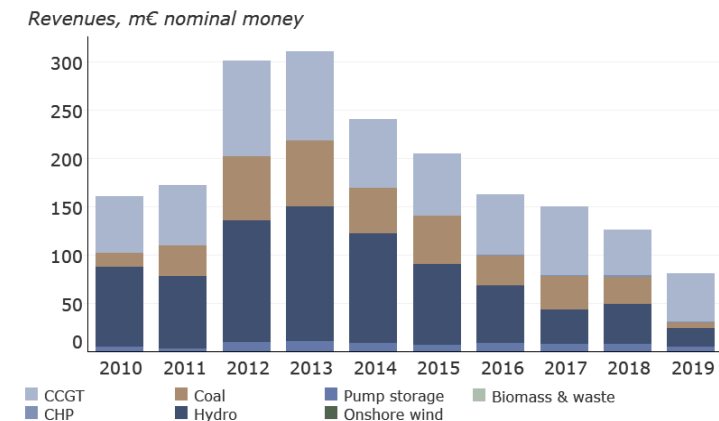
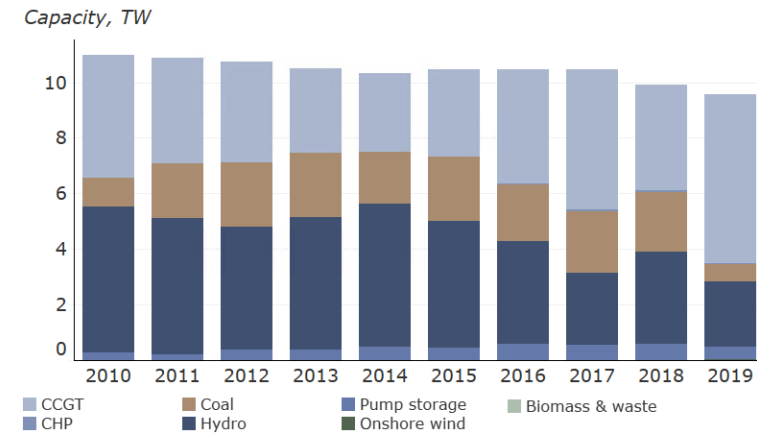
- Reserve energy is required to provide rapid access to generation, or demand reductions, to accommodate errors in demand and renewable forecasting, provide contingency arrangements for generation failures and restore frequency response capabilities
- The arrangements for energy reserve are similar to those for frequency response in that the provision of a reserve further ensures that an energy balance can be reached in the transmission system contributing to maintaining the system frequency and stability, as well as export schedules. The key differences between frequency response and secondary reserve services relate to delivery timescales, with frequency response being provided within very short timescales of up to 30 seconds. Moreover, it is also automatically triggered by deviations in frequency from 50Hz or deviations in the export schedules with France or Portugal. The secondary reserve market works on a timescale of 30 seconds (request is a time constant of 100 seconds) and must be maintained up to 15 minutes. Therefore, a quick response time is a pre-requisite for providing and capturing the value in this market
- The UCTE (entity responsible for coordinating European technical standards and policies) recommended that downward reserve levels should be between 40% and 100% of the upward reserves. The Spanish Grid Code also establishes a minimum level of upward and downward reserves at 500MW and 400MW respectively. These minimum requirements are increased by the TSO depending on the prevailing conditions of the system: maximum demand variation, demand shifting, interconnections, etc.
- In order to procure the reserve it needs, REE organises an auction to communicate the players the upwards and downwards requirements for each hour of the following day. It then opens the period for receiving offers and assigning the secondary regulation band. In real time, the TSO requests the utilisation of the secondary band, and this energy is remunerated at the price of the tertiary bids merit order. The secondary band price has historically ranged from €15-30/MW

Historically, secondary band market has been dominated by CCGTs and hydro power plants

SECONDARY BAND AND REGULATION (RESERVE PROVISION)

- Needing a quick response from producers, this market has traditionally been dominated by CCGTs and hydro power plants, with only a few coal power plants capable of providing secondary reserve capacity
- Since 2016, renewable energy producers and high-efficiency cogenerations have been allowed to provide this service. However, current participation is low, 1% in 2018
- Volumes have had a decreasing trend in the short term due to the lowering needs from the TSO to respond to changes, partially thanks to the better forecasting accuracy from agents and TSO altogether
- Revenues (or costs for the system) have followed a decreasing trend since 2013 due to the decrease in volumes but as well due to the contraction in prices in the market; this is the result of the decreasing commodity prices, increasing competition in this market, etc.

HISTORICAL CAPACITY AND REVENUES IN SECONDARY BAND



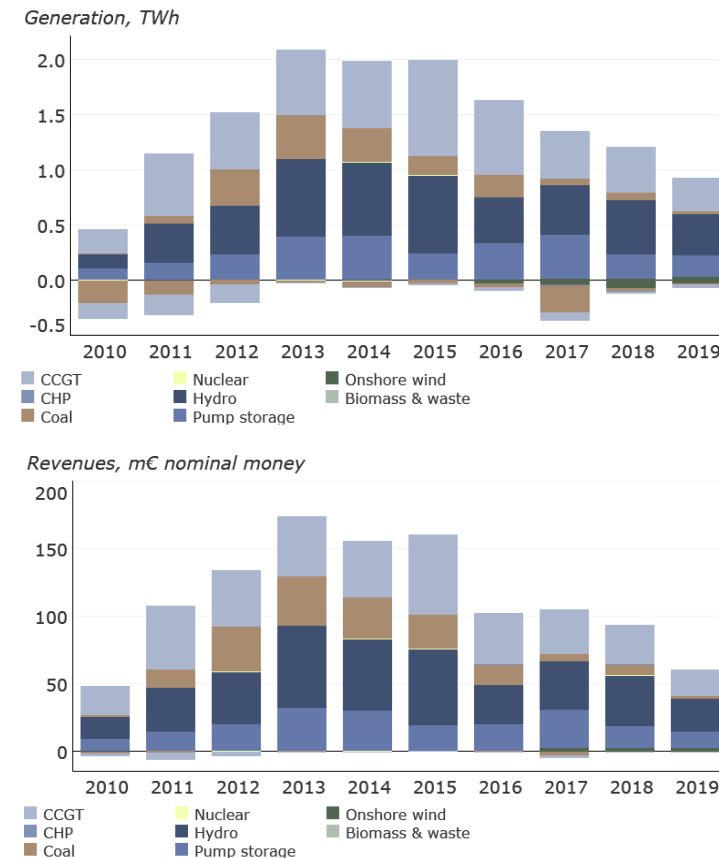
Tertiary regulation and imbalance management markets are used to manage the foreseen imbalances in the electricity market

TERTIARY REGULATION

- In a timeframe closer to real-time, demand and renewables production forecasting and unplanned outage information becomes more accurate. In cases in which the secondary reserve has been consumed beyond safe levels, REE requires a fast response from already synchronized generators to restore and free up the secondary reserve. This reserve is called tertiary regulation
- Generators, consumption from pump storage power plants and soon demand-side response participate in this market, including both renewable generators and high-efficiency cogeneration since 2016; it is paid solely per use, i.e. on a €/MWh basis. Units must be able to respond within a 15-minute timescale, maintaining provision for at least two hours. The choice of providers is based on an economic merit order and payment is marginal for each hour. Tertiary prices are highly dependent on the volume of requirements
- This market has been dominated by hydro and CCGTs, with some renewable participation in the last years, mainly onshore wind
- The TSO has required lower quantities in this market due to the improvement in the forecasting of services

Sources: REE and AFRY

HISTORICAL ENERGY VOLUMES AND REVENUES IN TERTIARY MARKET

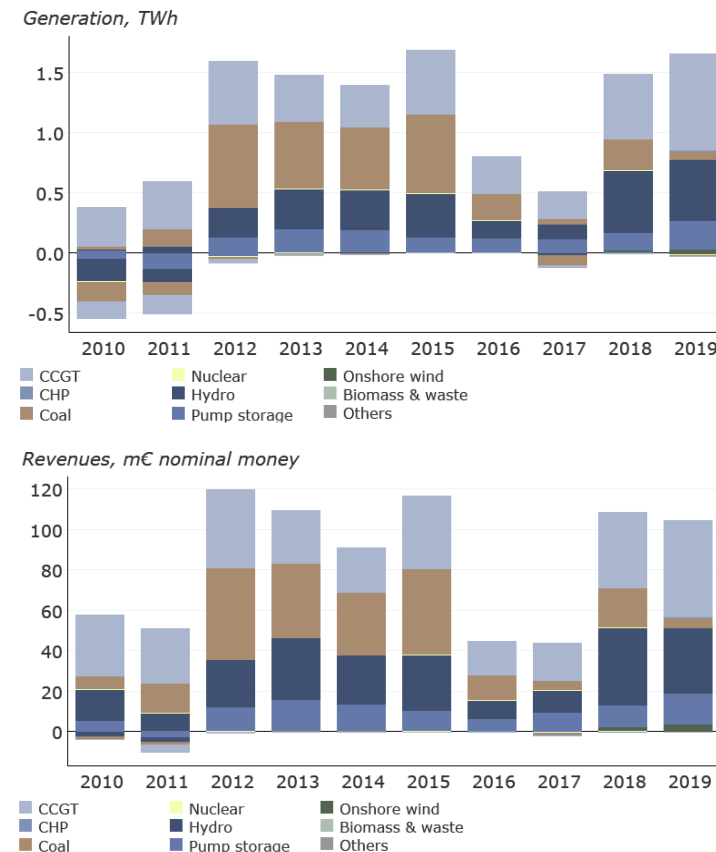


Tertiary regulation and imbalance management markets are used to manage the foreseen imbalances in the electricity market

IMBALANCE MANAGEMENT

- Imbalance management market is similar to a slow tertiary reserve. This market is used to manage foreseen imbalances in between the last intraday session and real time, by calling on additional generation and so avoiding the consumption of all tertiary reserves close to real time. It is called discretionarily on REE’s request, whenever changes have occurred to plant availability, consumers’ expectations and REE’s demand forecasts from the last intraday session
- If the deviation in the forecast imbalance is less than 300MW, it is resolved through the other ancillary services and no imbalance management market is summoned. If the imbalance is greater than 300MW, REE publishes the foreseen deviation value and accepts the lowest bids required to cover it. All accepted bids receive the Imbalance market marginal price
- This market has been dominated by hydro and thermal plants, with some renewable generators in the last years
- **Imbalance market stopped operating in the Spanish electricity market in March 2020.** And a similar market has been established, **Replacement Reserve market**

HISTORICAL ENERGY VOLUMES AND REVENUES IN IMBALANCE MARKET



Sources: REE and AFRY

Replacement reserve market is an European platform that started operating in March 2020 in Spain, replacing the Imbalance management market

- Replacement reserve (RR) market is a new ancillary service in the Spanish market which operates since March 2020 and substitutes the Imbalance management market
- European Regulation Commission regulation (EU) 2017/2195 establishes common principles for the procurement and the settlement of frequency containment reserves, frequency restoration reserves and replacement reserves and a common methodology for the activation of frequency restoration reserves and replacement reserves. This European regulation was transposed into the Spanish market regulation and the Replacement reserve market was defined
- This market is used to manage foreseen imbalances in between the last intraday session and real time, by calling on additional generation and so avoiding the consumption of all tertiary reserves close to real time. It is called discretionarily on REE's request 30 minutes before the energy supply and it is composed by four phases:
 - Generators present their offers corresponding to the replacement reserve market to the system operator
 - The Spanish system operator send to the European replacement reserve platform all the information regarding: the validated offers, the energy requirements to cover in this market and the interconnections available capacity and the flows requirements
 - The European platform send to the Spanish system operator the information regarding: the activation approval of some offers, the requirements being met by the European RR platform, the interconnection capacity used for this process, the net positions of the Spanish system, the interconnection programming and the resulting prices in the RR market
 - Finally, the Spanish operator informs the results to the generators

Generators allowed to participate in the Imbalances management are now allowed to participate in the replacement reserve market

- Generators that are allowed to provide this service are both:
 - Generators that were included and approved by the system operator within the Imbalance management market the day before the activation of the replacement reserve market; and
 - Other generators with the capacity of providing the technical requirements of this market and that have obtained the approval from the system operator
- Some of the main requirements in this replacement reserve market are as follows:
 - Bids from the generators can have different schemes to be considered in the market: totally divisible, divisible or indivisible, as well as exclusive, multi-part, time-linked, etc.
 - Preparation/offers time: <30 mins
 - Activation time: 30 mins
 - Minimum capacity: 1MW
 - Minimum duration of the activation/supply period: 15 min*
 - Maximum duration of the activation/supply period: 60 min
 - Offer validity period: Defined in the offer (15, 30, 45, 60 min)

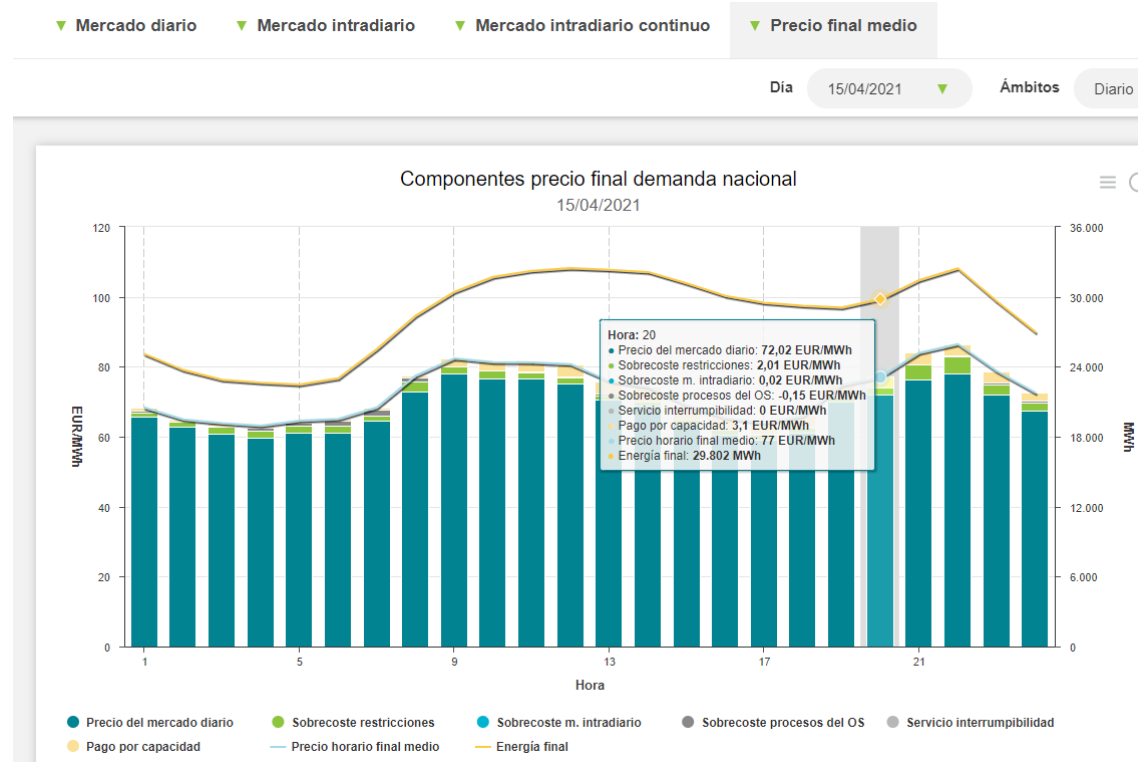
Notes: *Currently, offers are working as hourly offers but it is expected to start working in 15 minutes periods; so until the Spanish system starts working in a quarterly-hour mode, the minimum duration of the activation period is 60 min. Sources: BOE 14th January 2021 resolution

Review on the inclusion of storage power plants to the different operative procedures existent in Spain

- Storage facilities on standalone basis are not able to participate so far in day ahead and ancillary services markets in Spain as both REE operating proceedings and OMIE rules need to be fully amended
- On December 24th, 2020, the BOE published the modification of the following REE Operational Procedures (P.O.s), in order to adapt them to the operation of Storage units in all REE markets:
 - **P.O. 3.1:** Daily programming. Storage units are included as participants in REE markets. These programming units (over 1MW and one per BRP or Balancing Responsible Participant) are able to take and deliver electricity separately
 - **P.O. 3.2:** Restrictions. Storage facilities are able to participate as sellers or buyers modifying their initial program
 - **P.O. 3.3:** Replacement Reserves. Storage facilities are able to participate as balancing service providers according to technical issues established in Regulation (EU) UE 2017/2195 and Regulation (EU) 2017 /1485
 - **P.O. 3.6:** Unavailability of storage facilities
 - **P.O. 3.8:** This new procedure establishes the conditions of storage facilities to participate on balancing markets..
 - **P.O. 7.2:** Storage facilities in secondary band market.
 - **P.O. 7.3:** Storage facilities in tertiary market
 - **P.O. 9.1:** Info exchange for programming
 - **P.O. 14.1:** Settlements
 - **P.O. 14.2:** Market Agents
 - **P.O. 14.4:** Pricing methodology and payments
- The main change was including storage as a technology able to participate in the market and including it as a standard consumer/seller facility. So far the main features affecting storage in its participation on all REE managed markets are:
 - Installed capacity over 1MW
 - Facility to be included in the portfolio of a control centre
 - Be part of a Regulation zone (over 200MW)

ILLUSTRATIVE MARKET RESULTS

Final energy price for consumers is mostly the DA price, with additional components for System Operator processes and regulated costs



- Demand pays
 - DA price
 - ID and Continuous Market adjustments
 - socialised component of ancillary services
 - technical constraints
 - secondary band
 - imbalance costs
 - secondary energy
 - tertiary energy
 - replacement reserve

→ dual pricing Up/Down imbalance

- Generators
 - receive DA + ID + XBID + AS revenues
 - pay imbalance over their latest schedule

Agenda

1. AFRY
2. History of the Spanish market
3. Current Intraday and Ancillary Services
4. Challenges and outlook
5. Discussion on MEM proposal



The Spanish market will keep evolving towards higher integration with EU and towards more trading closer to Real Time

- Forward market
- Coupling with Europe
 - Day-ahead
 - Ancillary Services
- More trading by Market Participants closer to Real Time
 - XBID
 - all prices with 15' resolution
- Investment signals
- Marginal system for 'inframarginal technologies' (RES and Nuclear)
- Guarantees to operate in OMIE under high volatility

Agenda

1. AFRY
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What lessons can be learnt from the Spanish market?

- Day-ahead market algorithm
- Intraday sessions
- Ancillary services and imbalance design
- Flexibility for generators and consumers
- Integration of renewable energies
- Efficient generation dispatch
- Efficient pricing



SSCC – Desempeño

Anualmente el CND deberá elaborar un informe sobre los SSCC el cual deberá contener lo siguiente:



1. Balance del desempeño de los SSCC durante el año que contenga: uso de las reservas, problemas asociados a las reservas definidas, análisis de precio, identificación de indicadores de desempeño y propuestas de ajuste.
2. Identificación de necesidades de nuevos SSCC complementarios, justificando las necesidades de contar con dicho servicio.

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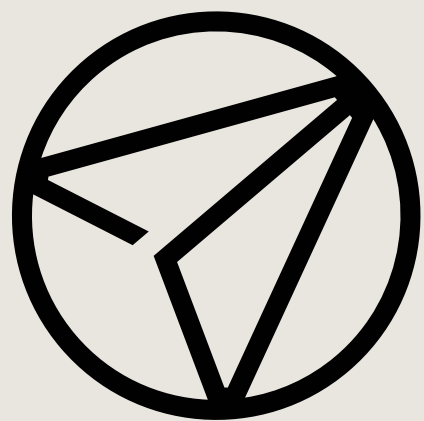
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Making Future



AFRY

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