Renewable Electricity Bulletin
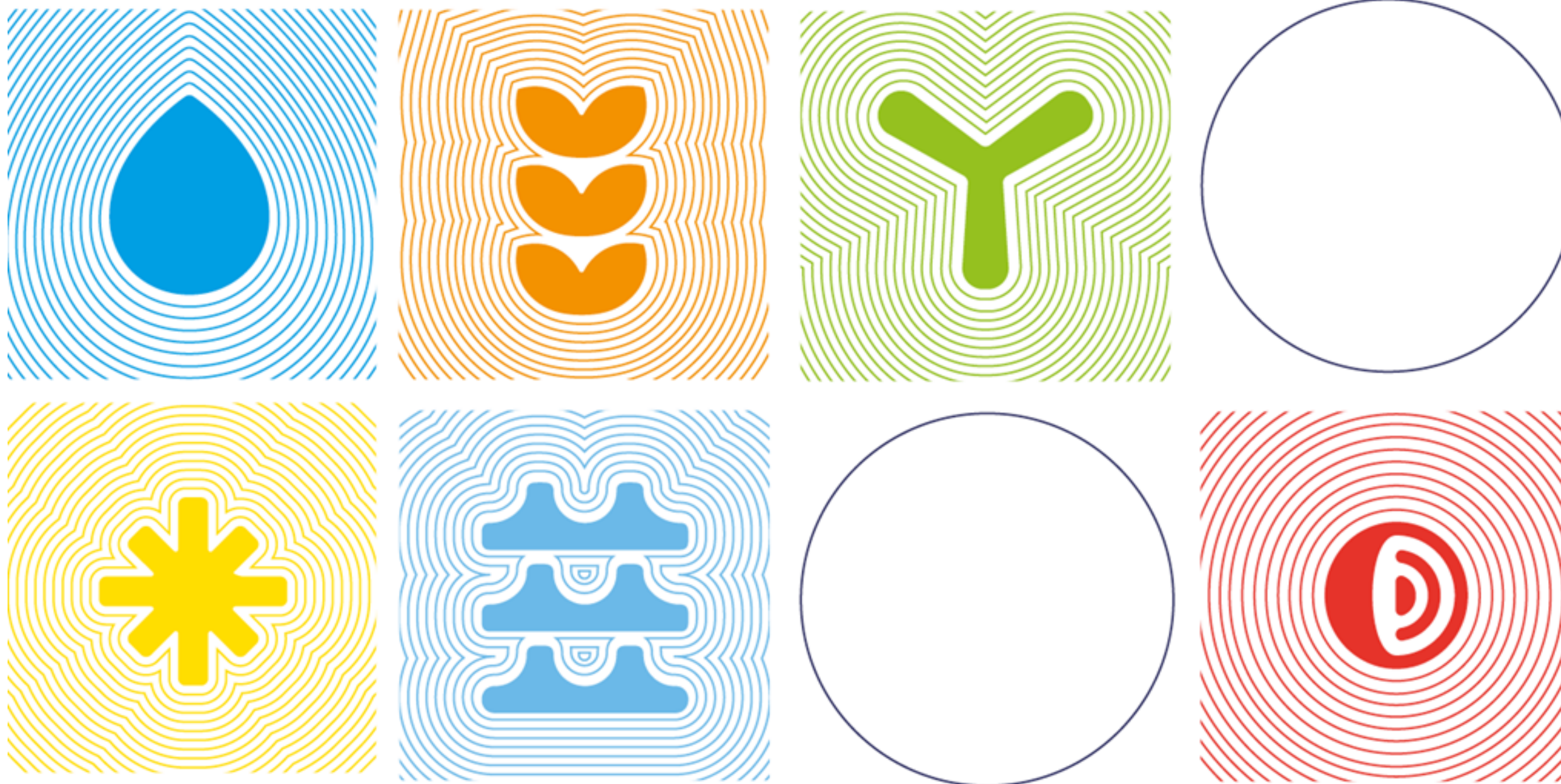# October 2023
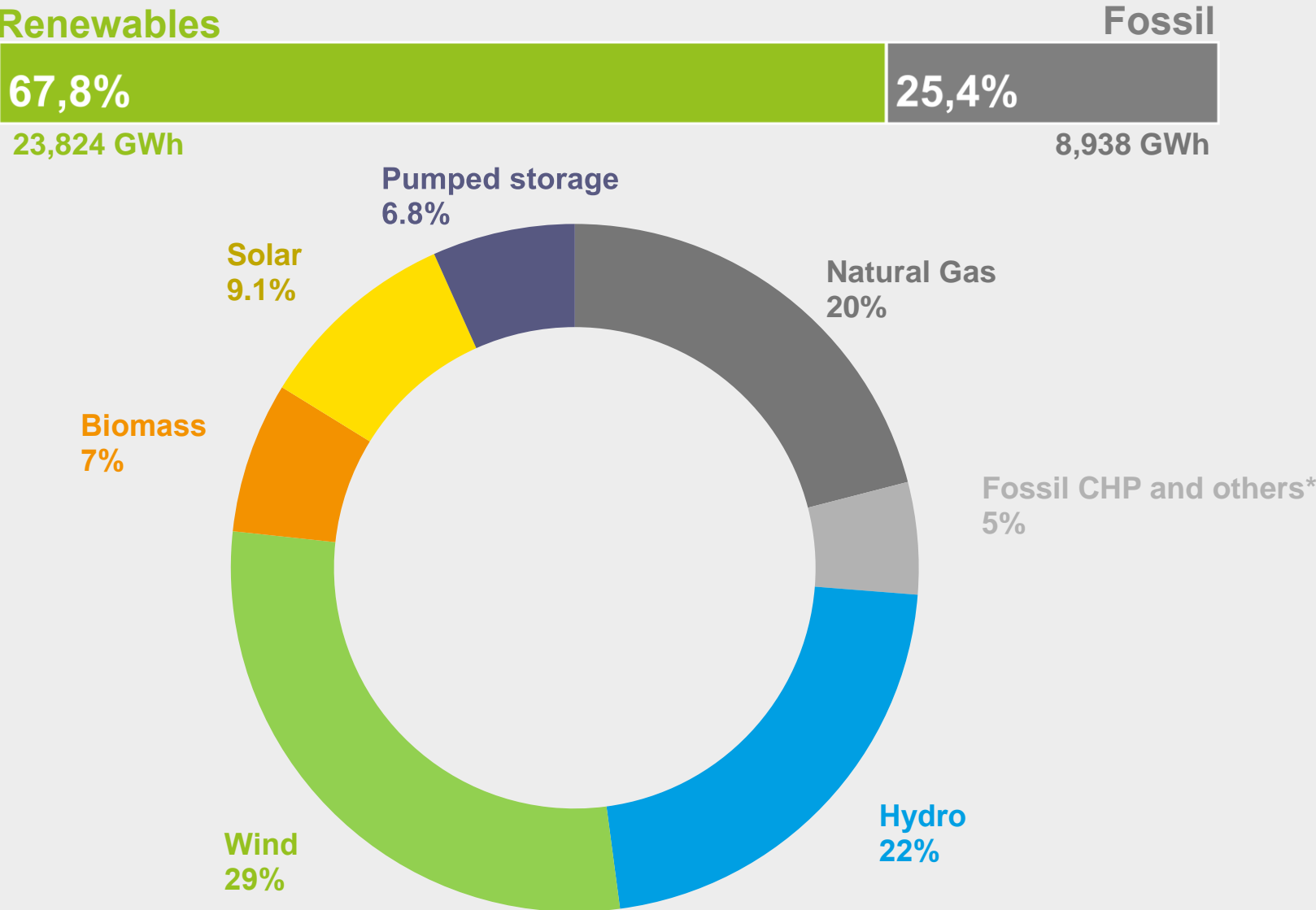
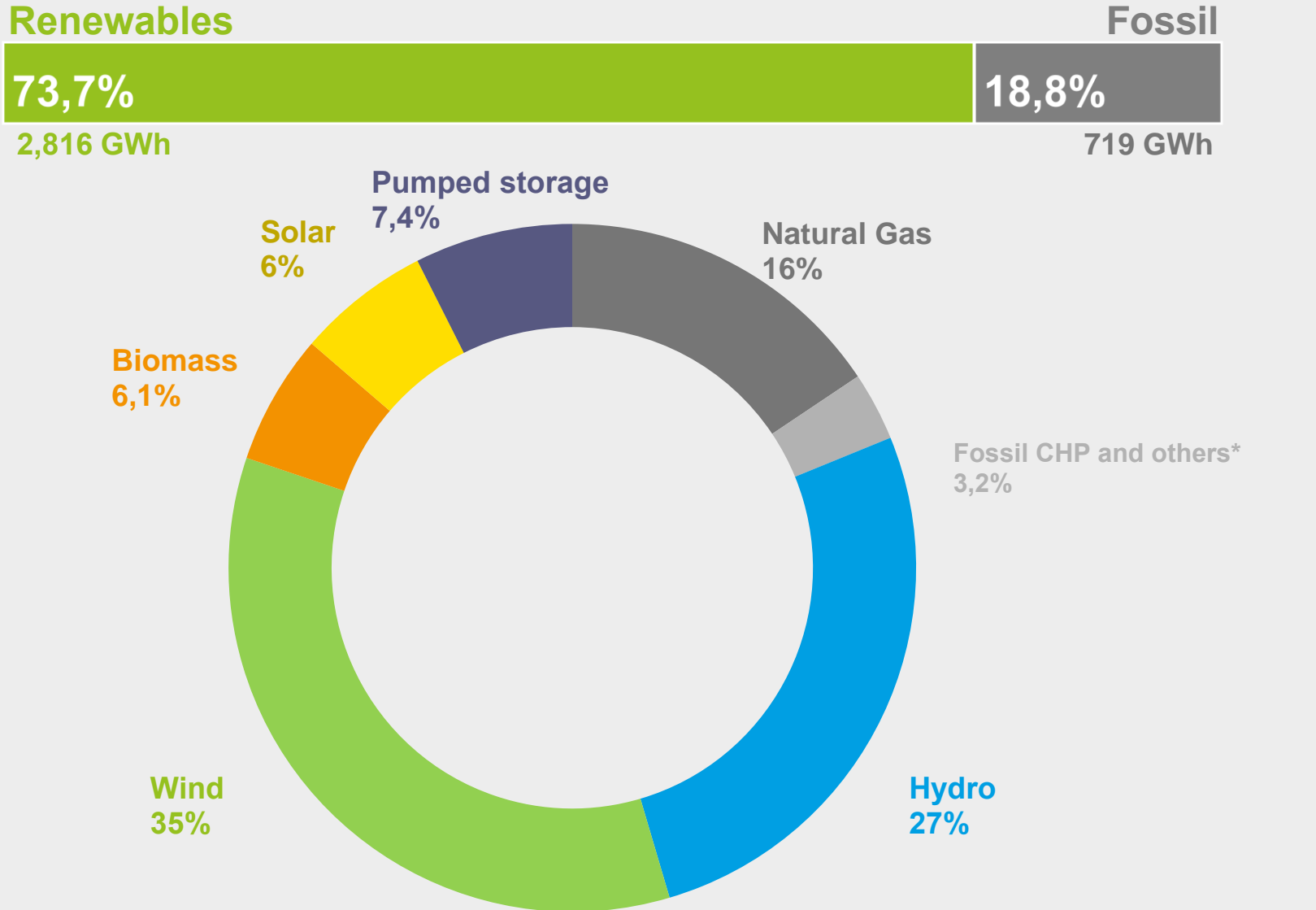2023

PORTUGAL NEEDS
OUR ENERGY

APREN

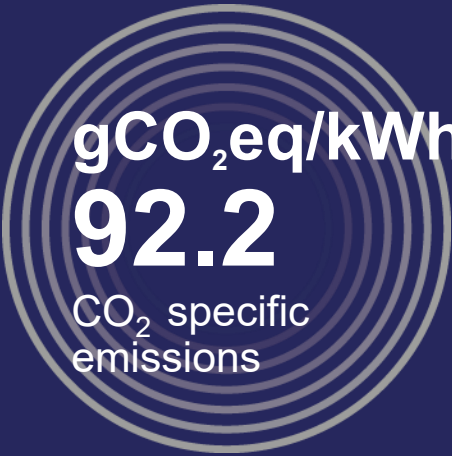# Executive Summary

Accumulated Generation (Jan-Oct)

Renewables	Fossil
67,8%	**25,4%**
23,824 GWh	8,938 GWh

Pumped storage
6.8%

Solar
9.1%

Biomass
7%

Natural Gas
20%

Fossil CHP and others*
5%

Wind
29%

Hydro
22%

Monthly Generation (Oct)

Renewables	Fossil
73,7%	**18,8%**
2,816 GWh	719 GWh

Solar
6%

Pumped storage
7,4%

Natural Gas
16%

Biomass
6,1%

Fossil CHP and others*
3,2%

Wind
35%

Hydro
27%

Electricity sector indicators (Jan-Oct)

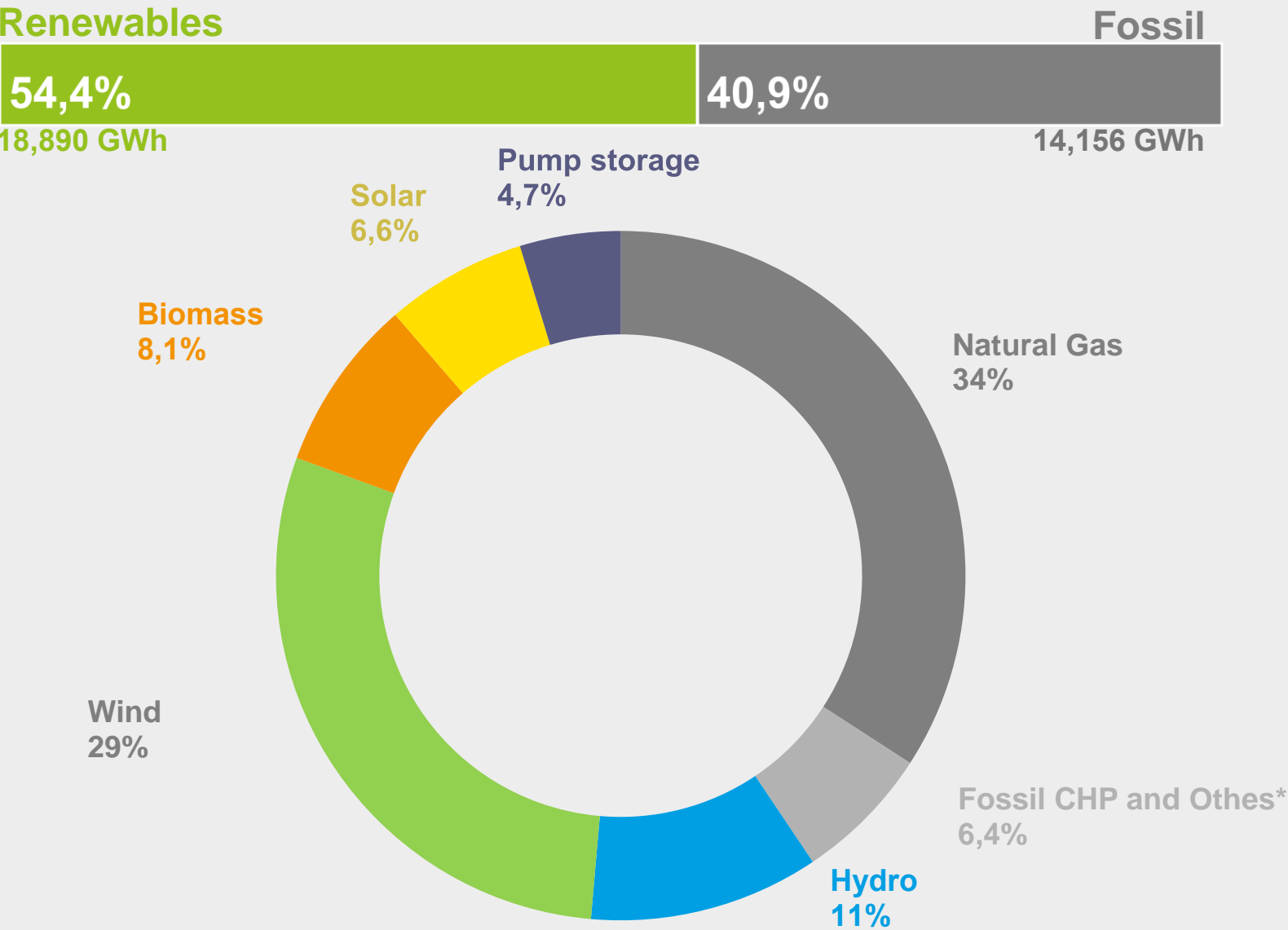| GWh **35,152** Generation[a]	tCO$_2$ **€85.6** Price CO$_2$	MWh **€92.4** MIBEL Price PT	MtCO$_2$eq **3,2** CO$_2$ Emissions	GWh **9.515** Import balance	gCO$_2$eq/kWh **92.2** CO$_2$ specific emissions

[a]Generation refers to the net power generation of the power plants, considering the production by pumping recently disclosed by REN. Pumping production is not accounted for in the percentage of production from renewable sources.
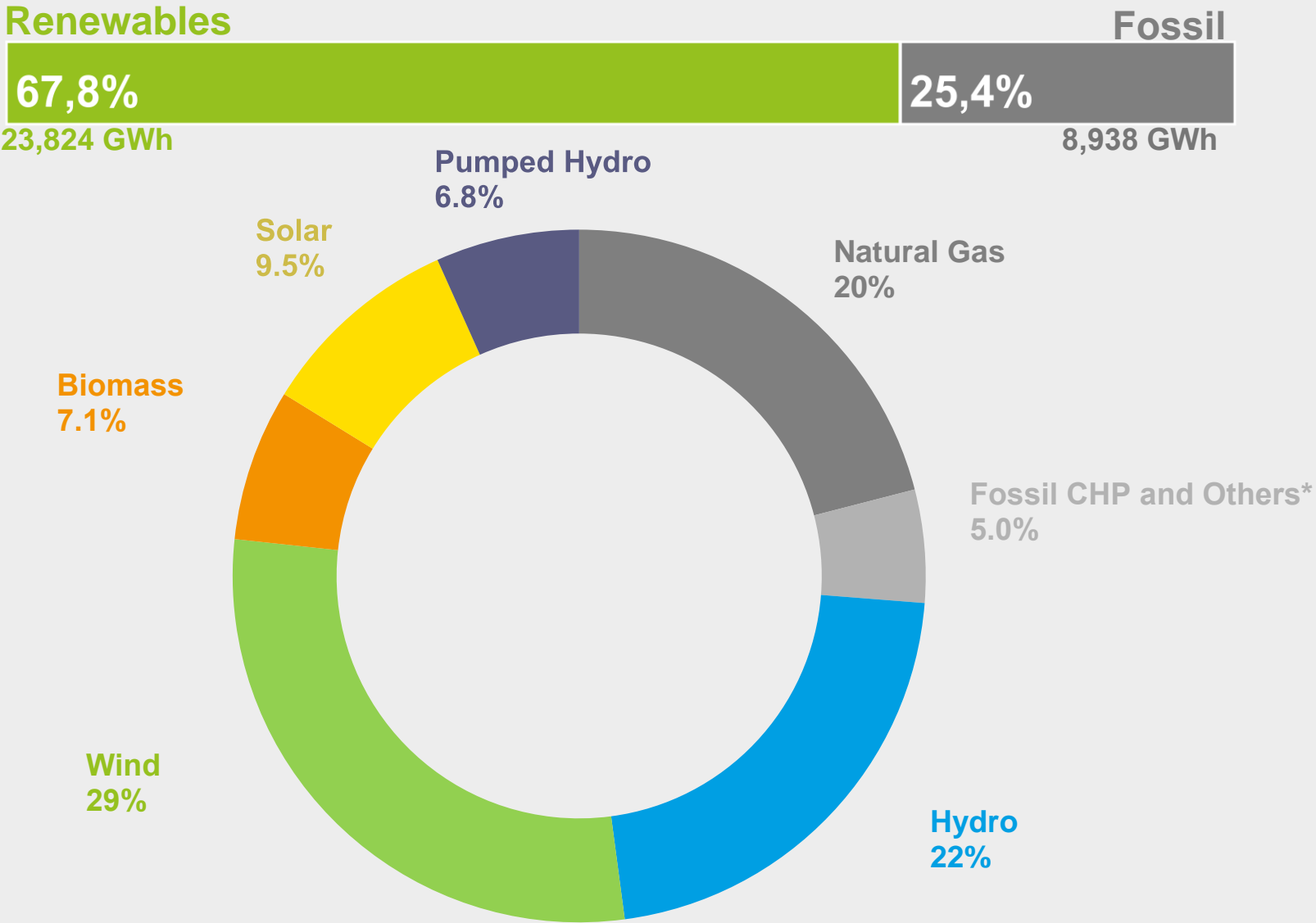Source: REN, Analysis APREN.

* Includes fuel oil, diesel, the non-biodegradable fraction of urban solid waste and other waste.

APREN Associação de Energias Renováveis

Executive Summary

Accumulated October 2022 (Jan-Oct)

Renewables
54,4% 18,890 GWh

Fossil
40,9% 14,156 GWh

- Pump storage 4,7%
- Solar 6,6%
- Biomass 8,1%
- Wind 29%
- Hydro 11%
- Fossil CHP and Othes* 6,4%
- Natural Gas 34%

Accumulated Oct 2023 (Jan-Oct)

Renewables
67,8% 23,824 GWh

Fossil
25,4% 8,938 GWh

- Pumped Hydro 6.8%
- Solar 9.5%
- Biomass 7.1%
- Wind 29%
- Hydro 22%
- Natural Gas 20%
- Fossil CHP and Others* 5.0%

Main indicators
In comparison to October 2022

1.3 % ▲	13.3% ▲	-0.3% ▼
GWh **35,152** Generation[a]	% **67,8** Incorporation	GWh **41,649** Consumption[b]

- **1.0** Wind index
- **0.85** Hydro index
- **1.02** Solar index

[a] Generation refers to the net power generation of the power plants, considering the production by pumped storage recently disclosed by REN. Pumping production is not accounted for in the percentage of production from renewable sources.
Source: REN, Analysis APREN

[b] Consumption refers to the liquid generation of power of the plants, considering the import-export balance.
Source: REN, Analysis APREN

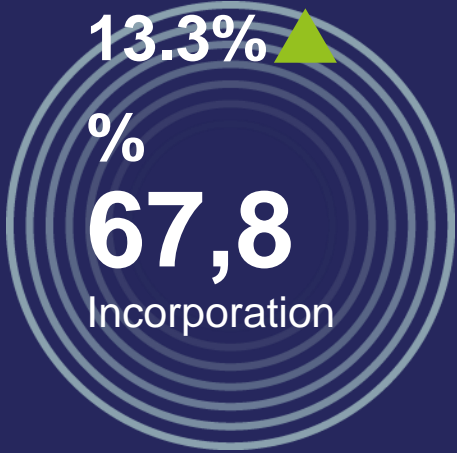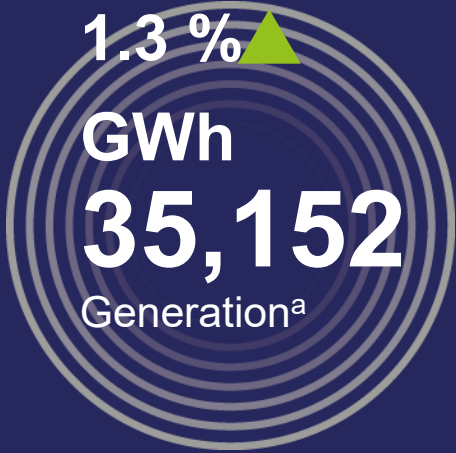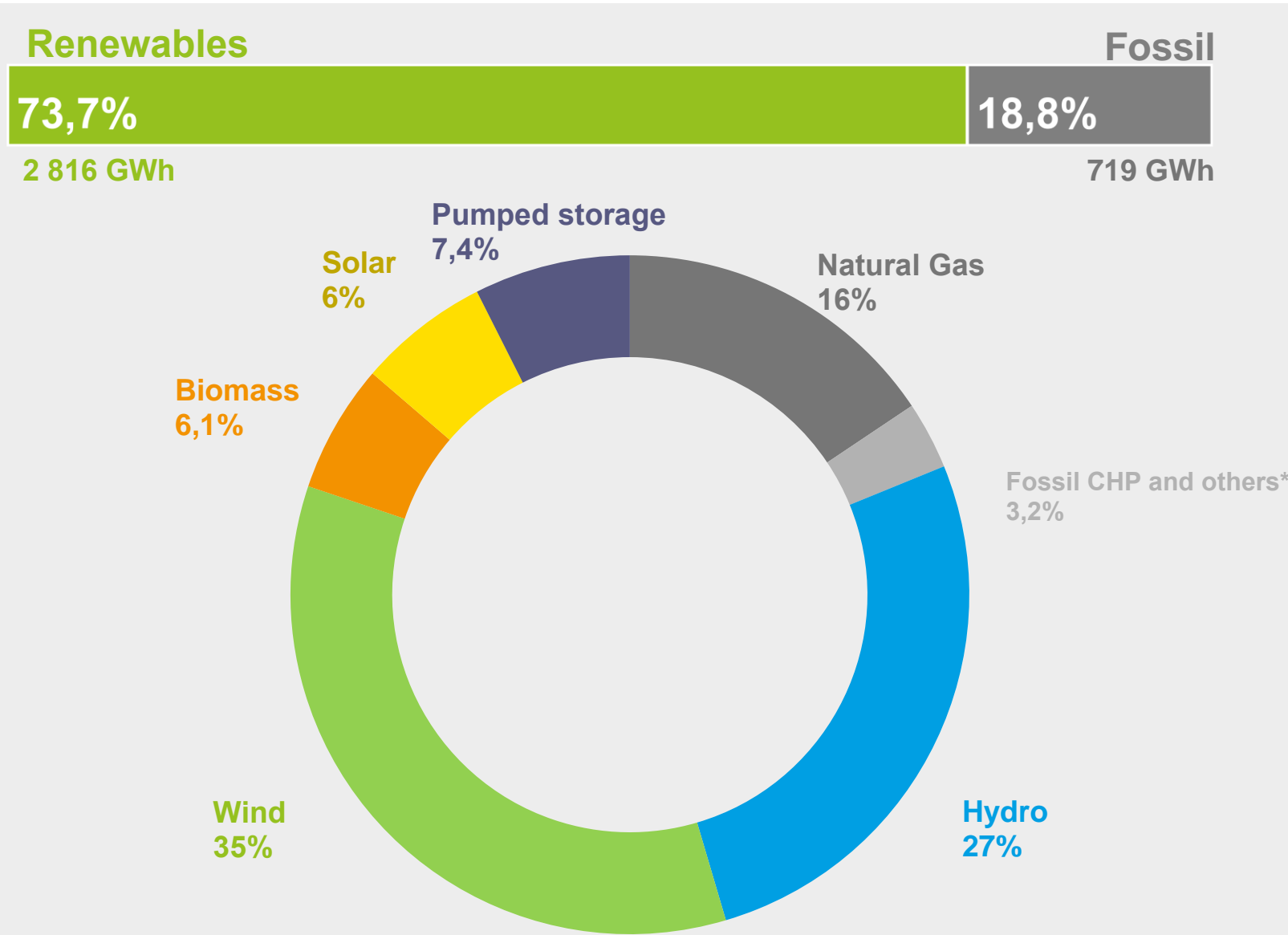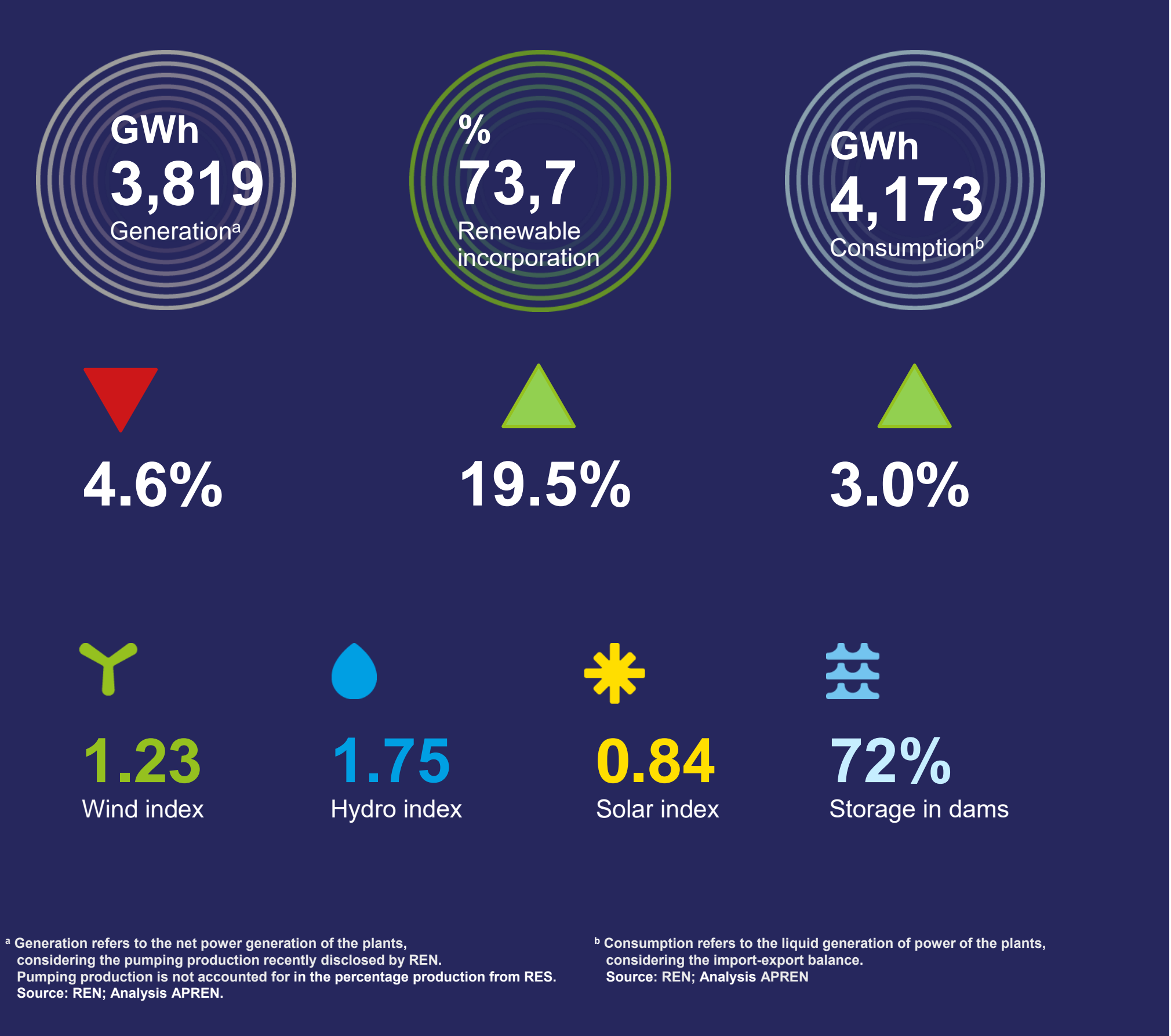* Includes fuel oil, diesel, the non-biodegradable fraction of urban solid waste and other waste.

APREN Associação de Energias Renováveis

Monthly analysis in Portugal:
October

Renewables	Fossil
73,7%	**18,8%**
2 816 GWh	719 GWh

Pumped storage
7,4%

Solar
6%

Natural Gas
16%

Biomass
6,1%

Fossil CHP and others*
3,2%

Wind
35%

Hydro
27%

Between July 1 and October 31, 2023, renewable incorporation was 73,7%, with a total of 3.819 GWh produced. The increase of 19,5 % in comparison to October 2022 is due to the increase in eólic incorporation in 21 %, which produced 1016 GWh, in comparison to the 230 GWh in October 2022, and the increase of the production of the rest of the renewable tecnologies.
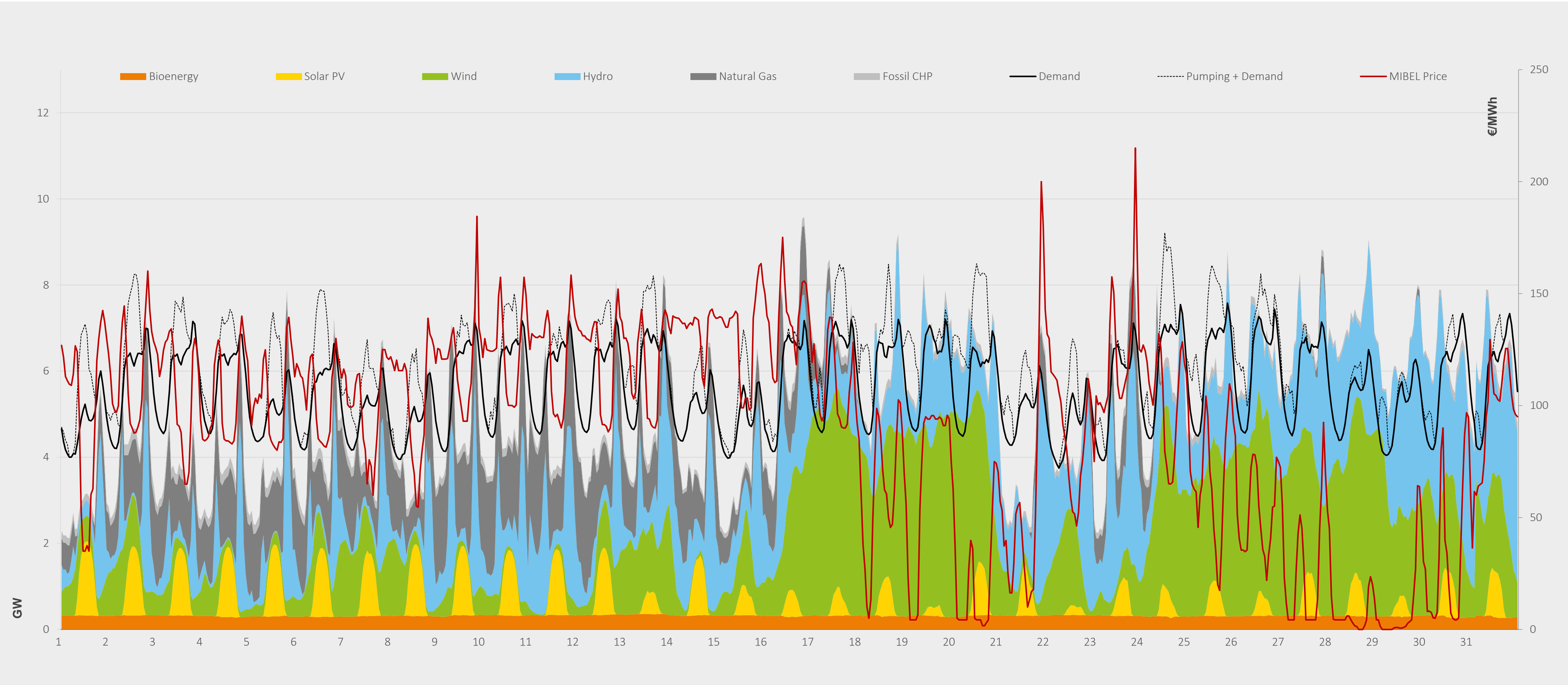
* Includes fuel oil, diesel, the non-biodegradable fraction of urban solid waste and other waste.

Indicators of the electricity sector
(in comparison to October 2022)

GWh	%	GWh
3,819	**73,7**	**4,173**
Generation[a]	Renewable incorporation	Consumption[b]
▼ 4.6%	▲ 19.5%	▲ 3.0%

1.23	**1.75**	**0.84**	**72%**
Wind index	Hydro index	Solar index	Storage in dams

[a] Generation refers to the net power generation of the plants, considering the pumping production recently disclosed by REN. Pumping production is not accounted for in the percentage production from RES. Source: REN; Analysis APREN.

[b] Consumption refers to the liquid generation of power of the plants, considering the import-export balance. Source: REN; Analysis APREN

APREN Associação de Energias Renováveis

Monthly analysis in Portugal:
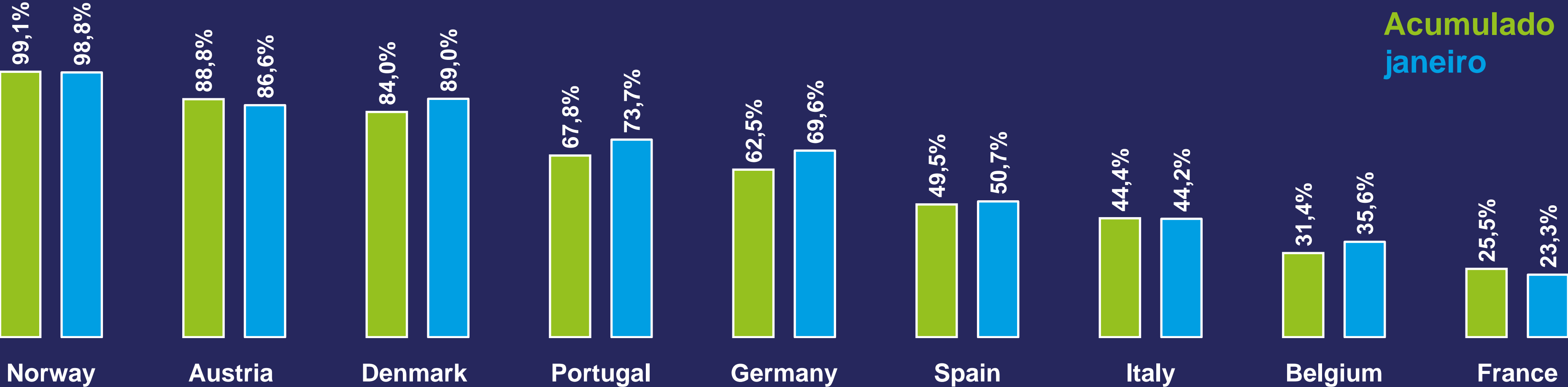## Load diagram for the month of October 2023

Source: REN; Analysis APREN

Renewable Electricity

Europe

In this analysis, only the main countries of the different European markets were considered in order to obtain a representative picture of comparison.

Between January 1 and October 31, 2023, Portugal was the fourth country with the highest renewable incorporation in electricity generation, behind Norway, Austria and Denmark, which obtained 99,1%, 88,8% and 84,0% from RES, respectively. From October 1 to 31, Portugal was in fourth place in the countries considered, with the largest renewable incorporation in Europe.

Acumulado
janeiro

	Norway	Austria	Denmark	Portugal	Germany	Spain	Italy	Belgium	France
Green	99,1%	88,8%	84,0%	67,8%	62,5%	49,5%	44,4%	31,4%	25,5%
Blue	98,8%	86,6%	89,0%	73,7%	69,6%	50,7%	44,2%	35,6%	23,3%

Renewable incorporation in the accumulated generation of electricity (Jan-October) and monthly (October).
Source: REN, Fraunhofer, REE, Terna, National Grid, ENTSO-E. Analysis APREN
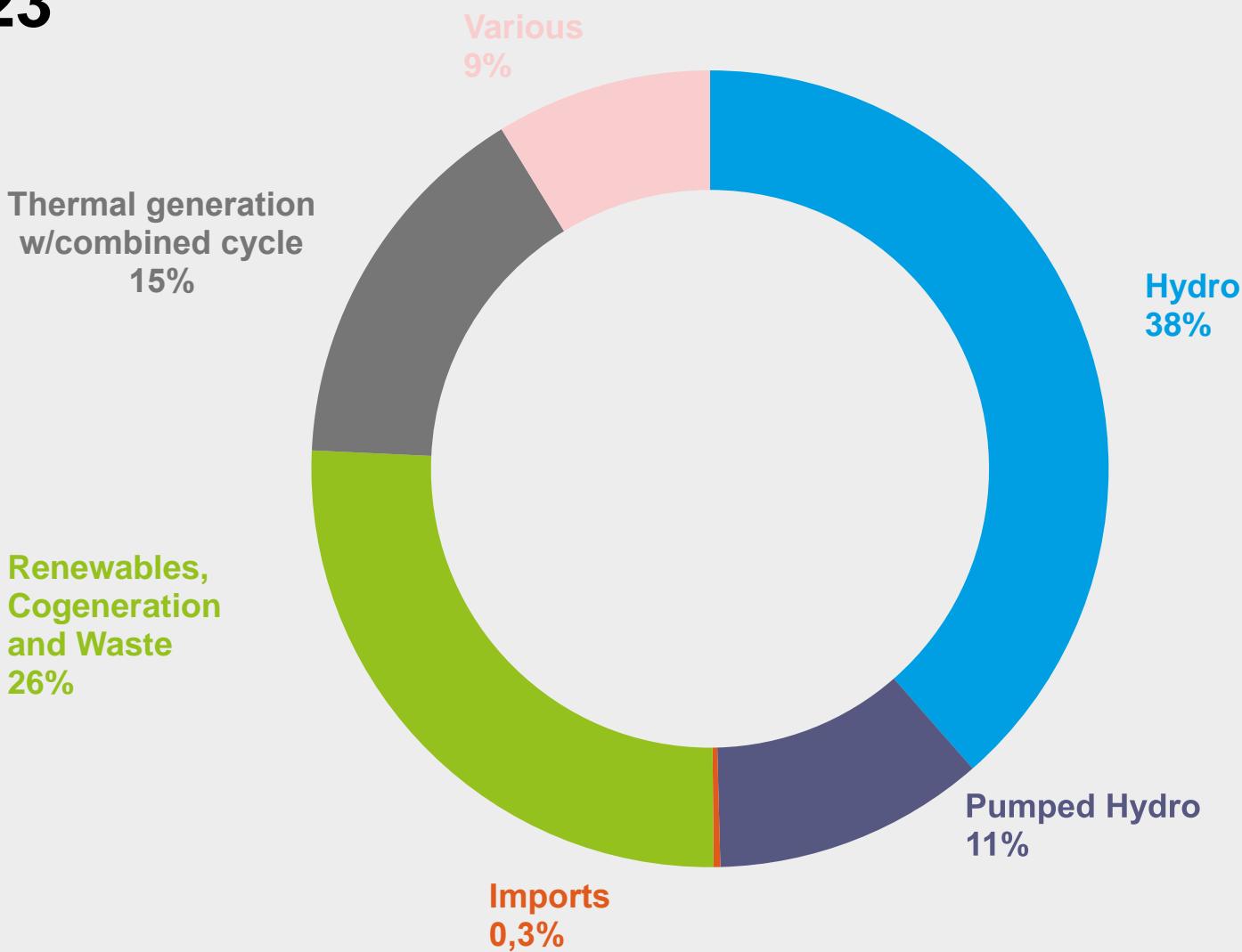
Market price setting
Portugal

Between January 1 and October 31, hydro was the market price setting technology that recorded the most hours, with 2,510 non-consecutive hours, followed by renewables, cogeneration and waste with 1,894 hours. And termal generation with combined cycles with 1,467 hours.

Accumulated January-October

2,510 — Hydro

1,894 — Renewables, cogeneration, and waste

1,467 — Fossil CHP

Number of market price setting hours of the three main market setting technologies (Jan-2023 to October-2023).
Source: OMIE. Analysis APREN

October 2023

- Various 9%
- Thermal generation w/combined cycle 15%
- Hydro 38%
- Renewables, Cogeneration and Waste 26%
- Pumped Hydro 11%
- Imports 0,3%

Percentage distribution of the number of market price setting hours of the various technologies, in a total 566 hours (October).
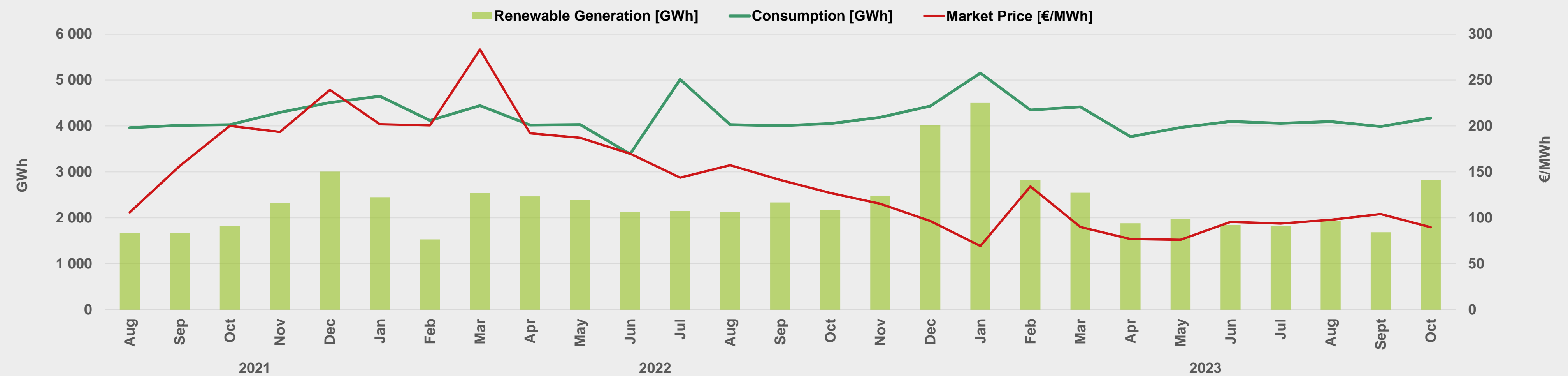Source: OMIE. Analysis APREN

APREN — Associação de Energias Renováveis

Electricity Market

Portugal

Between January 1 and October 31, the average hourly price recorded in MIBEL in Portugal was €92.4 MWh^c, representing a decrease to less than half compared to the same period last year.

In the same period, 624 non-consecutive hours were recorded, in which renewable generation was sufficient to supply electricity consumption in mainland Portugal, with an average hourly price in the MIBEL of €57.4/MWh. From October 1 to 31, renewable generation was insufficient to supply consumption at any given period of an hour.

Accumulated January-October

Legend: ■ Renewable Generation [GWh]   — Consumption [GWh]   — Market Price [€/MWh]

X-axis: Aug, Sep, Oct, Nov, Dec (2021) | Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec (2022) | Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sept, Oct (2023)

Left Y-axis: GWh (0 – 6 000); Right Y-axis: €/MWh (0 – 300)

Number of market price setting hours of the three main market setting technologies (October-2021 to October-2023).
Source: OMIE. Analysis APREN

APREN Associação de Energias Renováveis

Electricity Market

Iberian gas price limit mechanism

Since June 15, 2022, when the Iberian natural gas price limit mechanism came into operation, until October 31, the mechanism generated savings of €20.03/MWh[c], which amounted to a reduction of 12.6 % in the average hourly price at MIBEL.

The savings due to the price limit of natural gas, correspond to the difference between the price without the mechanism and the price with the compensation to be paid to natural gas plants. During the months of April until outubro, the price limit on natural gas didn´t introduce changes in the eletricity prices. In total, 283.3 of the 377.6 TWh produced, were subjected to the consumer ajustedment mechanism in the Iberian Peninsula.
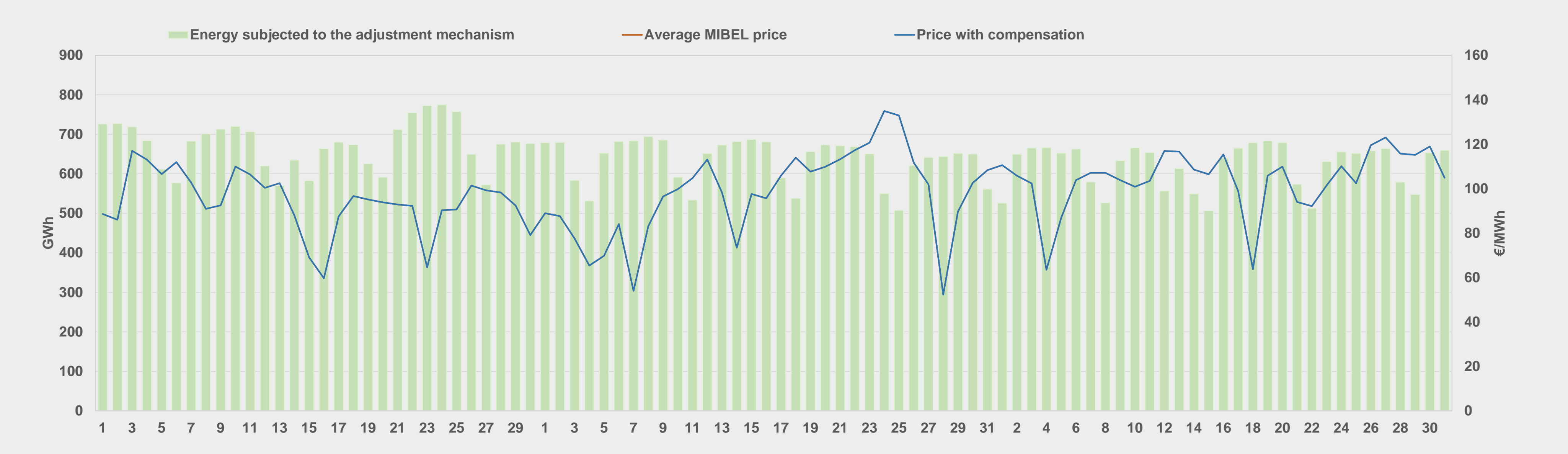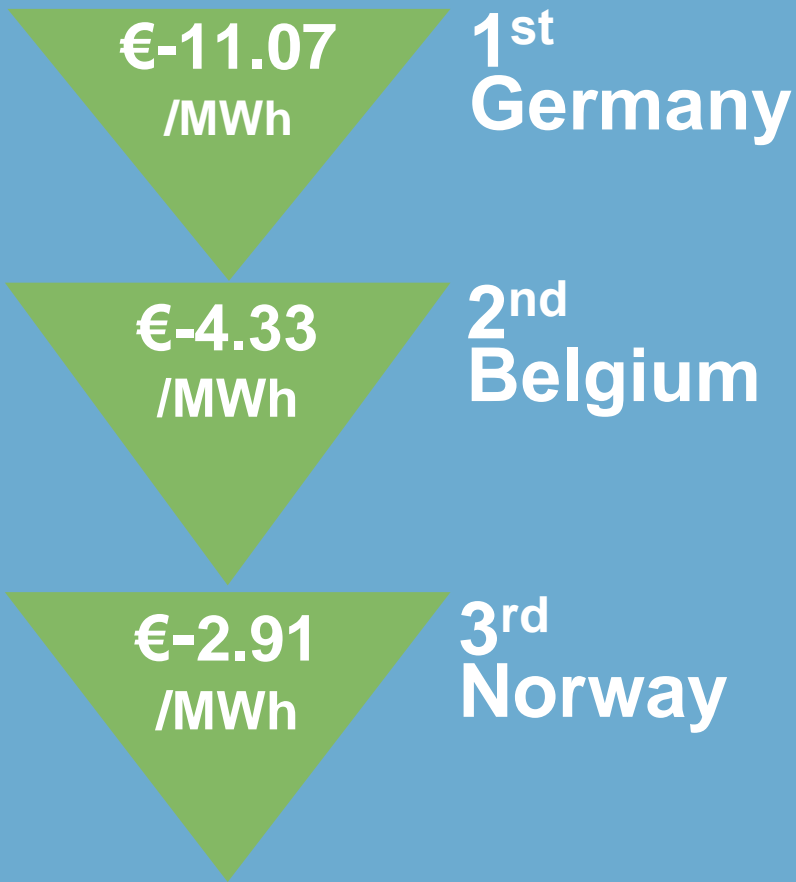
[c] Arithmetic average hourly prices
Source: OMIE. Analysis APREN
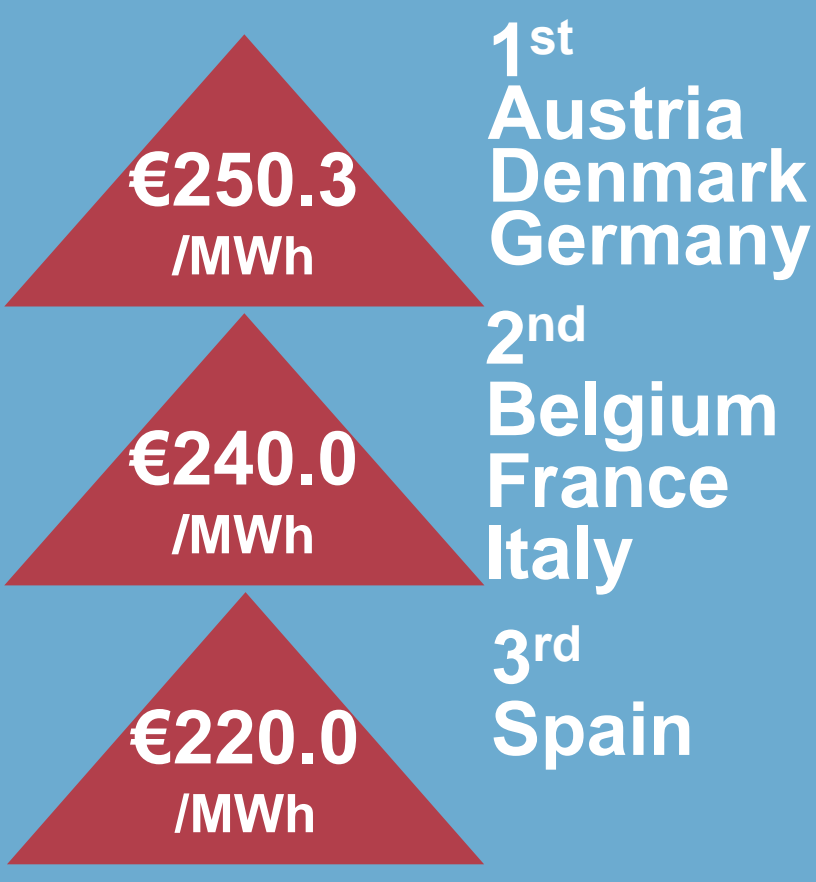
Renewable Electricity
Europe

During the month of October 2023, there was a minimum hourly price at MIBEL in Portugal of €0.00/MWh, in 3 hours in which the market setting was with various tecnologies. The maximum hourly price reached €215.00/MWh, where the market set with hydro technology.

Regarding prices in Europe, it should be noted that the average values were, in general, decreased to those of the previous month. The minimum prices also increased prices in comparison to the previous month, opposed to the decreased of the maximum prices.
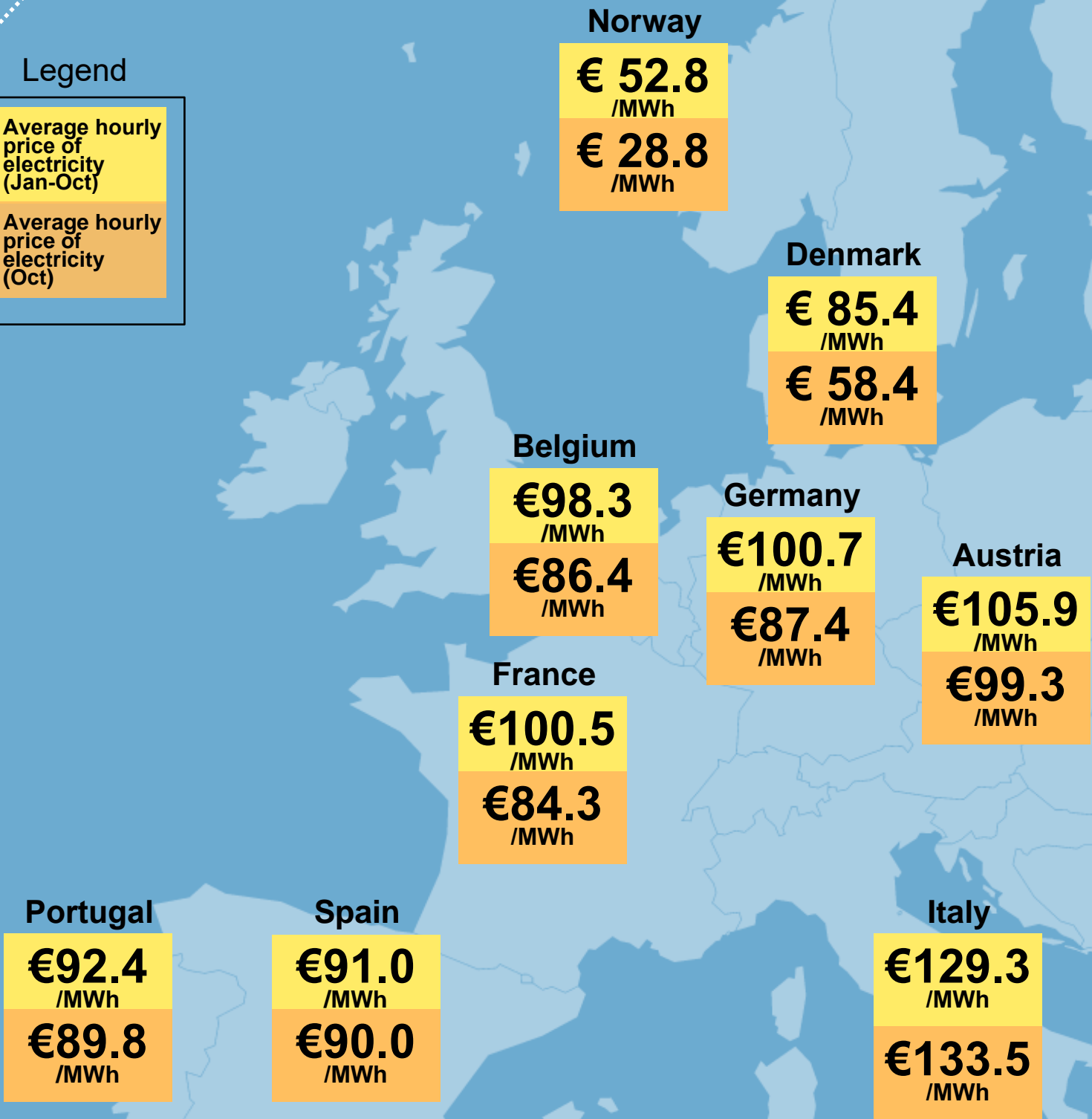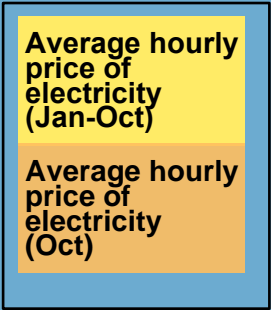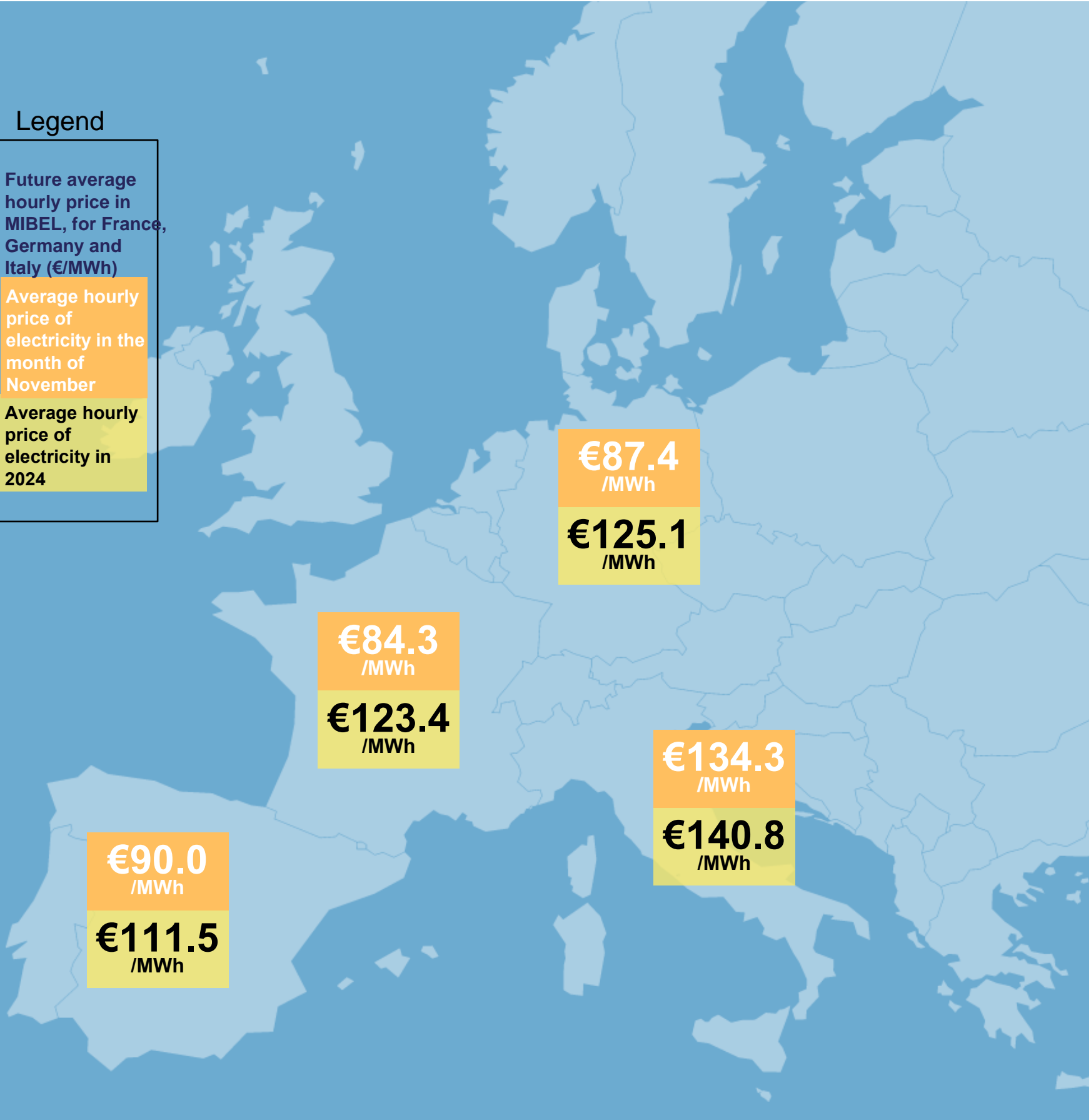
Minimum Prices (Oct)

€-11.07 /MWh — 1st Germany

€-4.33 /MWh — 2nd Belgium

€-2.91 /MWh — 3rd Norway

Maximum Prices (Oct)

€250.3 /MWh — 1st Austria Denmark Germany

€240.0 /MWh — 2nd Belgium France Italy

€220.0 /MWh — 3rd Spain

Legend

Average hourly price of electricity (Jan-Oct)

Average hourly price of electricity (Oct)

Norway
€ 52.8 /MWh
€ 28.8 /MWh

Denmark
€ 85.4 /MWh
€ 58.4 /MWh

Belgium
€98.3 /MWh
€86.4 /MWh

Germany
€100.7 /MWh
€87.4 /MWh

Austria
€105.9 /MWh
€99.3 /MWh

France
€100.5 /MWh
€84.3 /MWh

Portugal
€92.4 /MWh
€89.8 /MWh

Spain
€91.0 /MWh
€90.0 /MWh

Italy
€129.3 /MWh
€133.5 /MWh

Source: ENTSO-E, OMIE. Analysis APREN

APREN Associação de Energias Renováveis
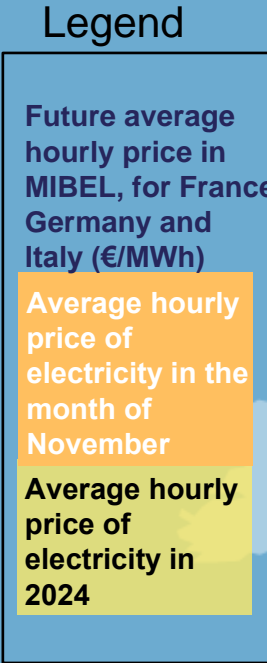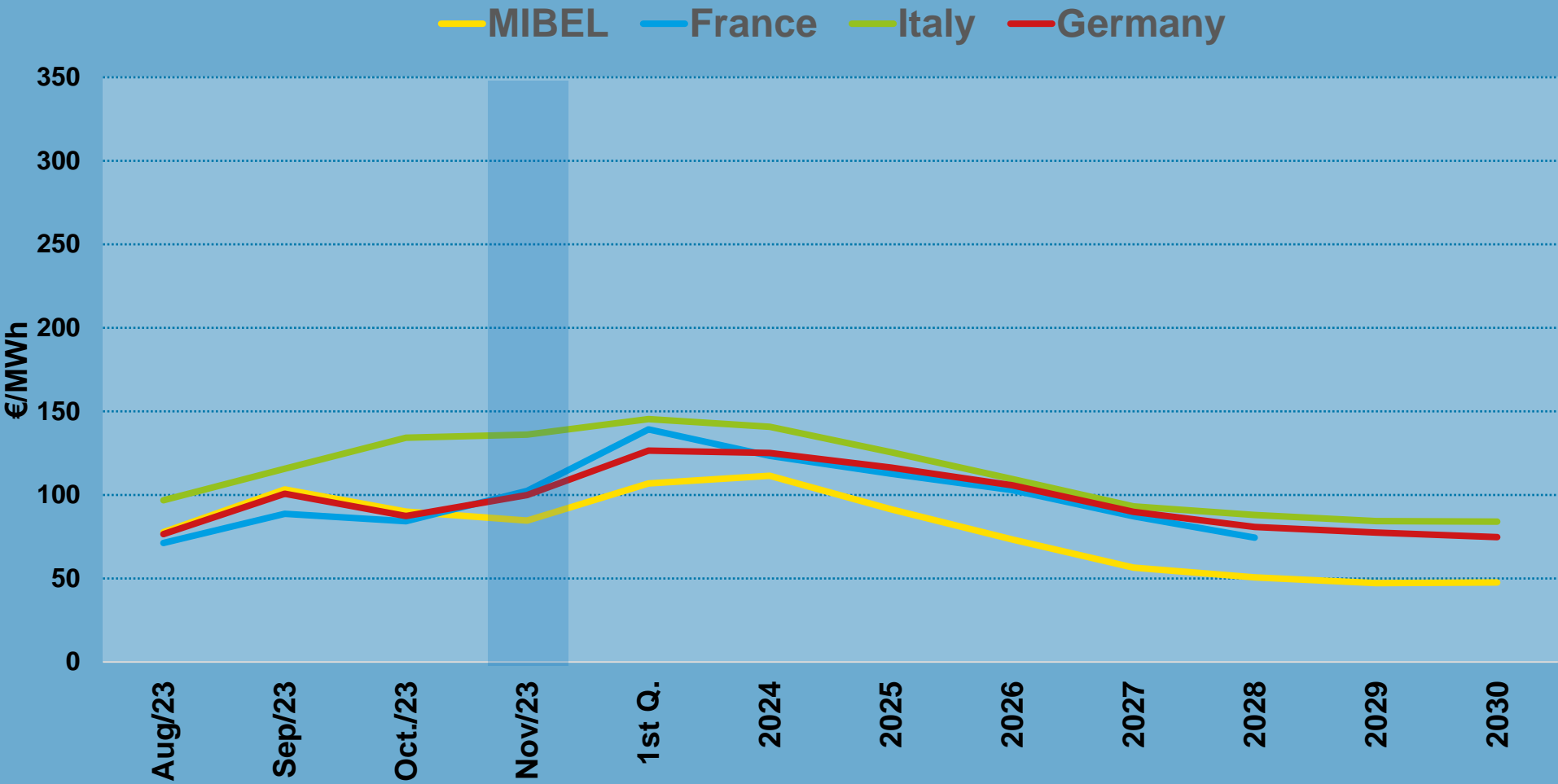
Future Electricity Market

The evolution of the average future hourly price is calculated based on the contracts for the purchase and sale of electricity [d].

The map on the right displays the price values for the next month (November) and for the next year. In both cases, the Italian market has the highest values, while the german and MIBEL have the lowest.

MIBEL has the lowest figures by 2030, coming from the Iberian gas price limit mechanism by July next year, and from investment in renewable production.

Legend

Future average hourly price in MIBEL, for France, Germany and Italy (€/MWh)

Average hourly price of electricity in the month of November

Average hourly price of electricity in 2024

Chart legend: ── MIBEL ── France ── Italy ── Germany

€/MWh

€87.4 /MWh
€125.1 /MWh

€84.3 /MWh
€123.4 /MWh

€134.3 /MWh
€140.8 /MWh

€90.0 /MWh
€111.5 /MWh

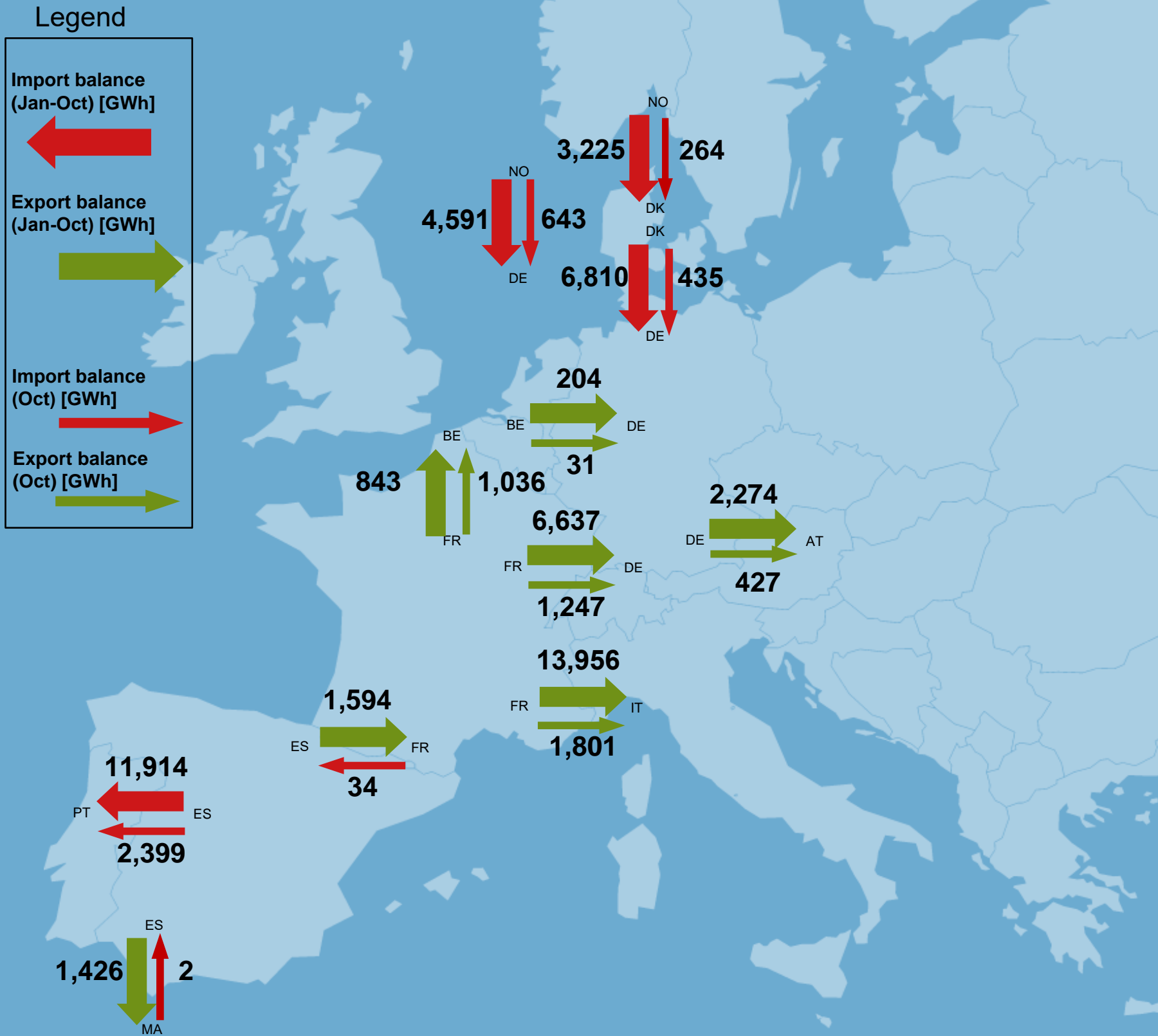APREN Associação de Energias Renováveis

International trade
Europe

Between January 1 and October 31, 2023, the electricity system of Mainland Portugal recorded electricity imports equivalent to 11,914 GWh and exports of 2,399 GWh, with Portugal being an importer with a balance of 9,915 GWh.

Main Interconnection Indicators PT-ES

Legend

Import balance (Jan-Oct) [GWh]

Export balance (Jan-Oct) [GWh]

Import balance (Oct) [GWh]

Export balance (Oct) [GWh]

	PT-ES		ES-PT	
Usage	**6.6%** (Jan-Oct)	**34.5%** (Oct)	**23.1%** (Jan-Oct)	**42.8%** (Oct)

	PT-ES		ES-PT	
Congestion	**0.3%** (Jan-Oct)	**6.2%** (Oct)	**0.2%** (Jan-Oct)	**0.8%** (Oct)

	PT-ES		MIBEL-FR	
Markets split	**5.9%** (Jan-Oct)	**2.4%** (Oct)	**66.1%** (Jan-Oct)	**73.8%** (Oct)

NO 3,225 264
NO 4,591 643
DK
DK 6,810 435
DE

BE 204
BE DE
31
843 1,036
FR
FR 6,637 DE
1,247
DE 2,274 AT
427
FR 13,956 IT
1,801

1,594
ES FR
34

11,914
PT ES
2,399

1,426 2
ES
MA

APREN Associação de Energias Renováveis

International trade: October
Diagram of imports and exports in Portugal

Source: REN. Analysis APREN

Power sector emissions

Between January 1 and October 31, 2023, specific emissions reached 92.2 gCO_2eq/kWh, with a total emissions from the power sector of 3.2 $MtCO_2eq$.

The European Emissions Trading System (EU-ETS) recorded an average price €85.6/tCO_2 [c], a reduction in 6% compared to the same period in 2022.
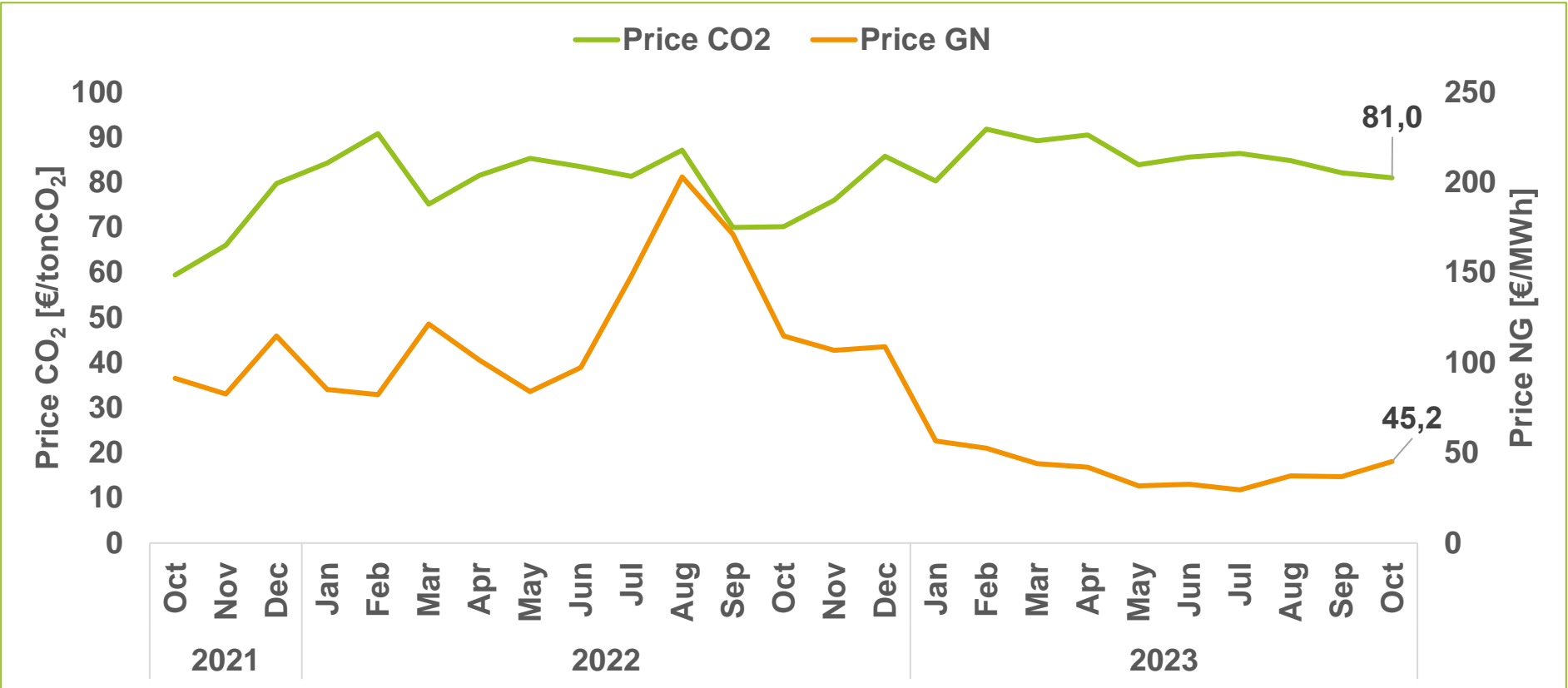
Sector emissions

3.2
$MTCO_2eq$

45%

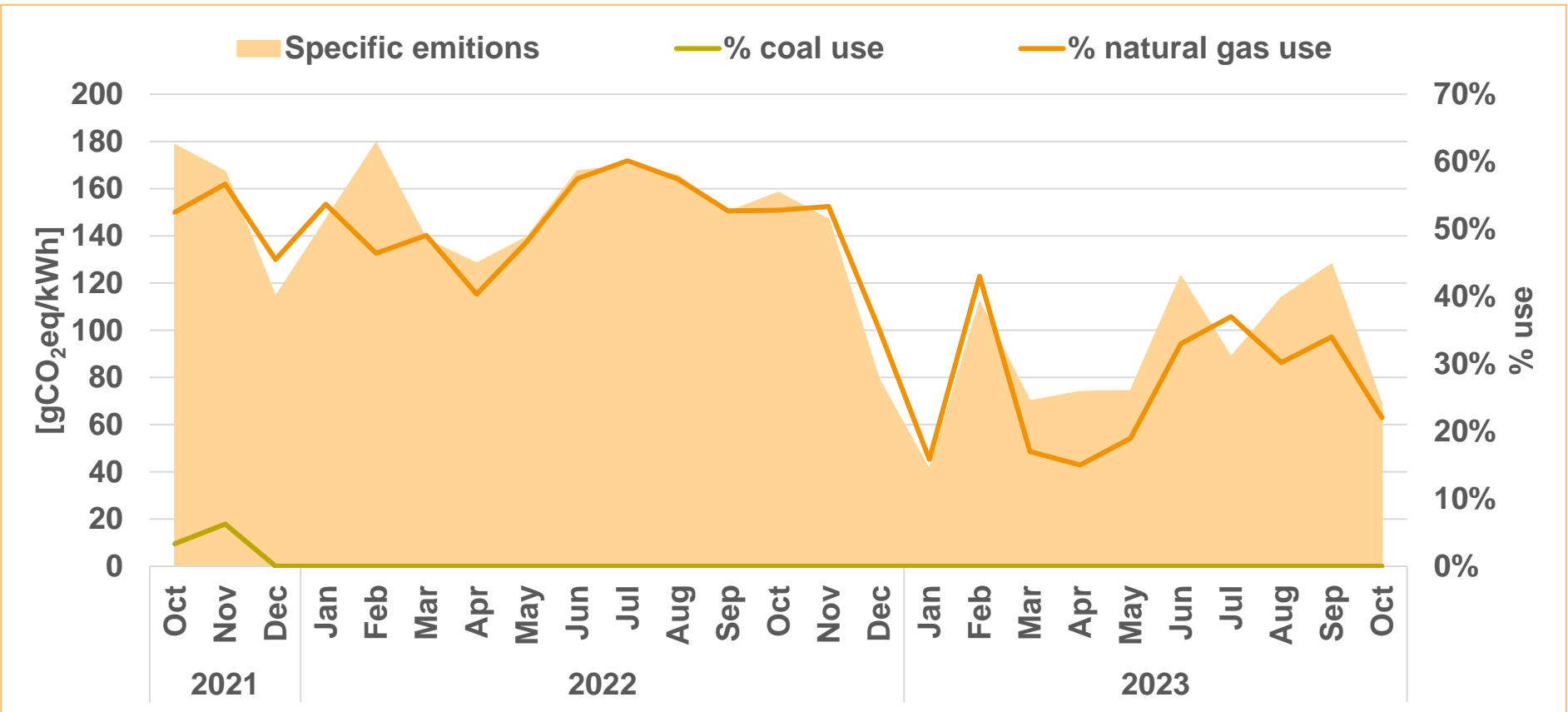In comparison to October 2022

Allowances average price

€85.6
/tCO_2

6%

In comparison to October 2022

[c] Arithmetic average hourly prices
Source: OMIE, WorldBank.

Price of CO_2 alowances in EU-ETS and natural gas price in Europe (Oct-2021 to Oct-2023).
Source: SendeCO2, WorldBank.

Specific emissions from the power sector of Mainland Portugal, % use of coal-free power plants and natural gas (Oct-2021 to Oct-2023).
Source: REN, DGEG, ERSE. Analysis APREN

APREN Associação de Energias Renováveis

Simulation of price formation without SRP

Renewables have avoided:

The indicators below identify the savings achieved between January 1 and October 31, 2023, due to the contribution Special Regime Production (SRP).

This study is conducted for SRP and includes all installed power of fossil cogeneration. Given that the capacity equivalent to this technology within the SRP is quite residual and that the other technologies are renewable, the figures are very close to the real savings generated by renewables.

€155.6/MWh
Accumulated savings (Jan-Oct)

€5,444.3M
Accumulated savings (Jan-Oct)

€205.5/MWh
Montlhy savings (Oct)

€786.1M
Montlhy savings (Oct)

Source: OMIE. Analysis APREN.

APREN Associação de Energias Renováveis

Environmental Service

The figures below identify the savings achieved between January 1 and October 31, 2023, in natural gas, CO_2 emissions and CO_2 emission allowances resulting from the renewable incorporation in electricity generation.

This analysis assumes that, in the absence of renewables, production would be ensured primarily by natural gas, followed by imported electricity.

Renewables have avoided:

€1,570 M
Imported Natural Gas (Jan-Oct)

€195 M
Imported Natural Gas (Oct)

€444 M
Imported Electricity (Jan-Oct)

€59 M
Imported Electricity (Oct)

7.7 MtCO$_2$eq
CO_2 emissions (Jan-Oct)

0.9 MtCo$_2$eq
CO_2 emissions (Oct)

€605 M
O_2 allowances (Jan-Oct)

€64.9 M
O_2 allowances (Oct)

Source: REN, REE, SendeCO2, WorldBank, DGEG, ERSE, Analysis APREN.
Note 1: For the estimate of the savings in imported natural gas, the price of natural gas in Europe indicated in the WorldBank has been considered.
Note 2: For the estimation of savings in imported electricity, the average price on the MIBEL market has been considered.

APREN Associação de Energias Renováveis