EMBER

Europe Electricity Interconnection Data Tool

How to read the grid map

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About Ember

Ember is an independent, not-for-profit energy think tank that aims to shift the world to clean electricity using data. It gathers, curates and analyses data on the global power sector and its impact on the climate, using cutting edge technologies and making data and research as open as possible. It uses data-driven insights to shift the conversation towards high impact policies and empower other advocates to do the same. Founded in 2008 as Sandbag, it formerly focused on analysing, monitoring and reforming the EU carbon market, before rebranding as Ember in 2020. Its team of electricity analysts and other support staff are based around the world in the EU, UK, Turkey, India, China and Indonesia.

Introduction

This document provides the general public with examples and instructions on how to use Ember's Europe Interconnection Data Tool.

For more information, please visit the dedicated webpage.

How to read the grid map

1.0 Dashboard navigation

The first layer of the interactive grid map can be navigated by selecting the Year (*2024, 2030* or *2040*) and View (*Capacity* or *Flows*):



Image 1 - Dashboard navigation buttons.

1.1 Country focus

The second layer of the interactive grid map allows for in-depth exploration of the available data for all country nodes represented on the map.

When a country node is clicked, charts and indicators specific to that node – as well as to the currently selected *Year* and *View* – appear on the right side of the dashboard. The ring around the country code also darkens to highlight the selection.

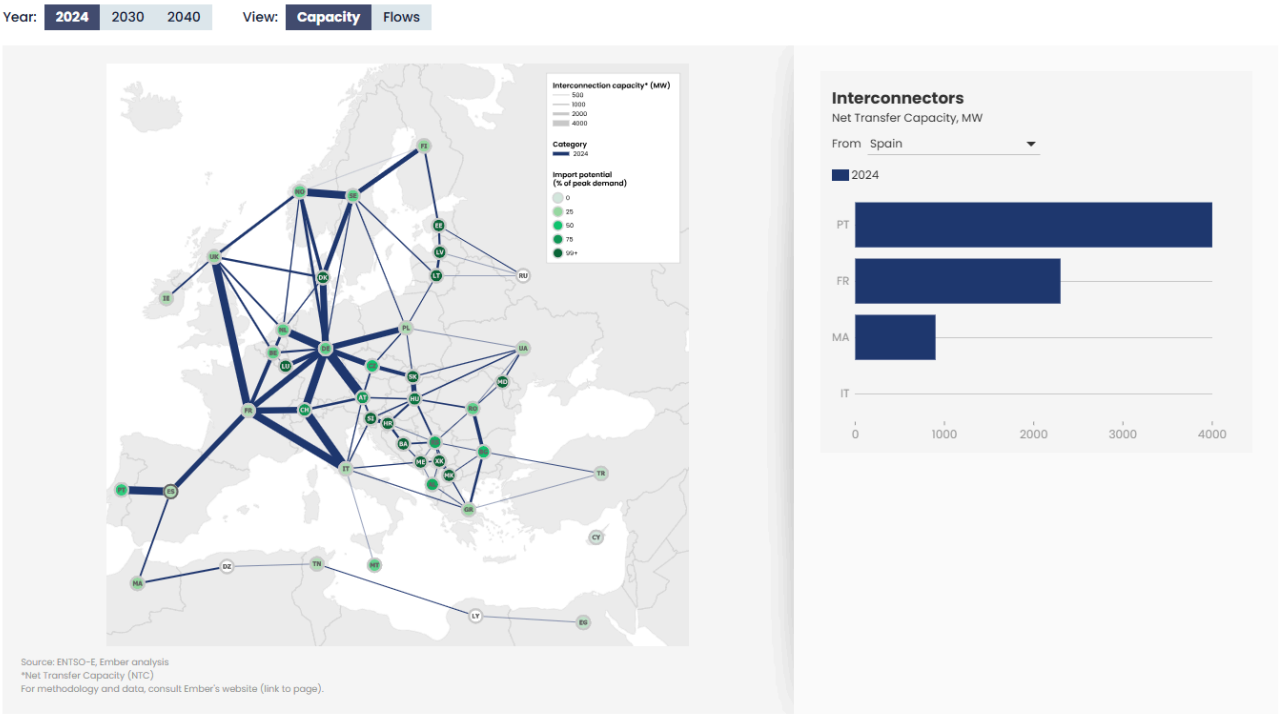


Image 2 - Country focus on *Spain (ES)*, 2024 Capacity view.

2.0 *Capacity* map

The *Capacity* view represents the potential for power transfer across European and neighbouring countries.

The width of lines connecting two country nodes on the map is proportional to their cross-border transmission capacity, with colors varying according to the interconnection category.

Each node is coloured green, with a darker shade indicating a high import potential (best estimate) relative to the country's peak power demand.

For example, consider Spain in 2030:

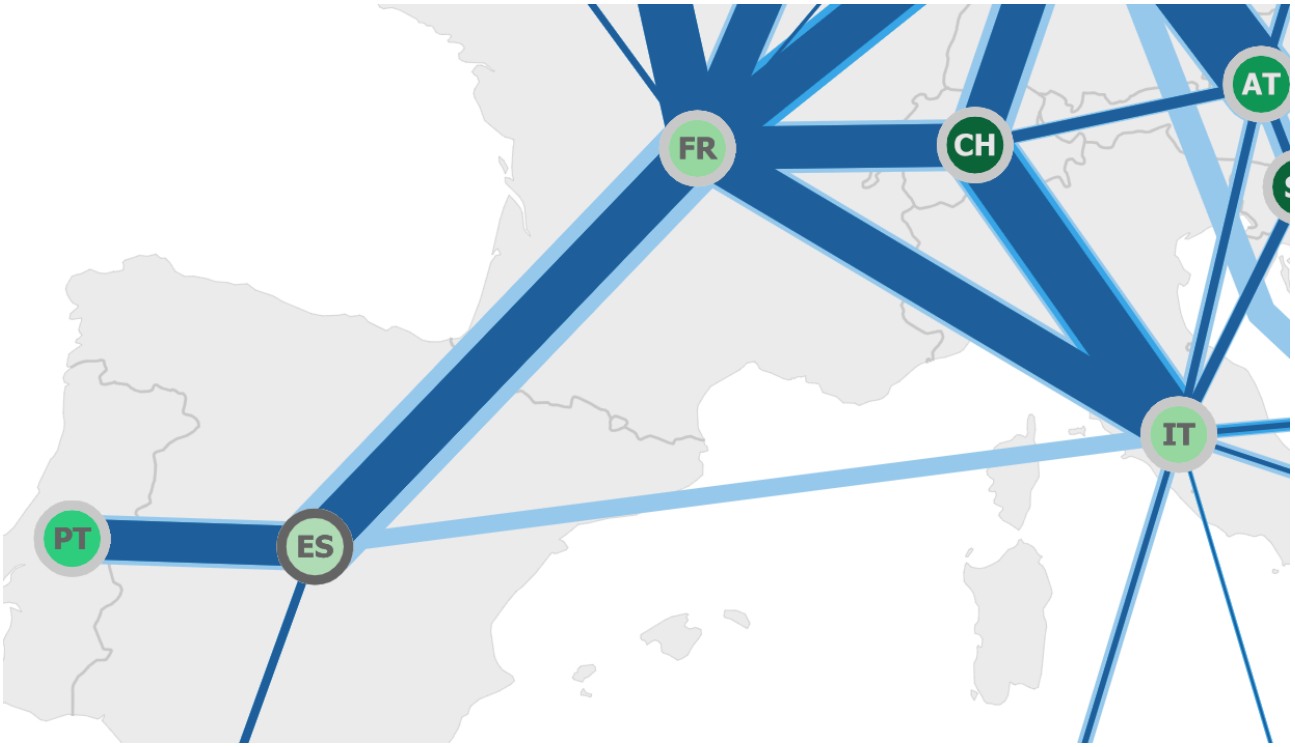


Image 3 - Map zoom on *Spain (ES)*, 2030 Capacity view.

Dark-blue lines indicate best-estimate (*Reference*) interconnection capacity, which primarily connect Spain (ES) to France (FR), Portugal (PT) and Morocco (MA, out of frame). Light-blue lines indicate the viability of extra cross-border capacity (*Needs*), highlighting a possible interconnection with Italy (IT), as well as profitable additional capacity – especially to and from France (FR), and to a lesser extent, Portugal (PT).

All the information described above also appears in greater detail on the right side of the dashboard when the ES node is selected. Historical capacity (*2024*) is also displayed for comparison with the best-estimate projection (*Reference*) for the selected year, highlighting a significant expansion in transfer capacity between Spain (ES) and France (FR) from 2024 to 2030.

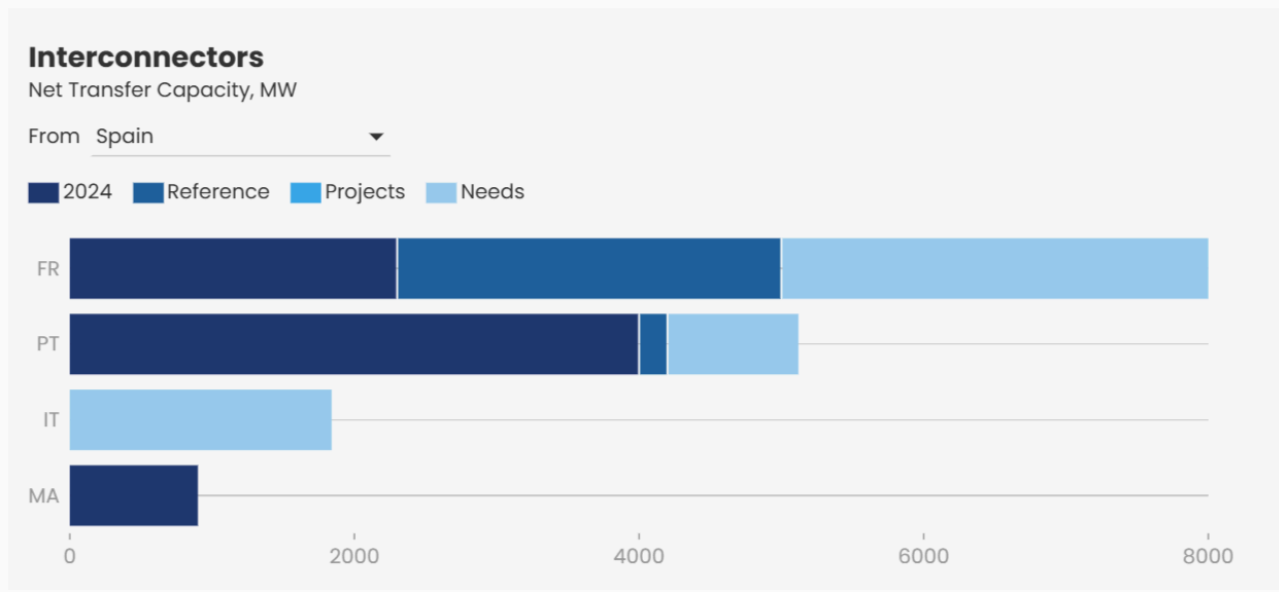


Image 4 - Interconnectors chart for *Spain (ES)*, 2030 Capacity view.

On the map, the node for Spain is coloured in a lighter green than those for Portugal (PT) and Switzerland (CH). This indicates that if Spain were to use all of its interconnectors solely for power import, it would be able to satisfy less of its peak demand compared to the other two countries.

All the information described above also appears in greater detail on the right side of the dashboard when the ES node is selected. The historical import potential (*2024)* is also displayed for comparison with the best-estimate projection (*Reference*) for the selected year. Notably, the import potential does not change between the high scenario (*Projects*, including all PCI candidates coming online by the selected year) and the best-estimate (*Reference*). This is most likely because all projects expanding cross-border capacity from 2024 onward are already considered realistic enough to be included in the central scenario.

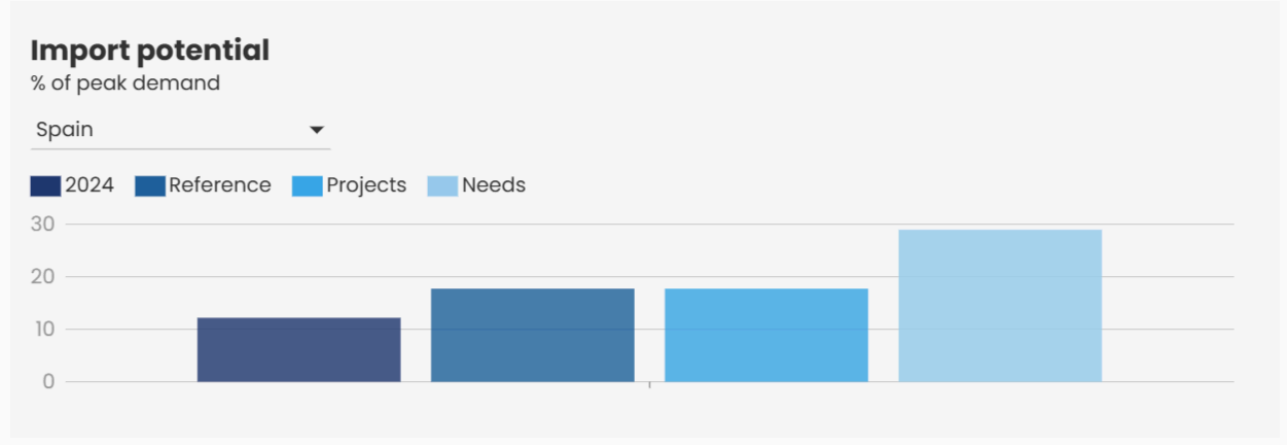


Image 5 - Import potential chart for *Spain (ES)*, 2030 Capacity view.

2.1 *Flows* map

The *Flows* view highlights the magnitude and direction of power flows across European and neighbouring countries. The information displayed is consistent with the *2024/Reference* category of the *Capacity* view.

Given that flows on an interconnector can occur in both directions, their representation on the map is more complex:

- The direction of an arrow from country node *A* to country node *B* indicates that, on average, power flows from *A* to *B*.
- The width of an arrow indicates the absolute average amount of the power flowing through it, regardless of direction. This helps assess how interconnectors are estimated to be used in relation to their capacity.
- The shade of green indicates how frequently the flow actually moves in the direction of the arrow. A very dark shade from *A* to *B* means that power flows mostly from *A* to *B,* while a very light shade indicates highly bidirectional power flow.

At the same time, each node is assigned a colour signaling its net position for the selected year: a very dark blue country has exported significantly relative to its demand, while a very dark red country has imported significantly.

For example, consider Spain in 2030:

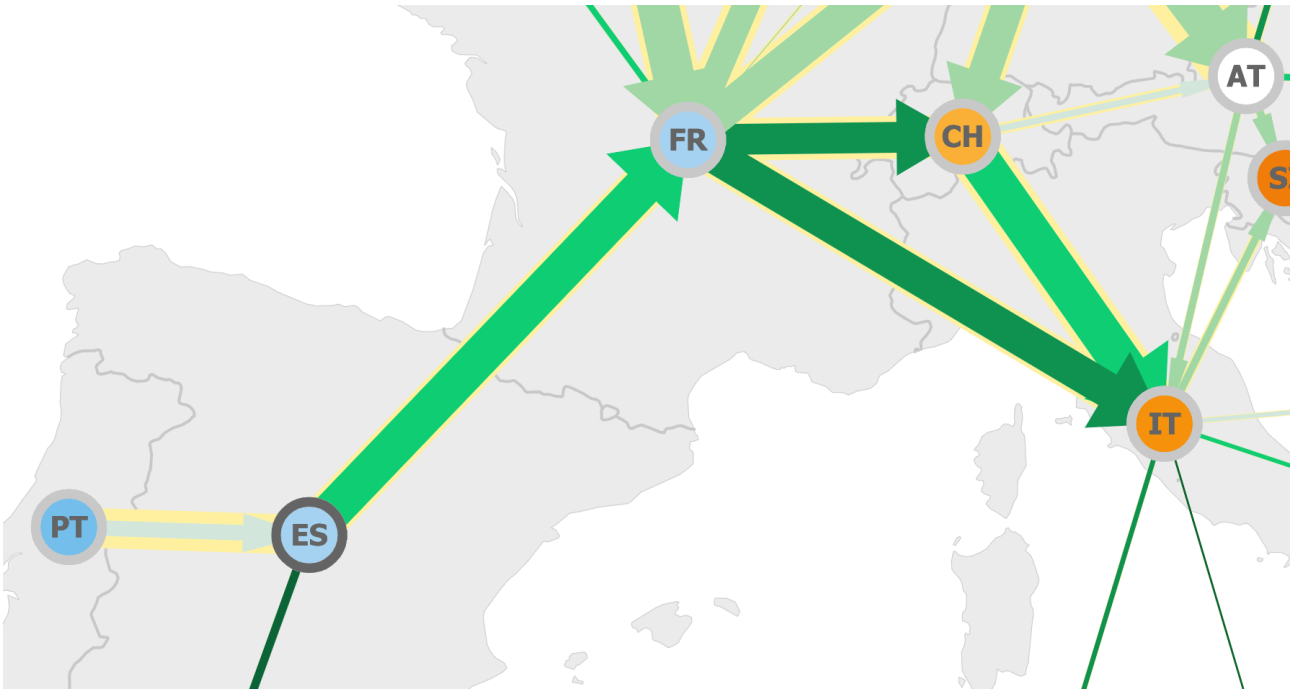


Image 6 - Map zoom on *Spain (ES)*, 2030 Flows view.

The arrows on the map indicate very frequent power flows from Spain (ES) to Morocco (MA, out of frame) and frequent power flows from Spain (ES) to France (FR). The interconnector between Portugal (PT) and Spain (ES) on average serves flows from the former to the latter, but with substantially less unidirectionality than for ES-FR and not always exploiting the full interconnection capacity, as highlighted by the underlying yellow area.

On the map, the node for Spain is coloured light blue, indicating that the country is expected to be a power exporter – similarly to France (FR) and, to a lesser extent, to Portugal (PT). In the snapshot above, Switzerland (CH) and Italy (IT) are clearly net importers, while Austria's (AT) net position is close to zero, meaning that

the country imports and exports very similar quantities of electricity ("copper plate").

More detailed information appears on the right side of the dashboard when the ES node is selected. The first focus area covers daily and seasonal patterns for the share of renewable (wind and solar, *RES-E*) generation and for net exports (positive when exporting, *NET-P*).

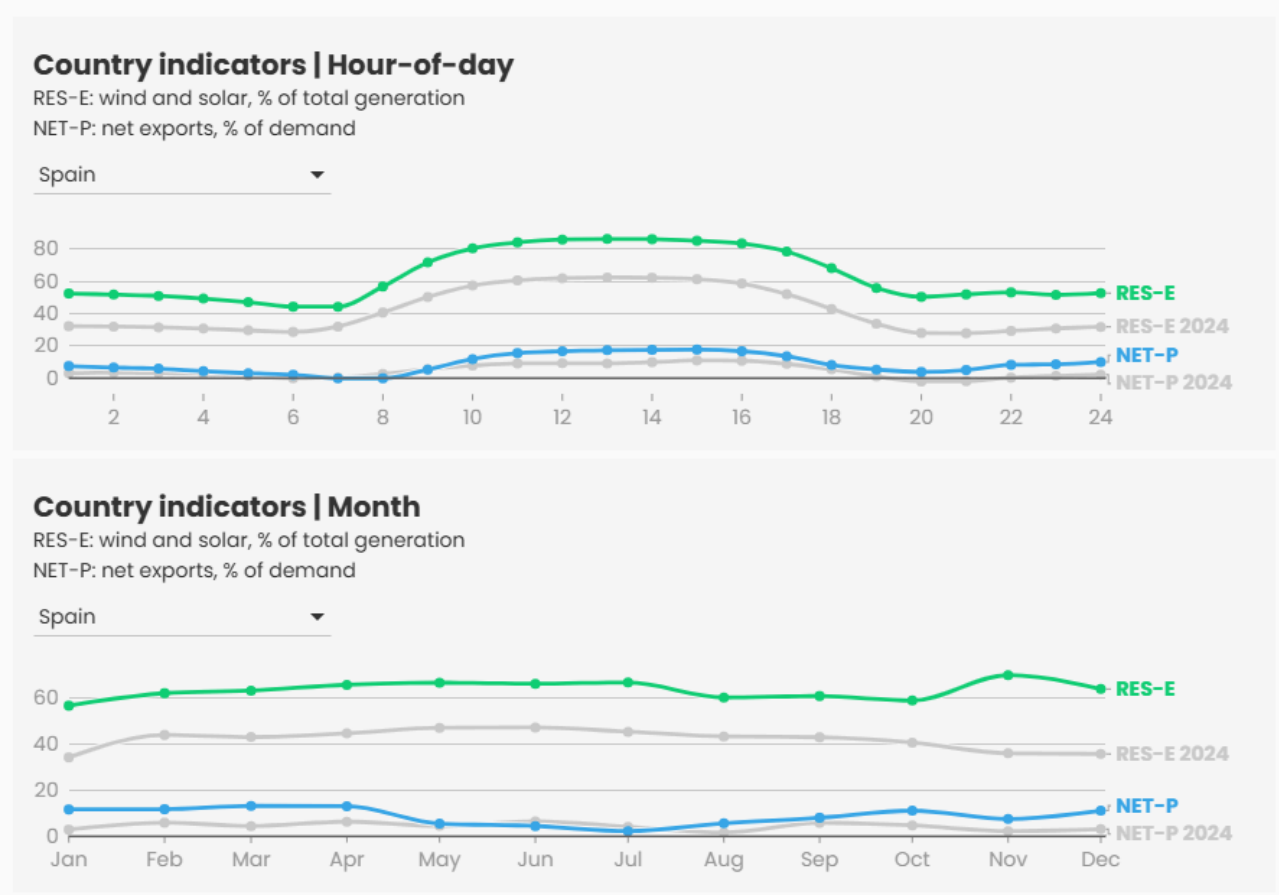


Image 7 - Country indicator charts for *Spain (ES)*, 2030 Flows view.

The *Hour-of-day* curves clearly show higher solar generation during the central hours of the day, with renewables being more relevant in the system than in *2024* (also shown for comparison). During these same hours, increases in net exports are also observed, likely corresponding to cheap renewable electricity being exported to France and Morocco.

The *Month* curves, aside from an (expected) higher penetration of renewables, do not show any particular patterns – possibly due to a greater presence of wind, which complements solar generation in the system.

The second focus area covers daily and seasonal patterns for flows to neighbouring countries (here, positive values indicate when Spain is exporting). These indicators are expressed as a percentage of the total interconnection capacity of the selected country.

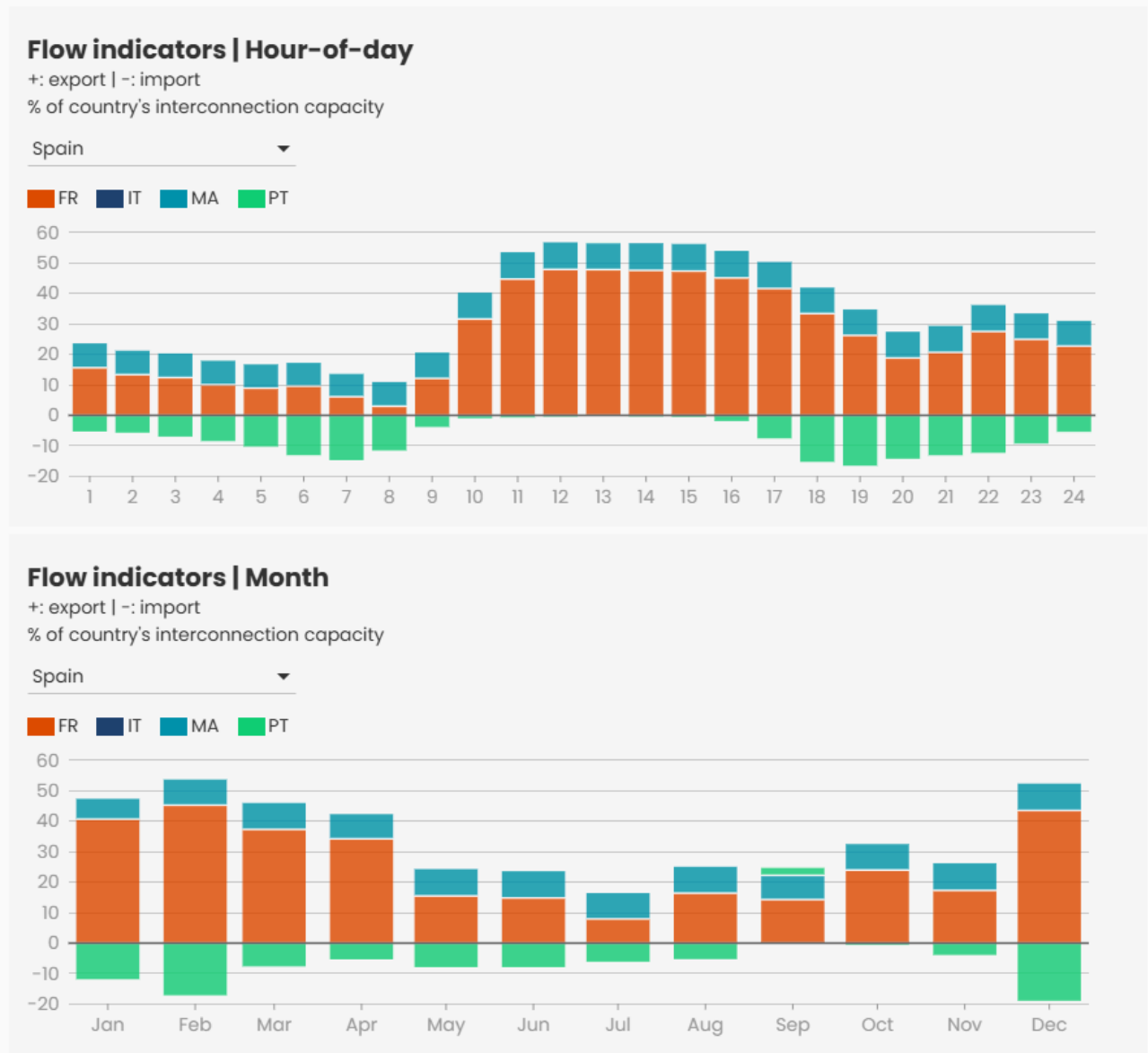


Image 8 - Flow indicator charts for *Spain (ES)*, 2030 Flows view.

The *Hour-of-day* bars show that, on average, during the central hours of the day – when wind and solar account for most of the generation – Spain indeed exports to Morocco (MA) and uses almost 50% of its interconnection capacity to export to France (FR), while relying less on imports from Portugal (PT). The *Month* bars reveal that Spain exchanges much more power during the winter months (Dec-Jan-Feb) than during the summer months (Jun-Jul-Aug).