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DOS SERVIÇOS ENERGÉTICOS

RES alternatives and e-mobility

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18 October 2022

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1. Energy transition to a carbon neutral society by 2050
2. The Solar PV Auctions in Portugal (2019, 2020 and 2022)
3. E-Mobility model in Portugal
4. Renewable and low-carbon gases
5. Flexibility: the power sector challenge

European vision and strategy

Ambition in the goals of the European Union:

Carbon neutrality by 2050!

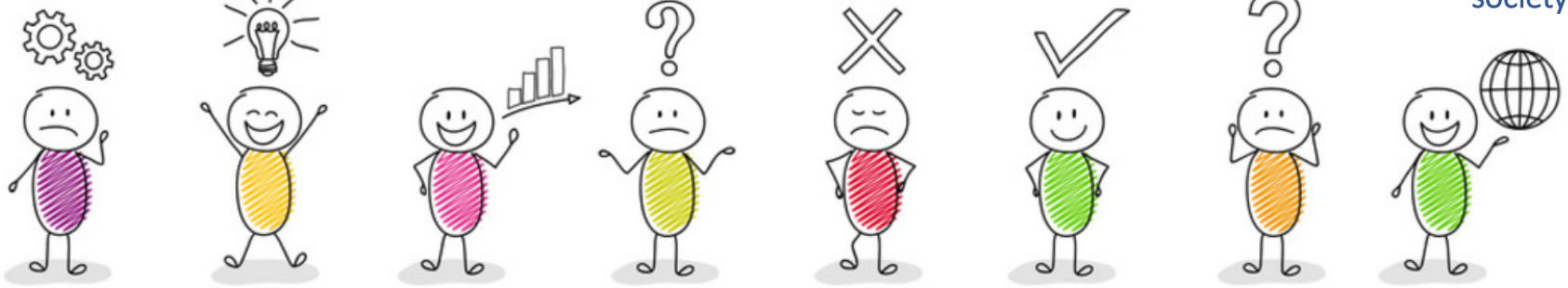
Strategy from European Regulators (CEER):

Empowering consumers for the energy transition (2022-2025)

3 fundamental axes for decarbonisation:

- **Internal Energy Market** (integration of markets in the European dimension)
- **Decentralization and local flexibility** (local energy economy)
- **Integration of energy vectors** (circular energy economy)

European vision and strategy

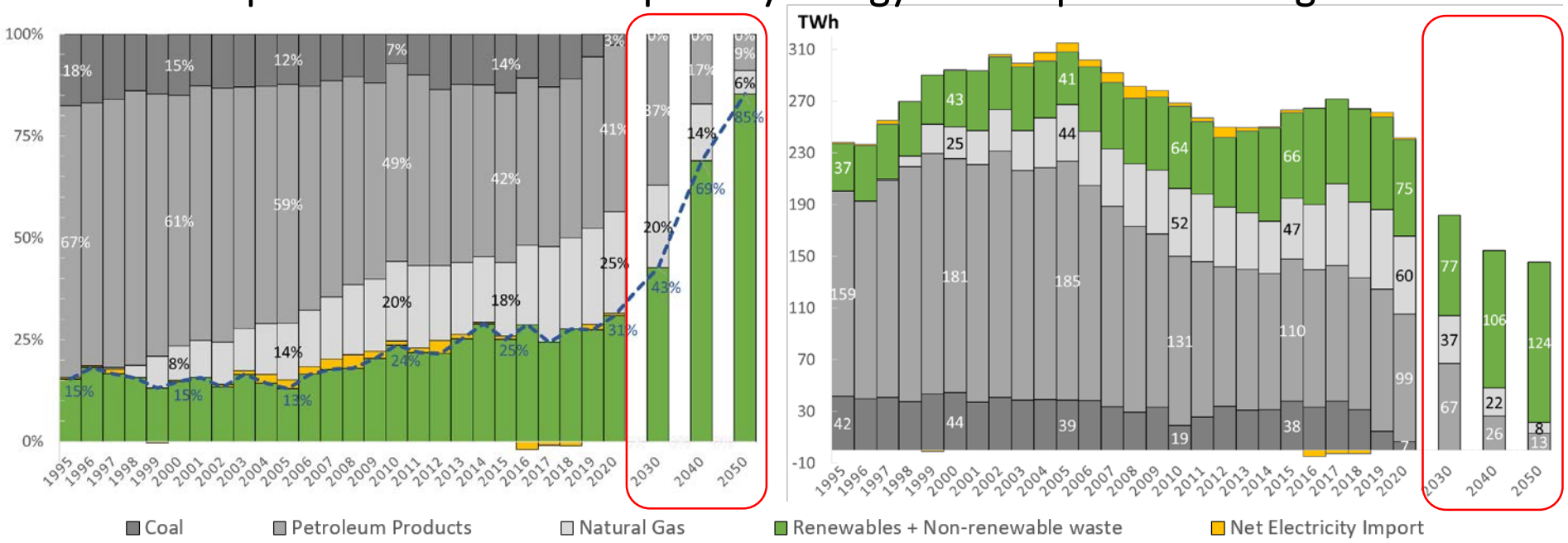


The energetic transition/metamorphosis
A transformational process

A process that started 30 years ago and is now projected for the next 30 years

Portuguese Roadmap for energy transition to a carbon neutral society by 2050

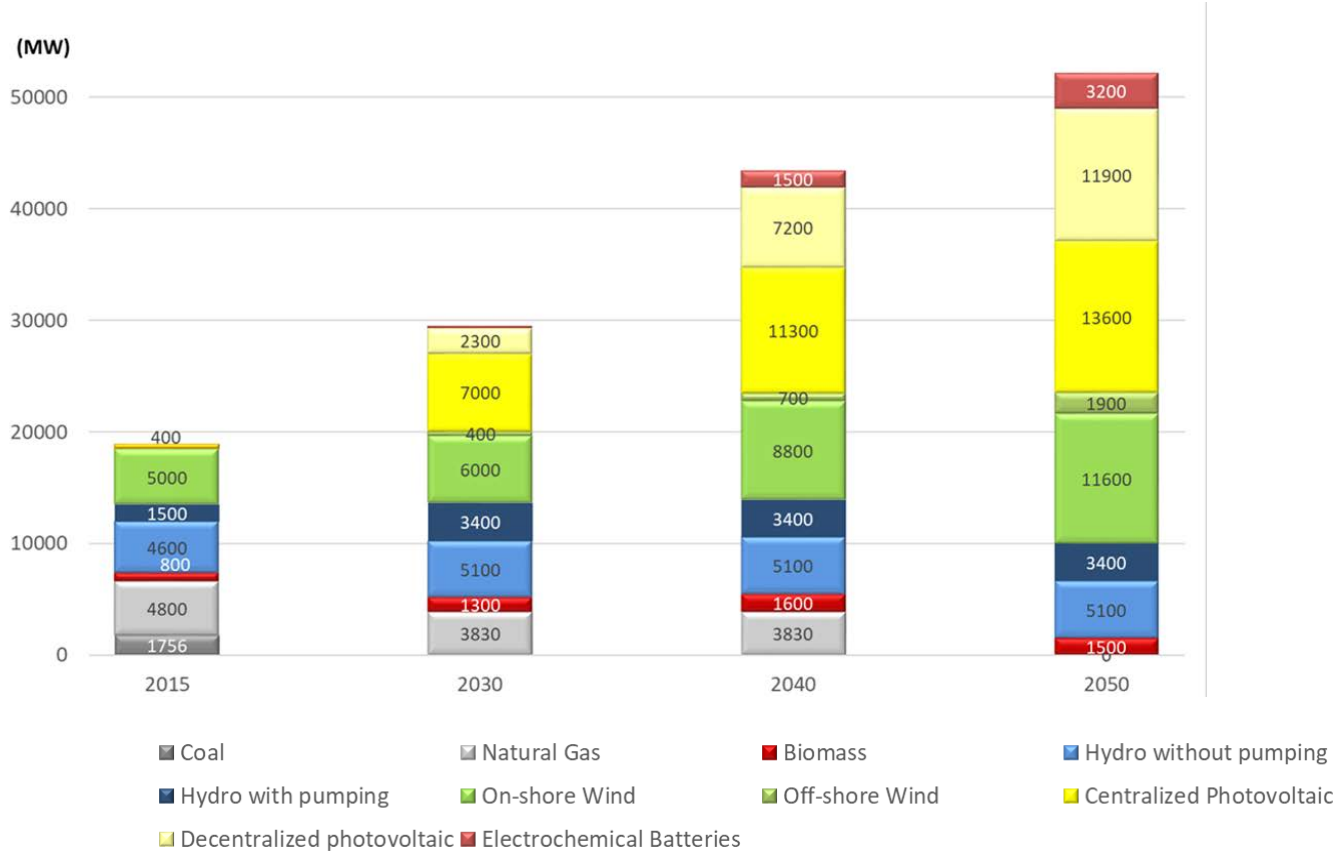
Real and predicted evolution of primary energy consumption in Portugal



- **Coal out from the Portuguese energy mix** during 2021
- **Renewables** will increase from 31% to 85% until 2050
- An **increase of 40% on energy efficiency** will reduce the overall primary energy consumption from 240 to 145 TWh/year until 2050
- **Energy dependence will reduce** from 66% **to 15%** until 2050

Portuguese Roadmap for energy transition to a carbon neutral society by 2050

Installed capacity evolution from the different power generation technologies



- The energy transition will be based on a strong commitment with **energy efficiency** and with **electrification of society**
- Only **CO_2 hard-to-abate** industrial **sectors** and specific mobility niches will need other alternative renewables fuels

Energy efficiency first!
Benefits from Decentralisation and Distributed Energy Resources

Electric technologies are more efficient and allow direct and decentralized use of renewable energy sources

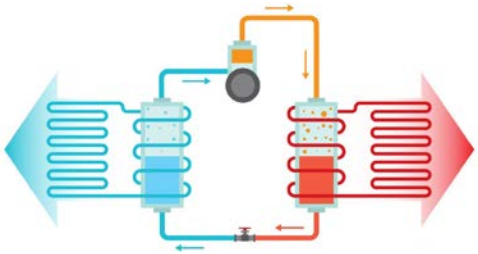
Distributed Energy Resources ensure the decentralization of the electrical system, local integration and the development of a proximity economy for energy

Distributed Energy Resources

Distributed Generation technologies from renewable energy sources

Self-generation

Heat Pumps



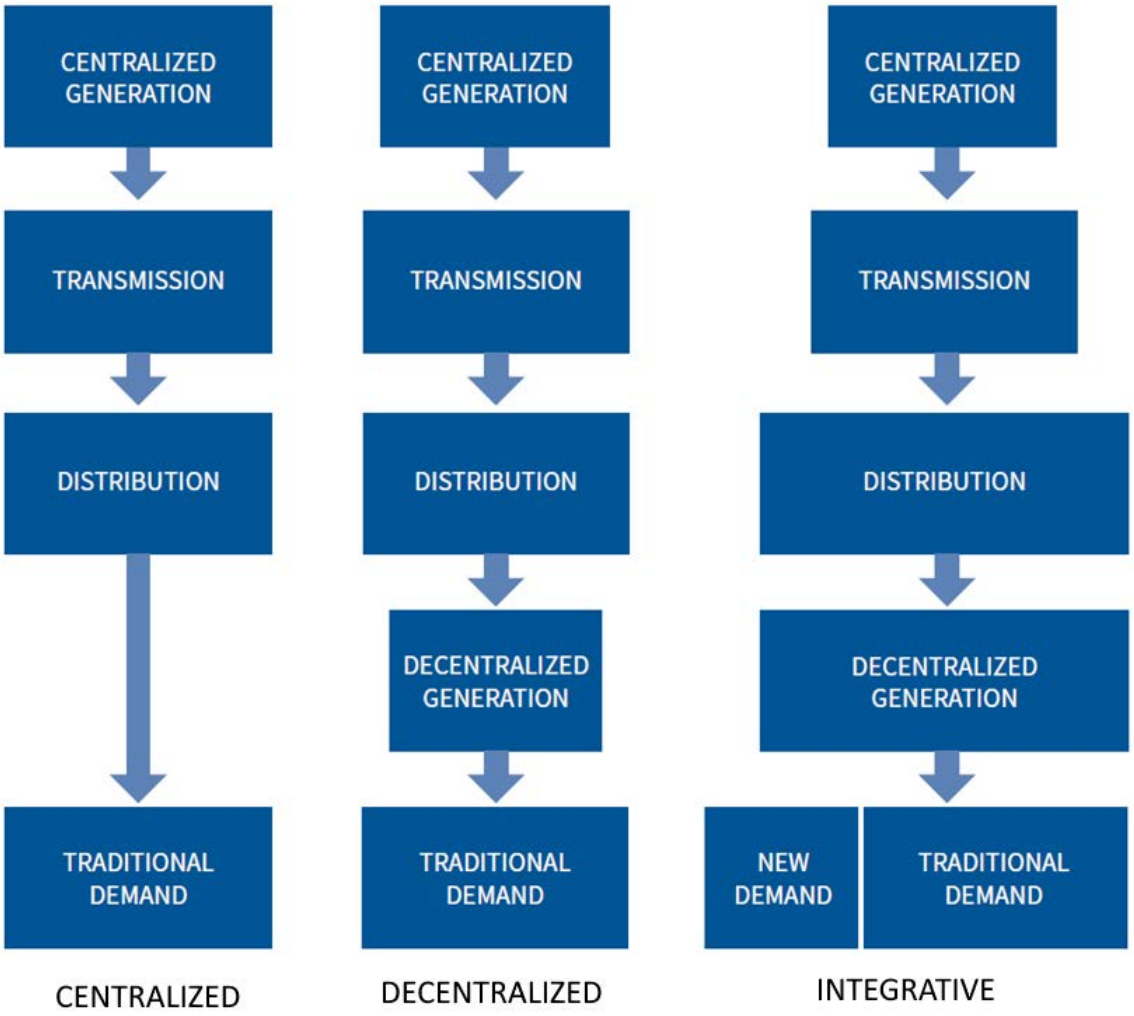
Electric Vehicles

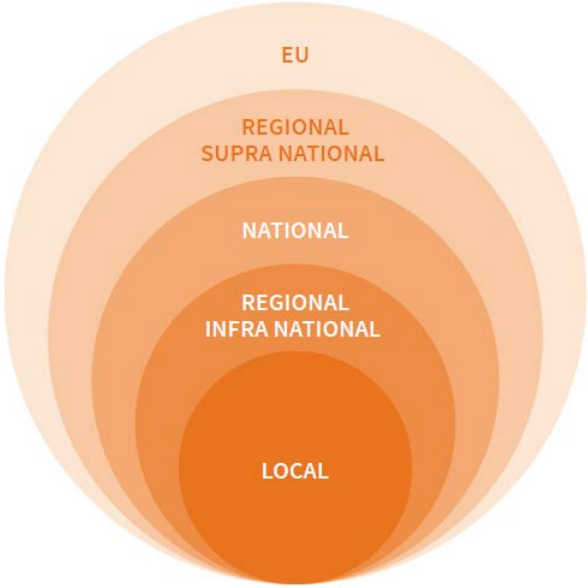
Emerging battery technologies

Digitalisation

Net Zero Energy Buildings

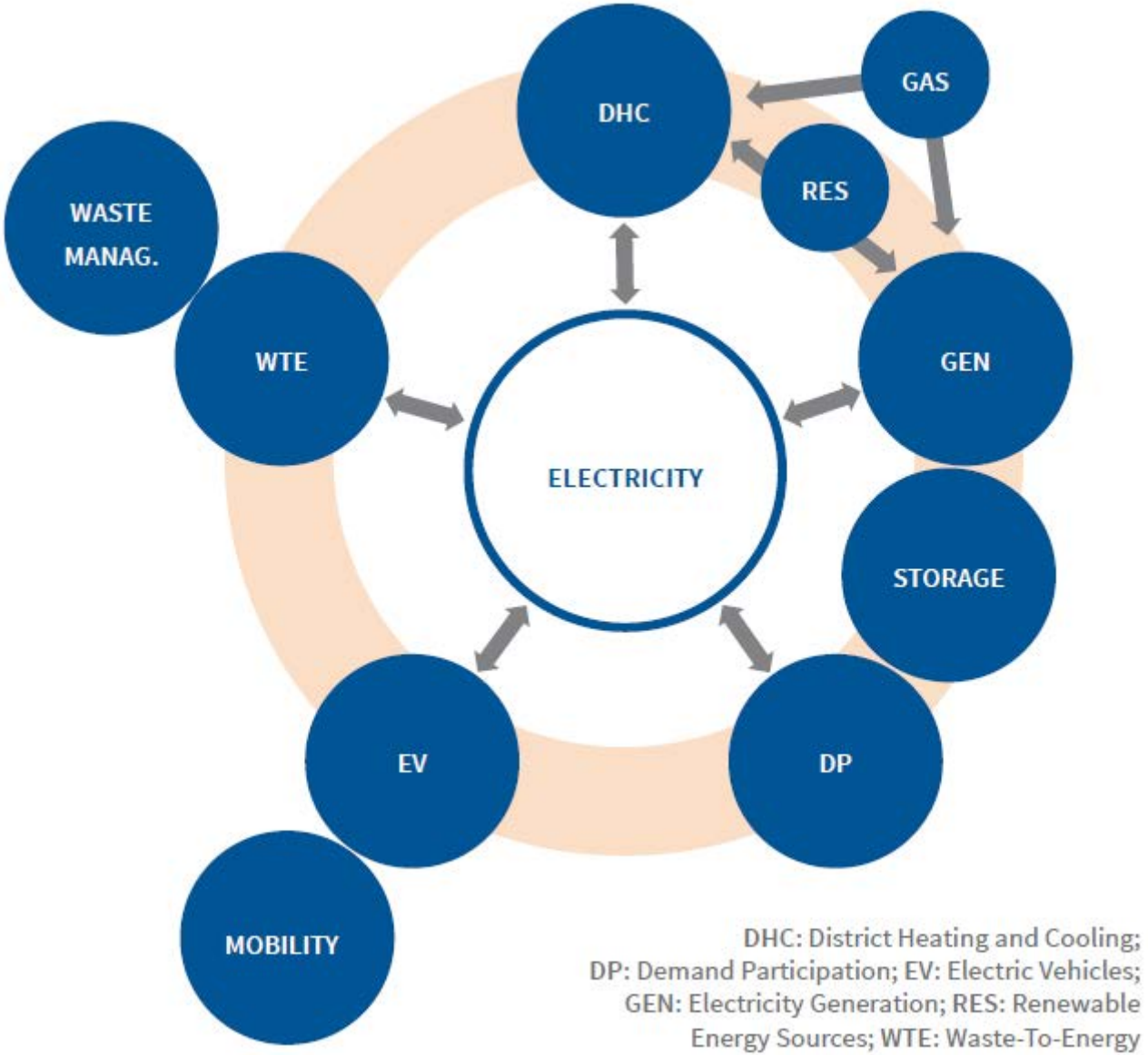
The evolution of the Electricity System





Source: "EU Electricity Reform", Jorge Vasconcelos, NEWES, May , available at https://fsr.eui.eu/wp-content/uploads/2022/05/eu_electricity_reform_may2022.pdf

Electricity as a platform for Energy System Integration



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The 2019 and 2020 Solar PV Auctions in Portugal

Pathway to the 80% renewables goal in 2030

AUCTIONS AS ENABLERS OF MATERIALIZATION OF MARKET TRENDS

2020 auction ensures regulatory stability of pathway started in 2019 and gives participants an additional option that values storage

THE PATH SO FAR AND THE ROAD AHEAD

2019 auction

- High competition in the first auction resulted in world record low bids
- 1GW awarded under the fixed tariff option, weighted average FiT of €20.4/MWh, nominal
- 288MW awarded under the merchant option, weighted contribution to the system of €21.35/MWh

2020 auction

- Two remuneration options of 2019 auction are maintained
- Third option included for storage facilities associated with solar generation
- Is storage a price competitive solution in today's market?

MEDREG

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MEDREG is co-funded by the European Union

Source: Presentation "Balancing mechanism – The Portuguese case" from Pedro Verdelho at the MEDREG – ECRB Joint Workshop on"Integrating RES in the Electricity Networks and Balancing Mechanism in MEDREG and ECRB Regions" – 15 April 2021

The 2019 and 2020 Solar PV Auctions in Portugal

2020 Solar PV Auction results

Batch	Revenue Scheme	Winner	Capacity Awarded	Merchant (No Storage)		Fixed Tariff		Merchant (With Storage)			VAL	Merchant (No Storage)	Fixed Tariff	Merchant (With Storage)
			MVA	MVA	€/MVA/Ano	MVA	%	MVA	%	€/MVA/Ano	€/MVA/Ano	€/MWh	€/MWh	€/MWh
1	Merchant (No Storage)	Green Show - Lda	99	99	72 976,5	0		0			903 616	-37,27		
2	Merchant (With Storage)	Hanwha Q Cells GmbH	109	0		0		109	207,33%	-35 968	795 306			-18,38
3	Merchant (With Storage)	Endesa Generación Portugal, S.A.	99	0		0		99	187,93%	-29 467	721 005			-15,06
4	Merchant (No Storage)	Green Show - Lda	54	54	79 019,1	0		0			978 437	-40,36		
	Merchant (No Storage)	Green Show - Lda	4	4	75 873,9	0		0			939 493	-38,75		
	Merchant (With Storage)	Hanwha Q Cells GmbH	50	0		0		50	255,02%	-51 992	978 437			-26,55
5	Merchant (With Storage)	Iberdrola Renewables Portugal, S.A.	69	0		0		69	148,18%	-16 146	568 763			-8,25
6	Merchant (With Storage)	Hanwha Q Cells GmbH	99	0		0		99	244,86%	-48 585	939 493			-24,81
7	Fixed Tariff	Solarengoradar - Unipessoal, Lda.	10	0		10	73,30%	0			685 441		11,14	
8	Merchant (No Storage)	TAGENERGY SA	10	10	64 229,3	0		0			795 306	-32,82		
9	Merchant (No Storage)	TAGENERGY SA	10	10	64 229,3	0		0			795 306	-32,82		
10	Merchant (With Storage)	Hanwha Q Cells GmbH	19	0		0		19	187,93%	-29 467	721 005			-15,06
11	Merchant (With Storage)	Hanwha Q Cells GmbH	19	0		0		19	235,50%	-45 445	903 616			-23,21
12	Merchant (With Storage)	Hanwha Q Cells GmbH	19	0		0		19	276,31%	-59 133	1 060 043			-30,20

	Total (MVA)	# Batchs	Revenue scheme
Endesa Generación Portugal, S.A.	99	1	Merchant (With Storage)
Green Show - Lda	157	2	Merchant (No Storage)
Hanwha Q Cells GmbH	315	6	Merchant (With Storage)
Iberdrola Renewables Portugal, S.A.	69	1	Merchant (With Storage)
Solarengoradar - Unipessoal, Lda.	10	1	Fixed Tariff
TAGENERGY SA	20	2	Merchant (No Storage)

MEDREG

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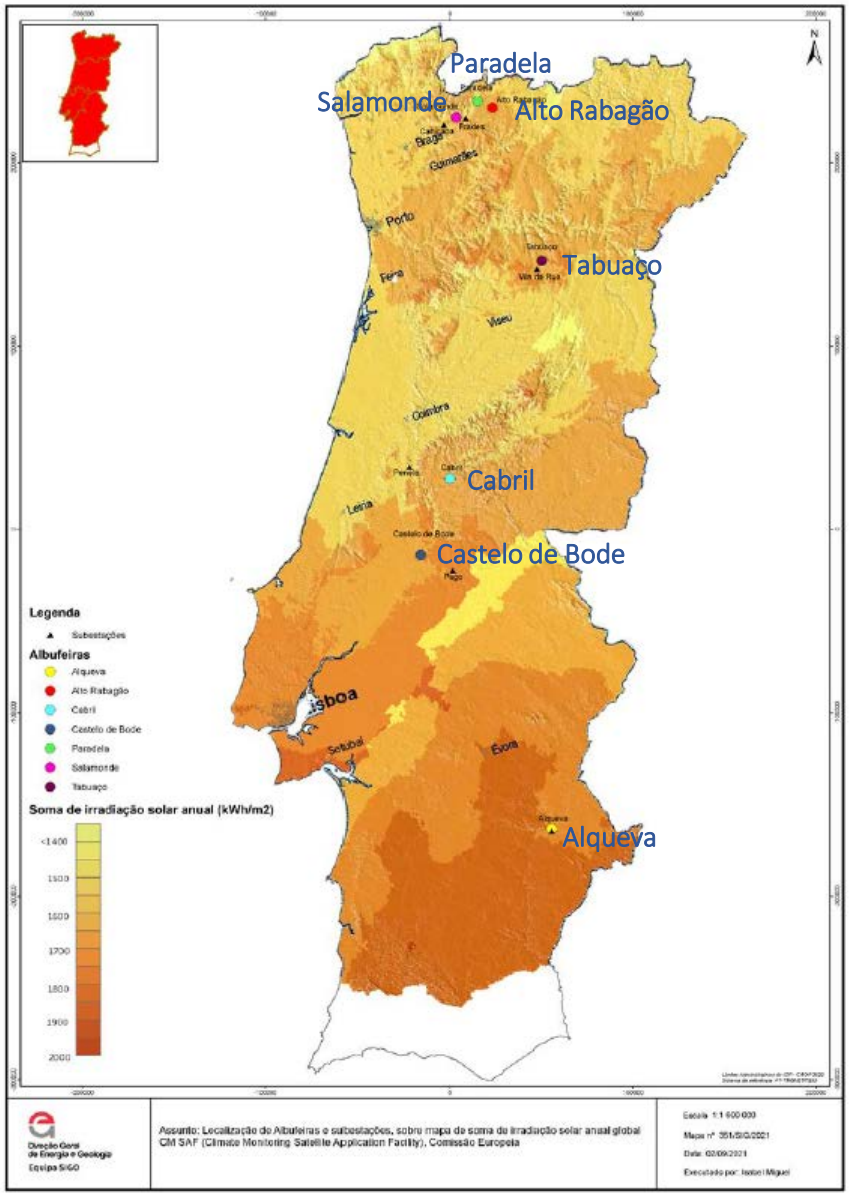
Source: Presentation "Balancing mechanism – The Portuguese case" from Pedro Verdelho at the MEDREG – ECRB Joint Workshop on"Integrating RES in the Electricity Networks and Balancing Mechanism in MEDREG and ECRB Regions" – 15 April 2021

The 2022 Floating Solar PV Auction in Portugal



Sites locations and characteristics

Lote	Albufeira	Subestação de ligação/Posto de Corte	Nível de tensão [kV]	Disponibilidade da capacidade de receção	Capacidade de receção disponível [MVA]
1	Alqueva	Alqueva	400	Imediata	100
2	Castelo de Bode	Pego	400	Imediata	50
3	Cabril	Penela	60	31.12.2023	33
4	Alto Rabagão	Frades	60	31.12.2023	42
5	Paradela	Frades	60	31.12.2023	13
6	Salamonde	Caniçada	60	31.12.2023	8
7	Tabuaço	Vila da Rua	60	31.12.2023	17

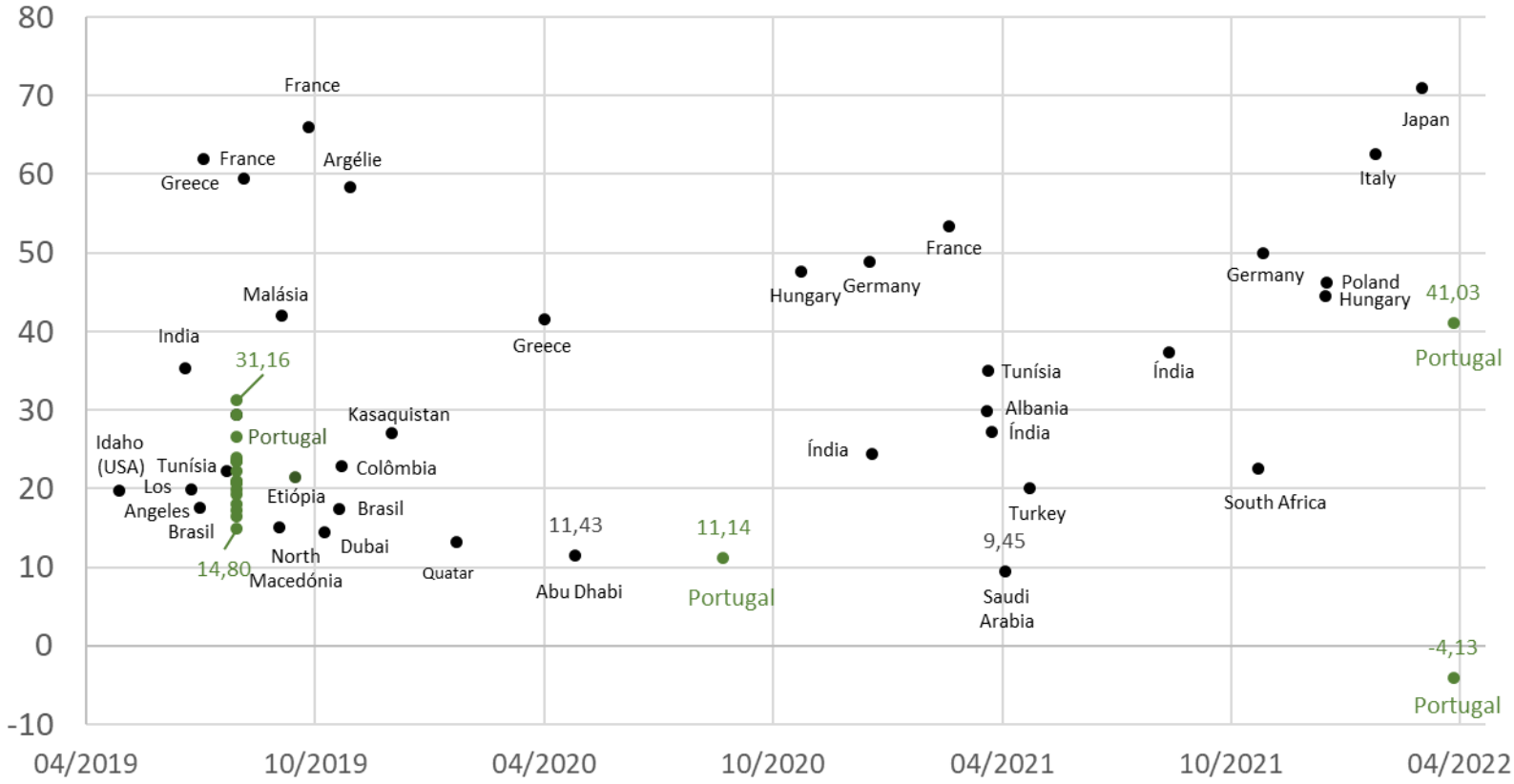
The 2022 Floating Solar PV Auction in Portugal

Results

Lote	Localização	Concorrente ganhador	VAL (€/MVA)	Capacidade Adjudicada (MVA)	Compensação Fixa ao SEN (€/MVA/Ano)	Prémio Variável por Diferenças (%)	Compensação Fixa ao SEN (€/MWh)	Prémio Variável por Diferenças (€/MWh)
1	Alqueva	EDP Renewables, SGPS, S.A.	956612	70		110,00		-4,13
3	Cabril	Voltalia Portugal, S.A.	9332	33		1,01		41,03
4	Alto Rabagão	Endesa Generación Portugal S.A.	557630	42	45713,10		25,70	
5	Paradela	Finerge S.A.	47990	13	3934,10		2,27	
6	Salamonde	Finerge S.A.	94892	8	7779,00		4,49	
7	Tabuaço	Finerge S.A.	1260128	17	103302,00		57,26	

Promotor	Total (MVA)	# Lotes	Modalidade
EDP Renewables, SGPS, S.A.	70	1	Prémio Variável por Diferenças
Voltalia Portugal, S.A.	33	1	Prémio Variável por Diferenças
Endesa Generación Portugal S.A.	42	1	Compensação Fixa ao SEN
Finerge S.A.	38	3	Compensação Fixa ao SEN

Results from worldwide Solar PV Auctions 2019-2022



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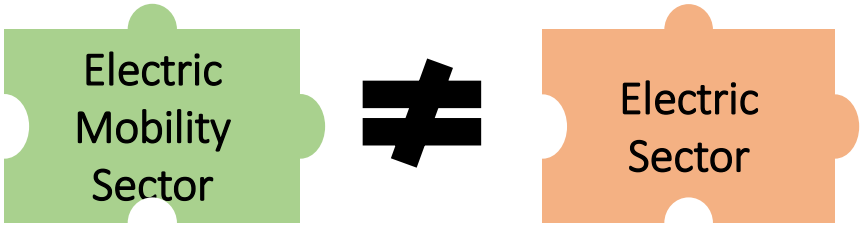
Electric mobility model in Portugal

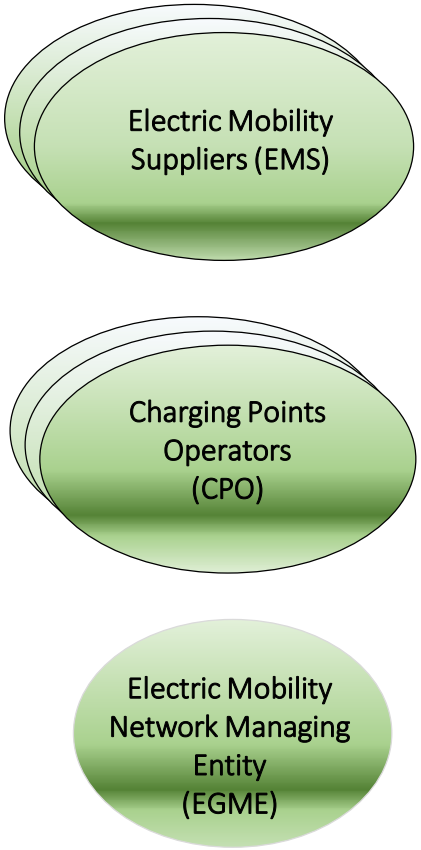


MINISTRY OF THE ENVIRONMENT, TERRITORIAL PLANNING AND ENERGY

Decree-Law no. 90/2014
of 11th of June

The main activities destined to assure **public network of charging points** for electric mobility are:

- Selling electricity for electric mobility (EMS);
- Operation of charging points of the electric mobility network (CPO);
- Operations management of the electric mobility network (EGME).



*EMS in PT: CEME
CPO or in PT: OPC

Electric mobility model in Portugal

Freedom of choice of supplier

Public network of charging points

Electric Mobility Sector

Electric Vehicle Users (EVU)

Electric Mobility Suppliers (EMS)

Activity developed in **market regime**

Activity developed in **monopoly regime**

Electric Mobility Network Managing Entity (EGME)

Activity developed in **market regime**

Charging Points Operators (CPO)

Private acess (parkings, buildings)

*EVU in PT: UVE

Electric mobility model in Portugal

- Regulation of the model concerning the correct market operation and protection of the consumers of electric mobility (users of electric vehicles)
- Regulation of the activity of the operation management entity of the electric mobility network
- Promotion of the relationship between the operation management entity and the electricity grid operators

ENERGY SERVICES REGULATORY AUTHORITY

Regulation no. 854/2019 altered by Regulation no. 103/2021

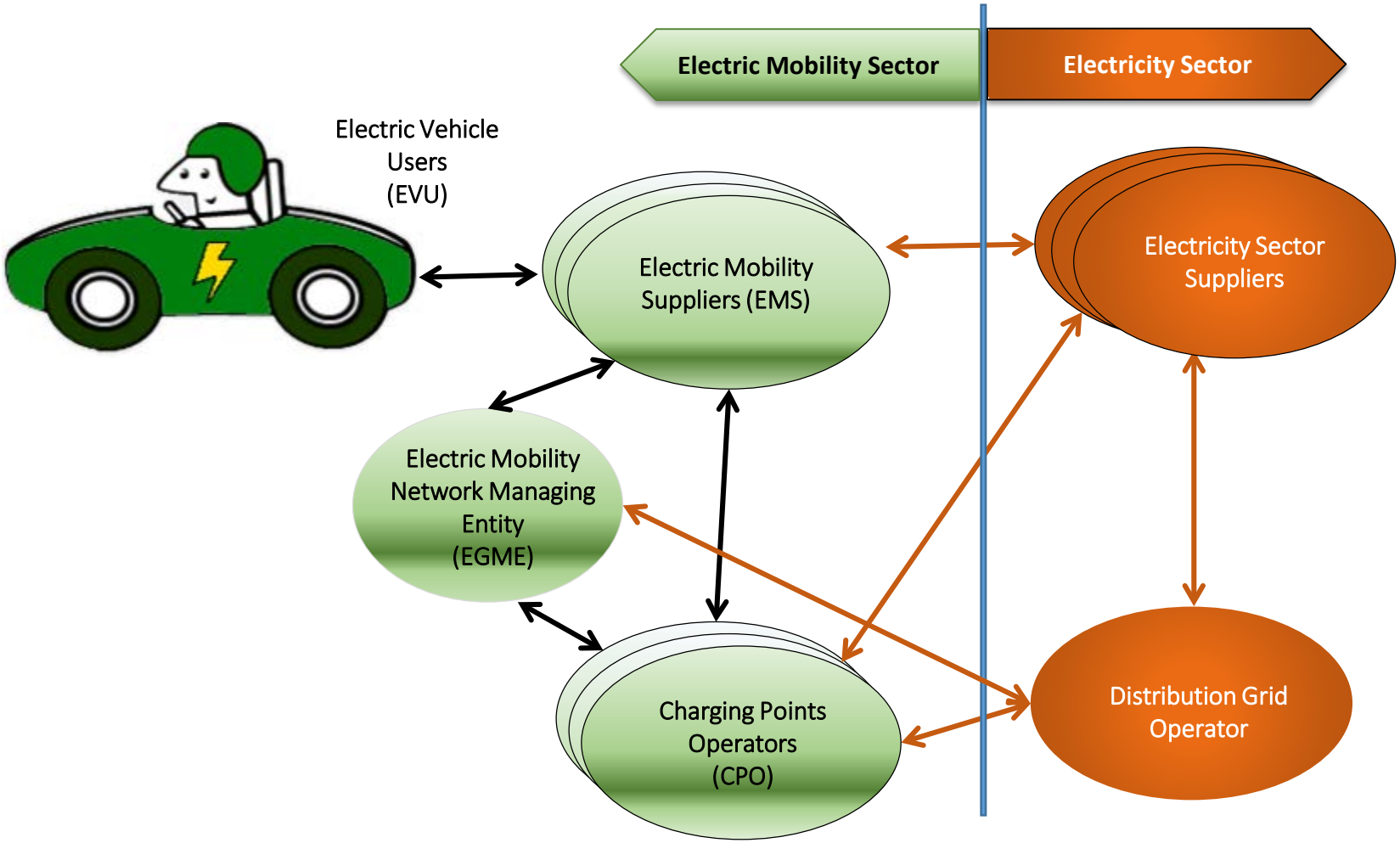
Regulation for electric mobility

Electric Mobility Network Managing Entity (EGME)

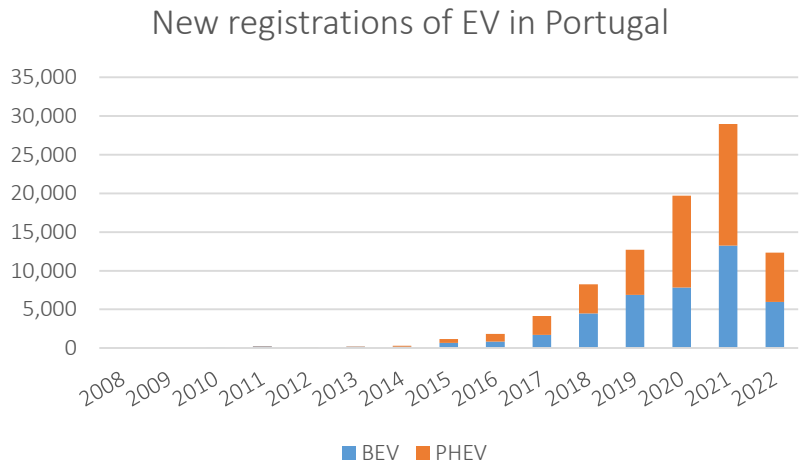
Electric Mobility Sector

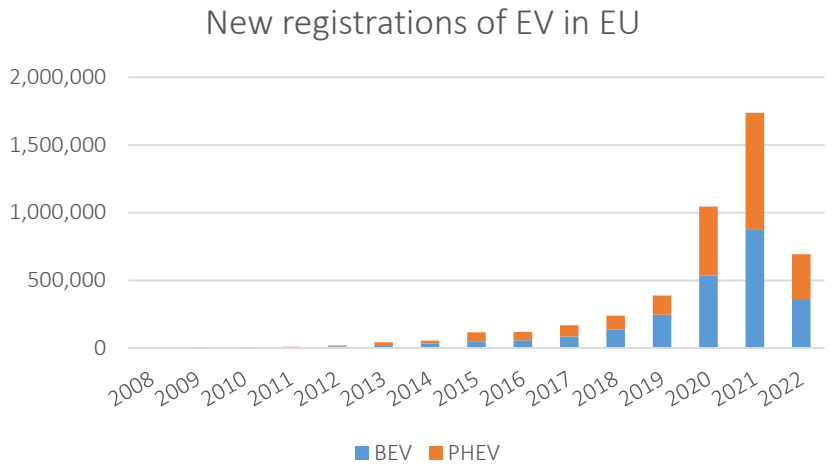
Electric Sector

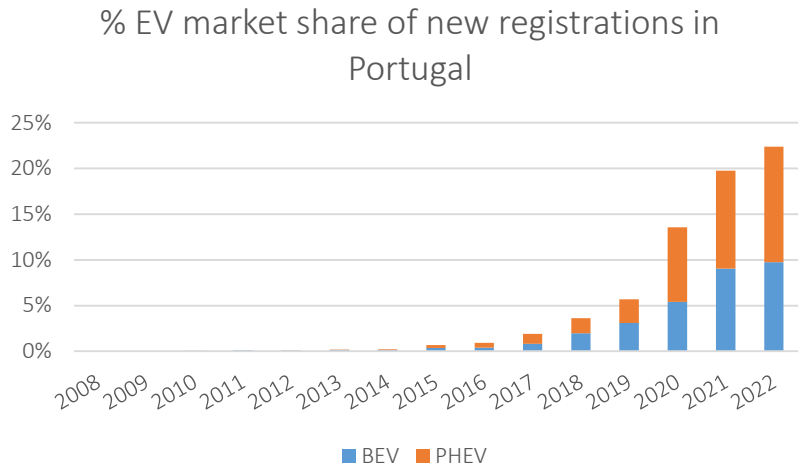
Interactions between the Sector for Electric Mobility and the Electricity Sector

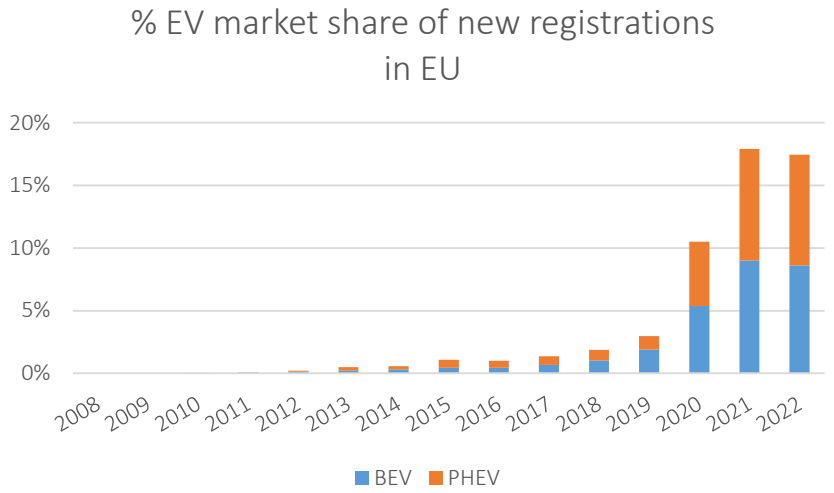


Number of electric vehicles registered in Portugal and Europe (passenger cars M1)



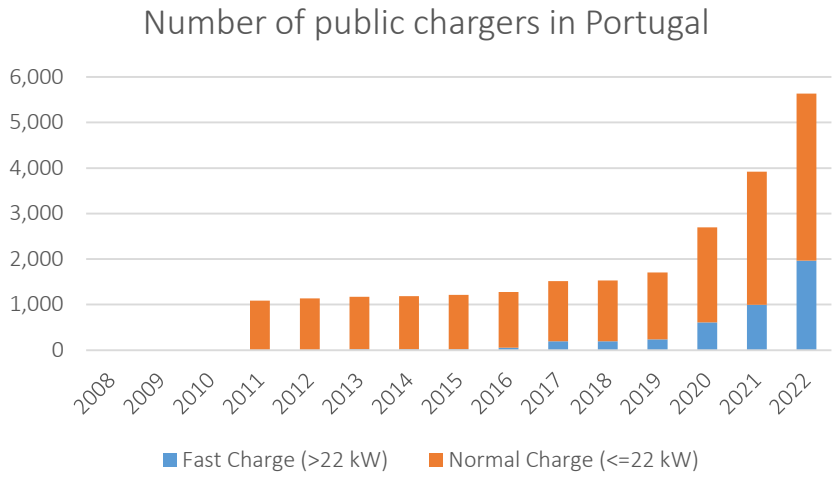


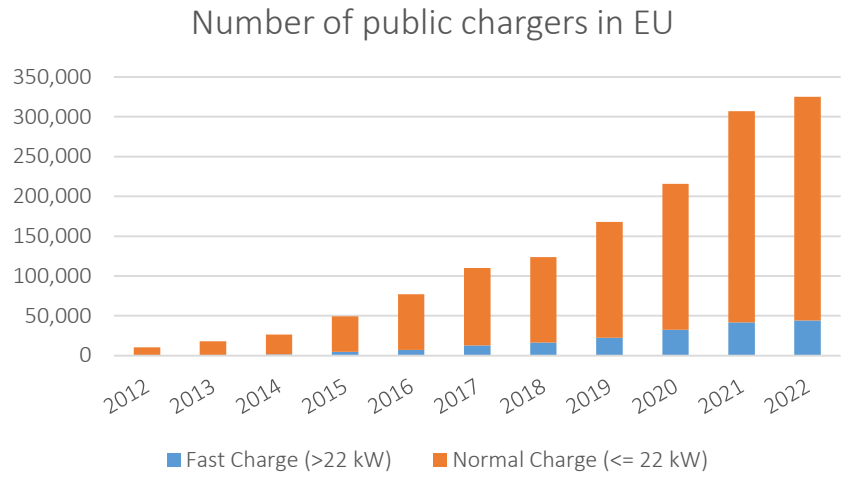


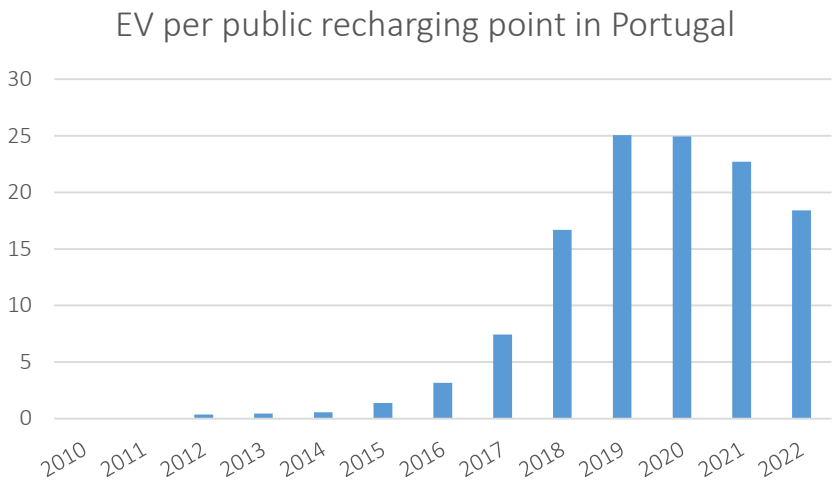


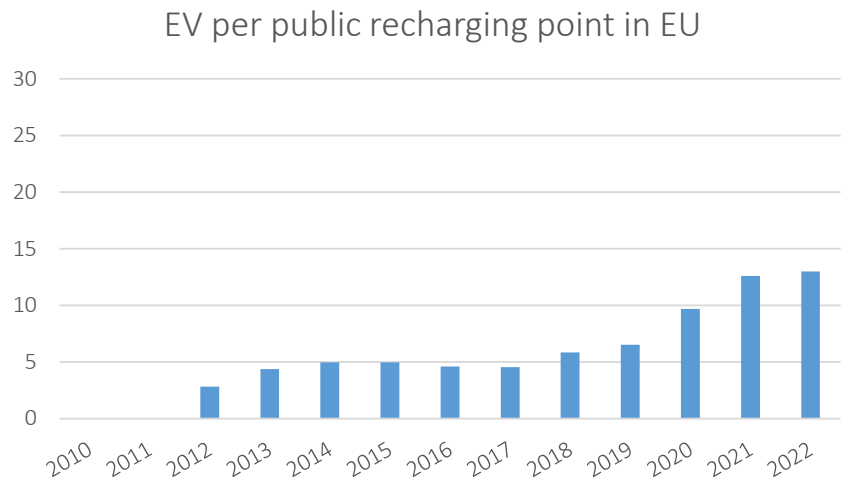
Source: "European Alternative Fuels Observatory", https://www.eafo.eu/ (13/10/2022)

Number of public chargers in Portugal and EU









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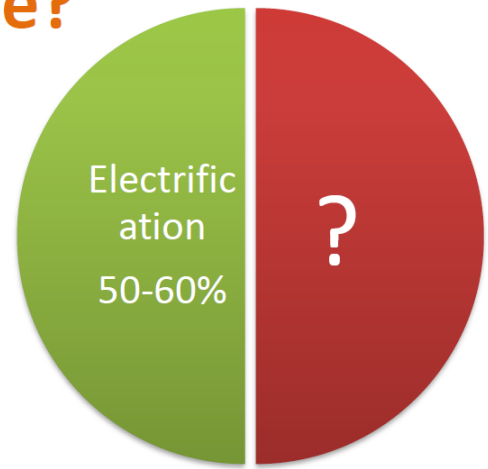
Role of gas in the future

« Clean molecules»: the other half of the pie?



Zero-carbon economy by 2050

EU Commission's LT strategic vision: deep decarbonisation of the economy requires 50% electrification or more, up to 60% by 2050

EU climate targets for 2030

- 55% CO2 emissions cut (SoU proposal)
- 32% gross final RES energy consumption*
- 32,5% energy efficiency

Role of gas → support to decarbonisation

- Smaller volumes
- Natural gas as a «back up» (storage, LNG-to-X, etc)
- Clean molecules: biogas, biomethane, synthetic methane, Hydrogen

Source:

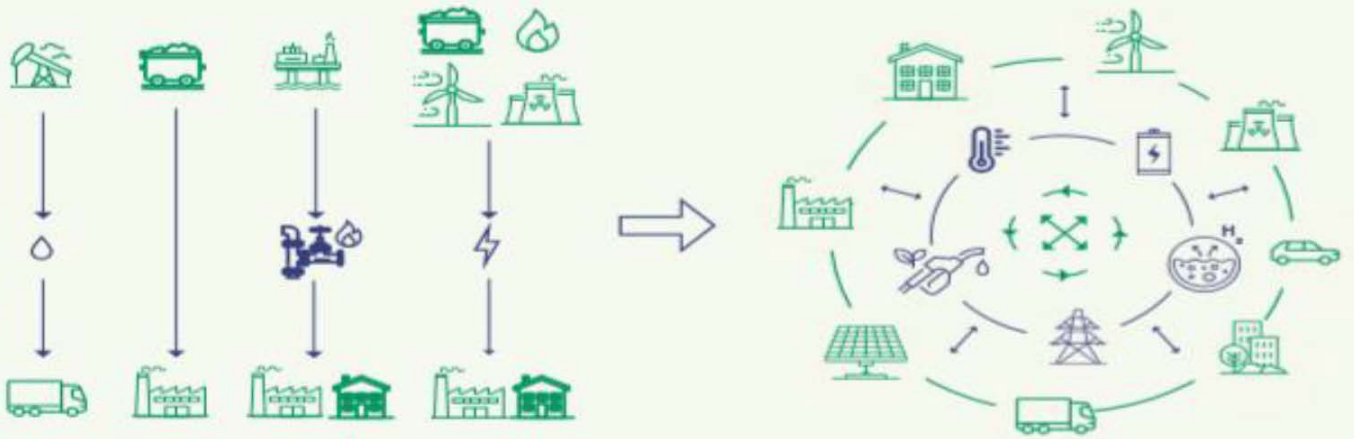
Role of gas in the future

The ESI Strategy

Energy System Integration is
«the coordinated planning and operation of the energy system 'as a whole', across multiple energy carriers, infrastructures and consumption sectors».

The energy system today : linear and wasteful flows of energy, in one direction only

Future EU integrated energy system : energy flows between users and producers, reducing wasted resources and money

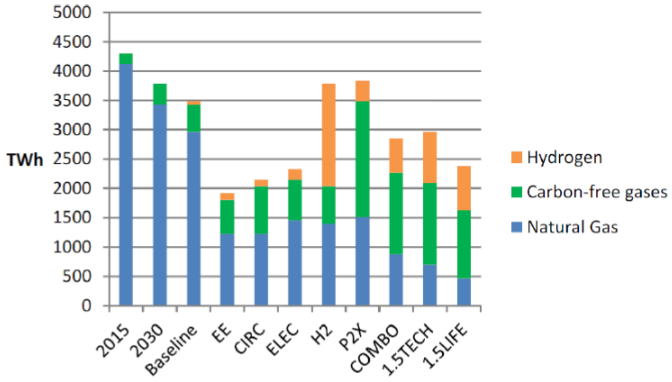


Source: EU Commission's Strategy for Energy System Integration, July 2020

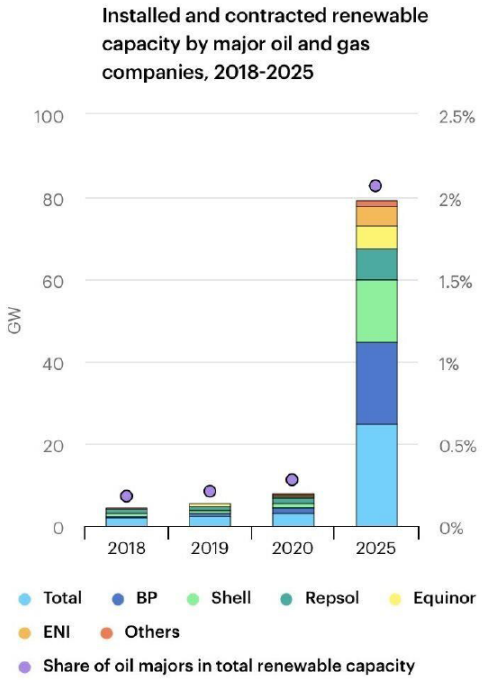
Source:

Renewable and low-carbon gases in the path to 2050

Several scenarios and projections see an important role for renewable gases in the path to 2030 and 2050



Source: EU Commission's Long-Term Strategy and OIES



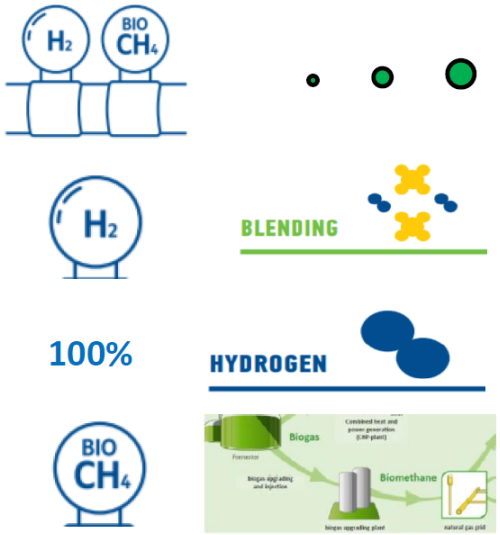
Source:

Role of gas in the future

ACER
European Union Agency for the Cooperation of Energy Regulators

Which gas infrastructure for H2 and biomethane?

Investigate gas network adaptations for ET: *Is gas* ***transmission*** *infrastructure in the EU ready to allow ren. & low-c gases (H2 and biomethane)?*



By 2050 "green gases" (H2 and bioCH4) ~ 30% to 70% of total gas use (*)

H2 TSO acceptance, blending limits/ targets, EU vs. national approach, type of injection, connection points, treatment in network plans

Networks regulation, national H2 strategies, operators, electrolysers ownership

BioCH4 injections, capacities, connection points, roles of producers/DSO/TSO

Available at: link – The Report is based on info provided by energy regulators (NRAs)
Published on 10 July 2020, info collected as of 20 May 2020. (*) EUCO Conclusions, 19.12.2019

Source:

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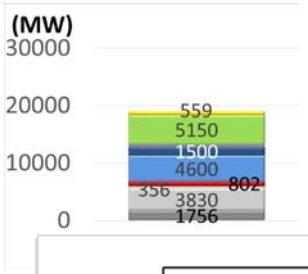
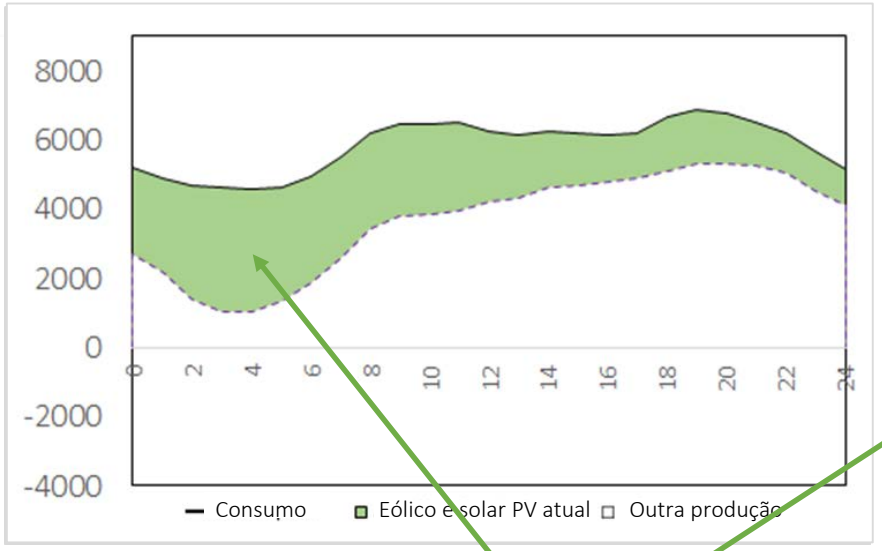
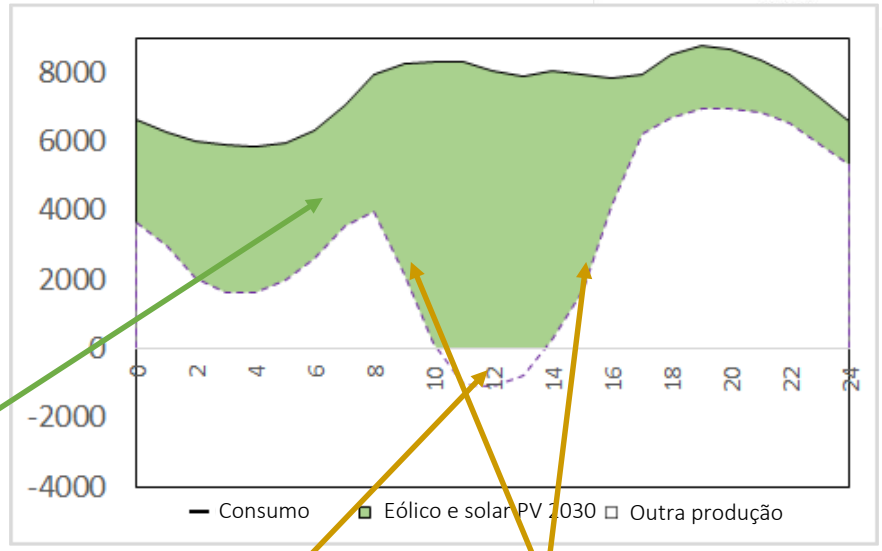
The growing importance of the Balancing Market and of the Flexibility Service Providers



2018



2030



Consumption provided by the Solar PV and Wind power plants

Potential curtailment situation

Bigger ramps

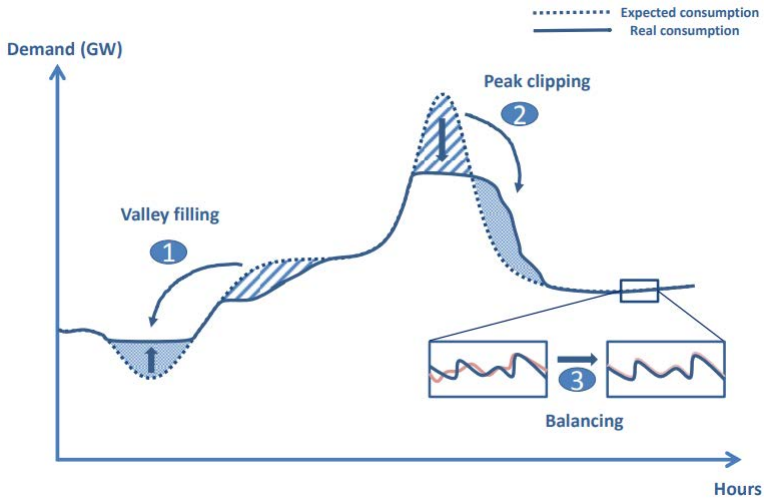
Great challenges for the balancing services providers

Flexibility: a key for the energy system of the future

Flexibility can be defined as **the ability** of the electricity system **to respond to fluctuations of supply and demand** while, at the same time, **maintaining system reliability**.

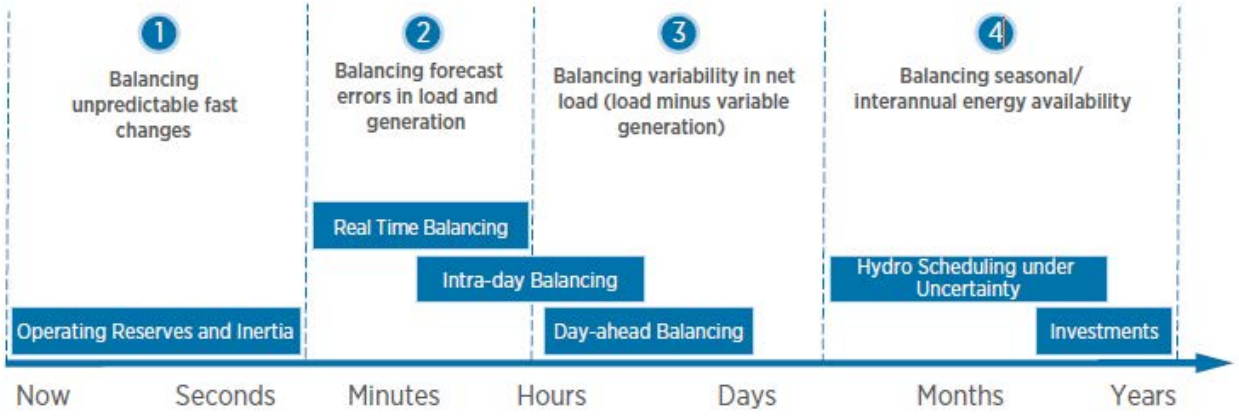
At the facility level (generation / consumption / storage), **flexibility** is **the modification of** generation injection and/or consumption **patterns** in reaction to an external signal (price signal or activation) **in order to provide a service within the energy system**.

The parameters used to characterise flexibility include the amount of power modulation, the duration, the rate of change, the response time, the location etc.



Source: "CEER Advice on Ensuring Market and Regulatory Arrangements help deliver Demand-Side Flexibility, CEER, June 2014

Different time scales for providing flexibility services



Source: IRENA, *Report on future of solar photovoltaic*, November 2019

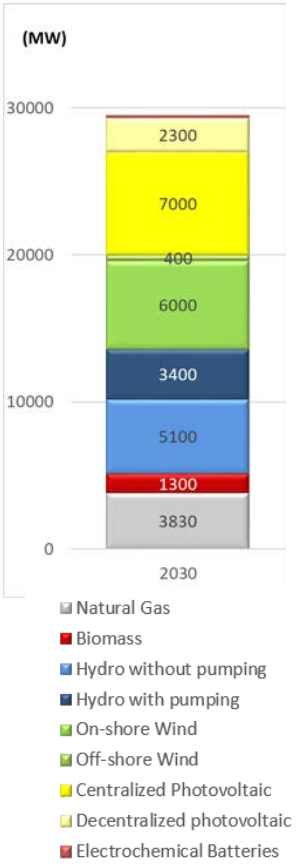
The “Residual load”

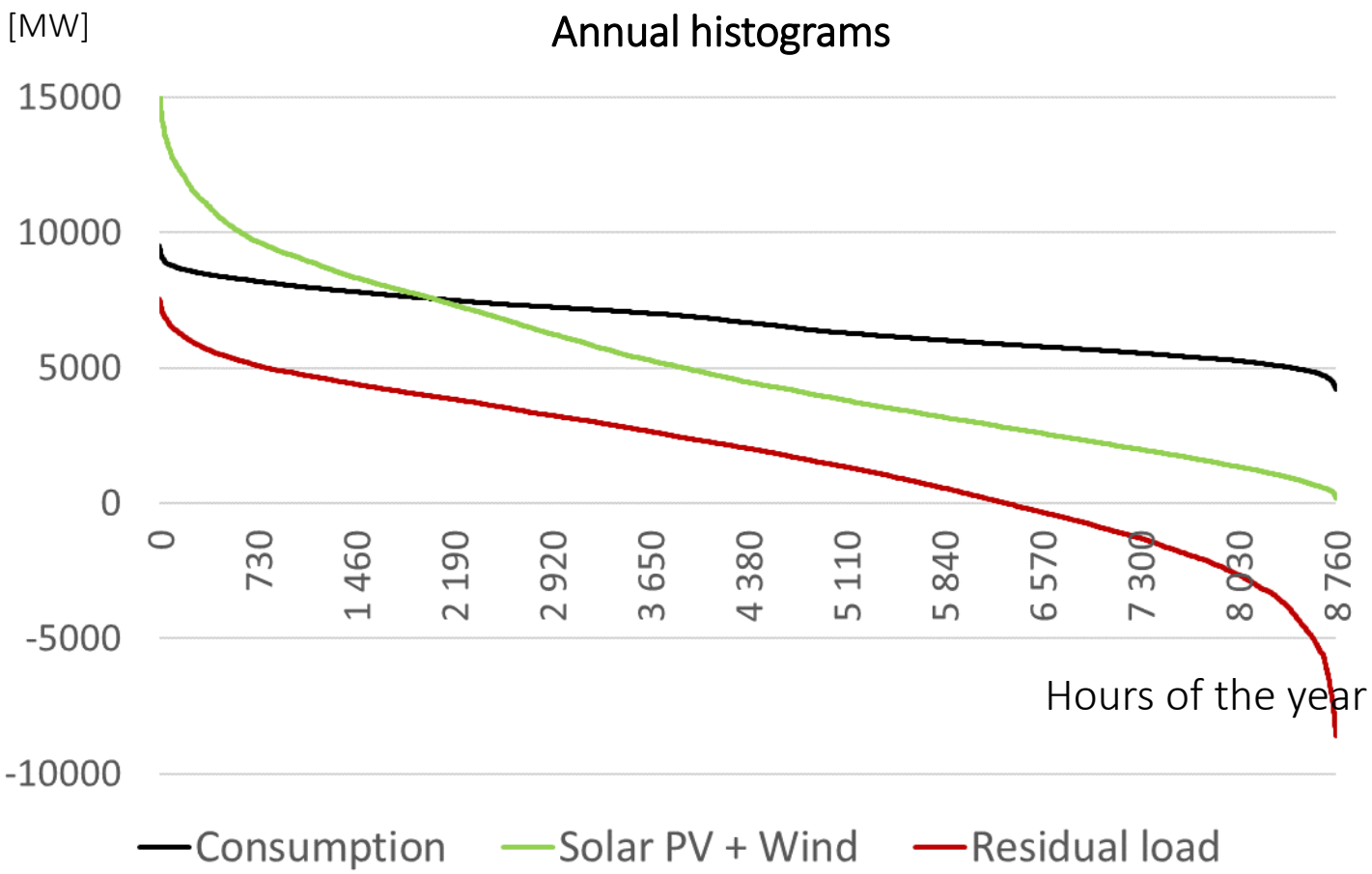
- The increasing penetration of **electricity generation on variable Renewable Energy Sources** (*vRES generation*) will impact the operation of the power system. To accommodate this new power generation, **adequate flexibility technologies** (e.g. storage, international interconnections, DSR – demand side response) are required to counterbalance the variations and keep balanced supply and demand at any time.
- In parallel, increasing RES shares may result in a **RES generation surplus** during an increasing number of hours throughout the year. In case of insufficient system flexibility, this surplus needs to be curtailed.
- The concept of “**Residual load**” can help to clarify the **power system adequacy** and the **flexibility needs** to be made available.
- The “**Residual load**” is defined as the hourly national demand less the generation from *vRES generation* and describes the part of the national demand that needs to be met by dispatchable generation units (such as coal, gas, hydro with dam storage and with or without pumping), exchanges with neighbouring countries through international interconnections or storage units.

$$\textit{Residual load} = \textit{Power demand} - \textit{vRES generation}$$

The “Residual load”

2030 Portuguese Power Mix





Residual load = Power demand − vRES generation

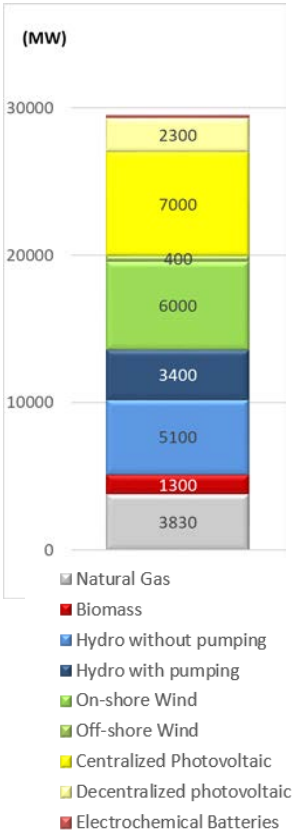
58 TWh Annual Consumption

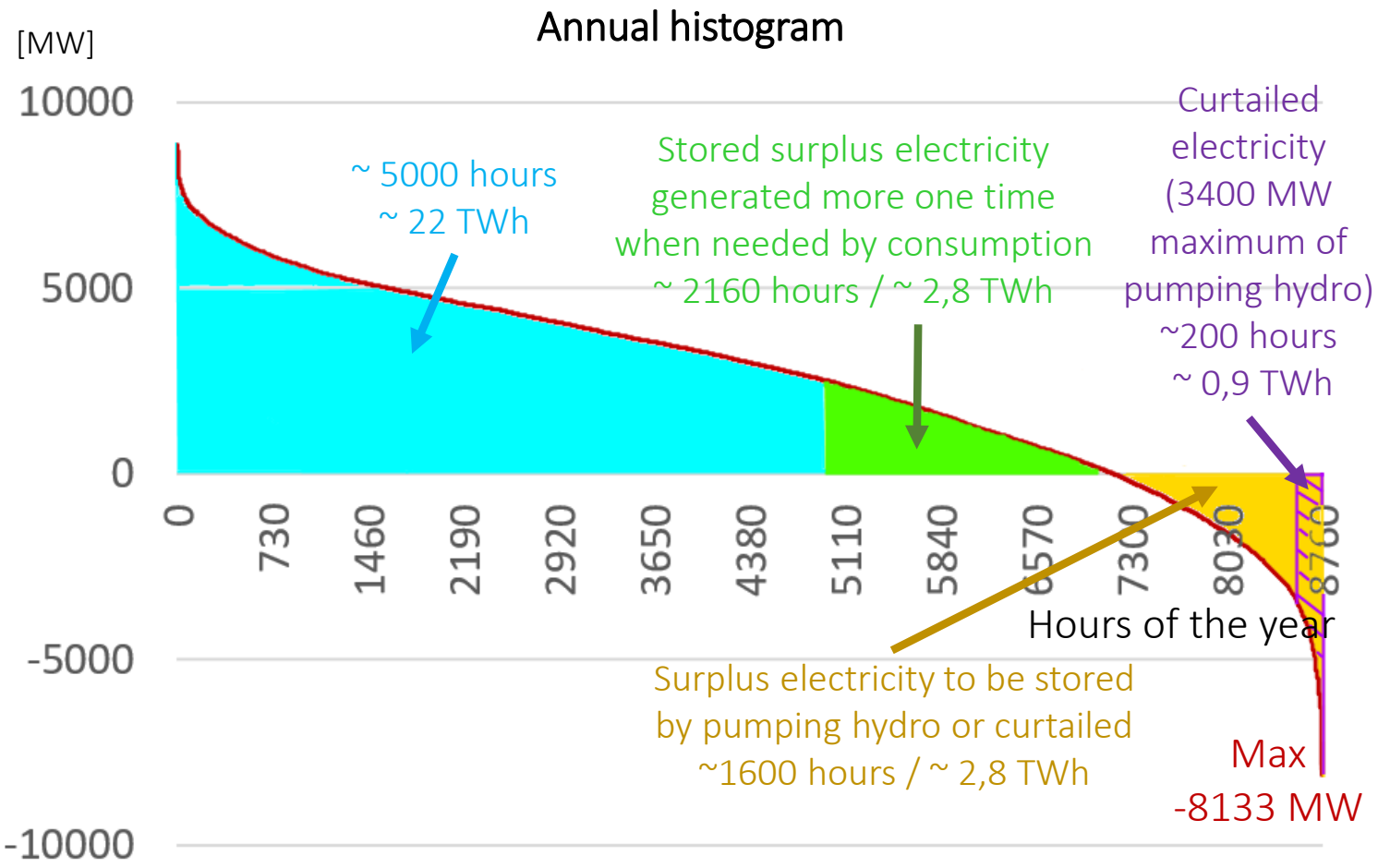
36 TWh Annual PV + Wind Generation

22 TWh Annual Dispatchable Generation

The “Residual load”

2030 Portuguese Power Mix

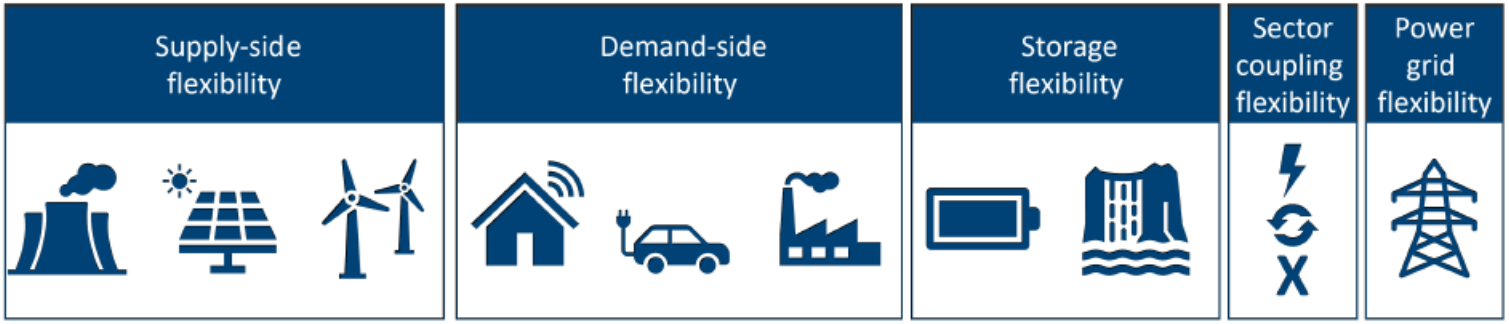




- Pumping hydro will solve the storing problem of the 2,8 TWh surplus electricity (yellow) generated when PV or wind resources were available and no needed for consumption. After, this stored energy will supply the consumption when needed.
- Hydro and natural gas power plants will generate the additional 22 TWh annual energy needed.
- Any additional solar and wind with the consequent extra storage capability will reduce the use of natural gas power plants

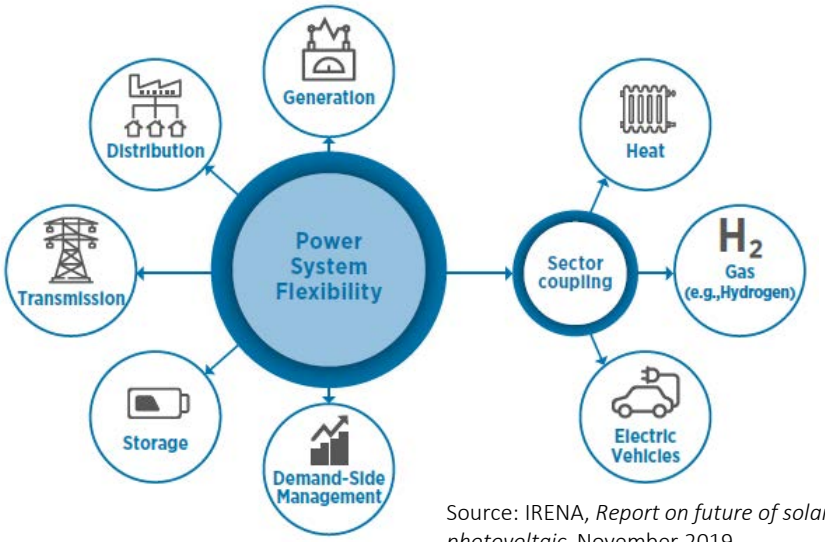
Flexibility service providers: a key for the future

Energy Resources with technical flexibility potential



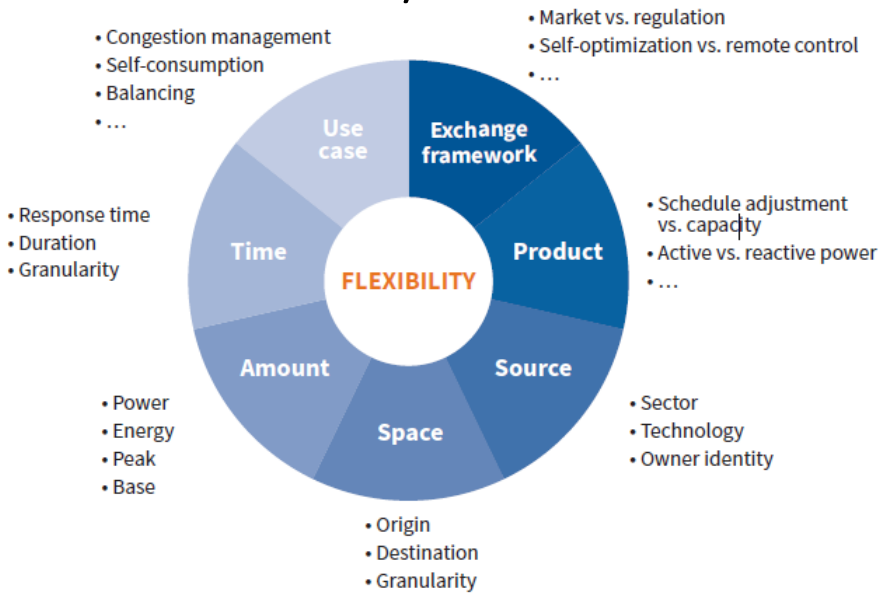
Source: Ahunbay, M., Ashour Novirdoust, A., Bhuiyan, R., Bichler, M., Bindu, S., Bjørndal, E., Bjørndal, M., Buhl, H. U., Chaves-Avila, J. P., Gerard, H., Gross, S., Hanny, L., Knörr, J., Köhnen, C. S., Marques, L., Monti, A., Neuhoff, K., Neumann, C., Ocenic, E., Ott, M., Pichlmeier, M., Richstein, J. C., Rinck, M., Röhrich, F., Röhrig, P. M., Sauer, A., Strüker, J., Troncia, M., Wagner, J., Weibelzahl, M., Zilke, P., 2021, *Electricity Market Design 2030-2050: Shaping Future Electricity Markets for a Climate-Neutral Europe*, https://doi.org/10.24406/fit-n-644366

Power system flexibility enablers in the energy sector



Source: IRENA, *Report on future of solar photovoltaic*, November 2019

Flexibility dimensions



Source: "EU Electricity Reform", Jorge Vasconcelos, NEWES, May , available at https://fsr.eui.eu/wp-content/uploads/2022/05/eu_electricity_reform_may2022.pdf

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Thank you!

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