The 2nd International Conference on

Sustainability in Hydropower 2023

–Ecological mitigation, best practises and governance

European Commission

Opportunities and challenges for sustainable hydropower in the European Union

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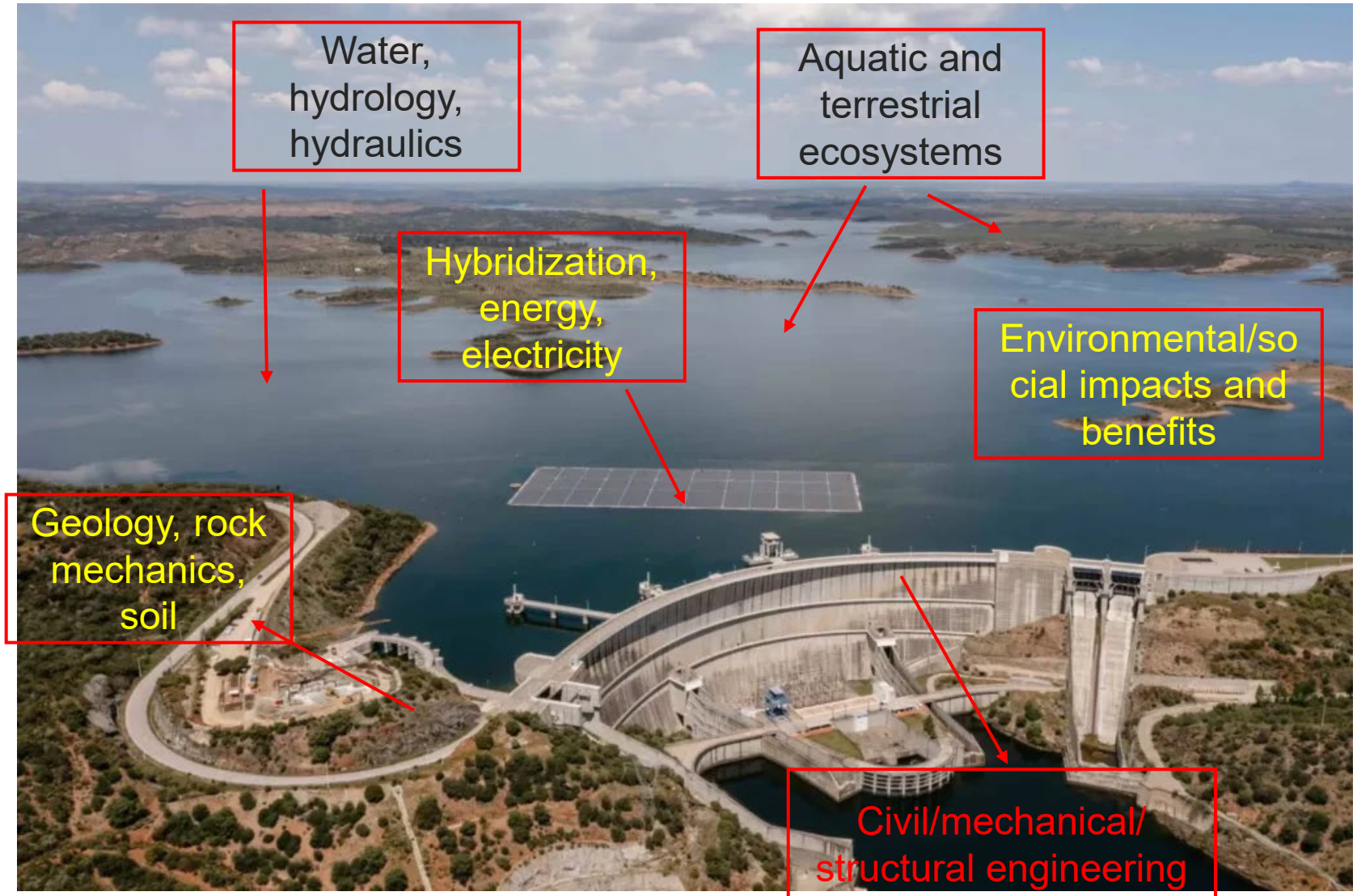
Summary

Hydropower as a complex system

The implications of complexity

Sustainable opportunities (main results): assessments for the EU

Hydropower is a complex system



High financial investments

Infrastructures

Economy of multiple use of reservoirs (fishing, irrigation, tourism, water availability)

Grid flexibility

Hydropower, environment and the hydrosphere

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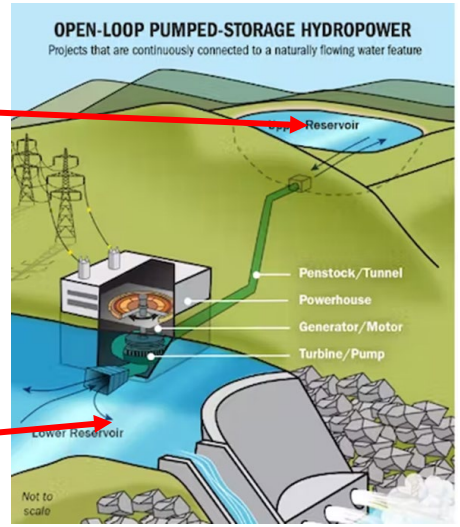
Hydropower and oceans

Fig. 1. Accumulation of floating debris behind the Three Gorges (Sânxiá) HPP dam on the Yangtze River, China [4].

Fish, sediments, wastes



Pumped-hydropower storage using the ocean as lower reservoir

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Water (e.g., hydropower) reservoirs and the atmosphere

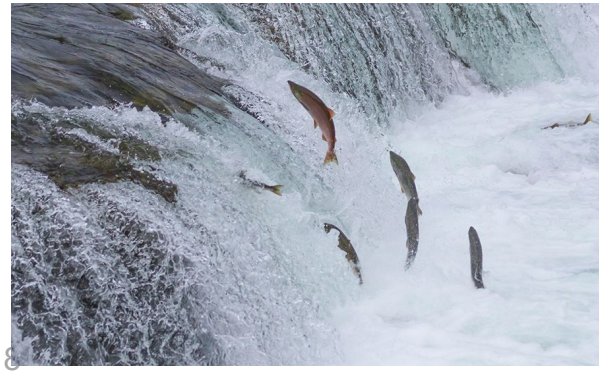
Evaporation, and may emit GHG

Hydropower and society






Hydropower is at the centre of the WATER-ENERGY-FOOD-ECOSYSTEM (WEFE) Nexus!



The complexity of the hydropower sector has several implications

- There are different points of view and aspects that, if not considered, may lead to wrong statements (e.g., real contribution of hydropower-type barriers)
- Benefits vs impacts (sustainable hydropower)
- Conflictual policies (Van de Bund presentation)
- Need of different experts and expertise

Hydropower and other barriers

- Hydropower barriers are no more than 10% of barriers in EU rivers (ref: AMBER, various sources)
- 50% of single purpose reservoirs are for hydropower and 50% of multi-purpose reservoirs are hydro-powered (ref: ICOLD)

Hydropower debate: benefits vs impacts

Renewable energy, energy storage, flexibility

Water management, flood control and water storage (e.g., for irrigation)

Tourism

Market development

Job opportunities

Fish injury

Sedimentation

Fragmentation

Hydropeaking

Flooding upstream

Ecosystem alterations

Hydropower and conflictual policies

Water Framework Directive: Hydropower as a source of impact

Renewable Energy Directive, REPowerEU: Hydropower as a clean energy technology

Flood Directive: Hydropower can be a dangerous interference, but reservoirs can mitigate droughts and can provide water storage

Conflicts can be overcome by sustainable hydropower

Sustainable hydropower needs to achieve a good balance between electricity generation, social benefits and impacts on the ecosystem and biodiversity, developing mitigation solutions and innovative technologies.

Hydropower Sustainability Standard: IHA (Valverde presentation)

Sustainable hydropower strategies in the EU: large-scale assessments without new barriers

Use of existing literature and involvement of experts to estimate large-scale potentials/results; despite their uncertainty, they anyway provide the order of magnitude of the problem/potential and help policy-makers in defining the right priorities and relevance of strategies

Previous assessments

- 8.7 TWh/y estimated by Punys et al. (2019), who studied all the historic non-powered sites from the Restor Hydro project database (64,910 sites) = +2.6%
- *Reservoir interconnection:* from Gimeno-Gutiérrez and Lacal-Arántegui (2015): + 29 TWh in Europe and + 4 TWh in the EU (of storage capacity) = +16% for Europe
- *Floating PV on hydropower reservoirs, + 139 TWh/y* (Kakoulaki et al., 2022) = +85% (of the current PV generation)

SustHydro Exploratory Activity

Modernization

+40 TWh/y (Quaranta et al., 2021 and Quaranta and Muntean, 2023) (+11%).

- *Digitalization of the operation.* Digitalization can increase the efficiency by 1%. But it can also increase energy generation by +10% due to a reduction of spills in reservoir-type power plants, thanks to a better inflow forecast and reservoir management.
- *Replacement of electro-mechanical equipment*. This can lead to an increased weighted efficiency between 4% and 6%, depending on the configuration and turbines type.
- *Waterways and penstocks*. Waterways and penstocks were assumed to be retrofitted and replaced with new ones with reduced head losses and friction, and assumed to be implemented in reservoir-type hydropower plants (those corresponding to higher heads) with an additional energy generation of +5%.

- - dam heightening
- - increased discharge and peak power
- - climate and market changes

Hydropower potential in historic low head sites (e.g. water mills)

Hydropower and safeguard of cultural heritage, +2 TWh/y (+0.5%) (Quaranta et al., 2022) using water wheels or +3.5 TWh (+1%) using also other turbines.

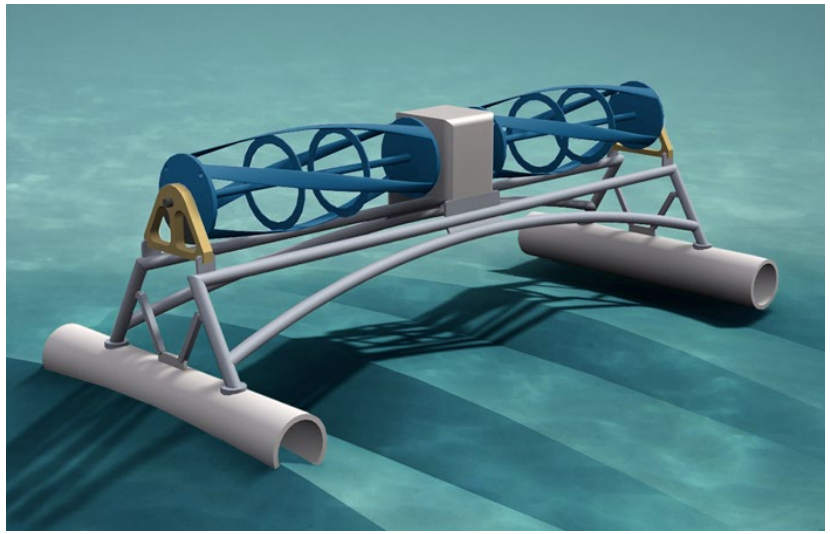
Updating the results of Quaranta et al., 2022

Hydrokinetic turbines:

+1 TWh/y (Quaranta et al., 2022) in rivers

+2.3 TWh/y in the tailrace (Quaranta and Muntean, 2023)

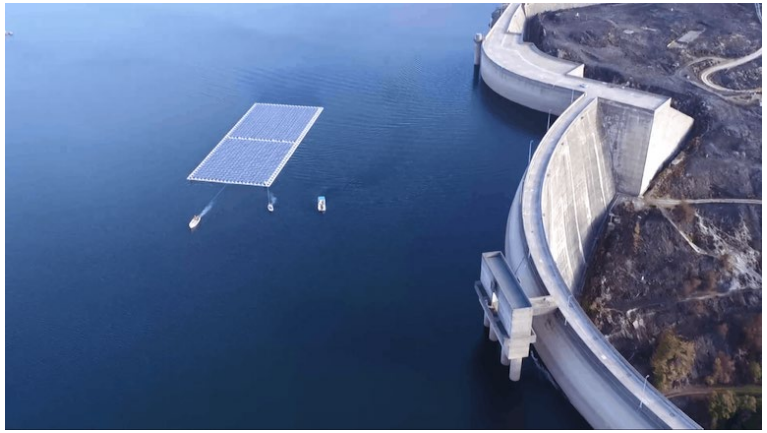
+0.9%

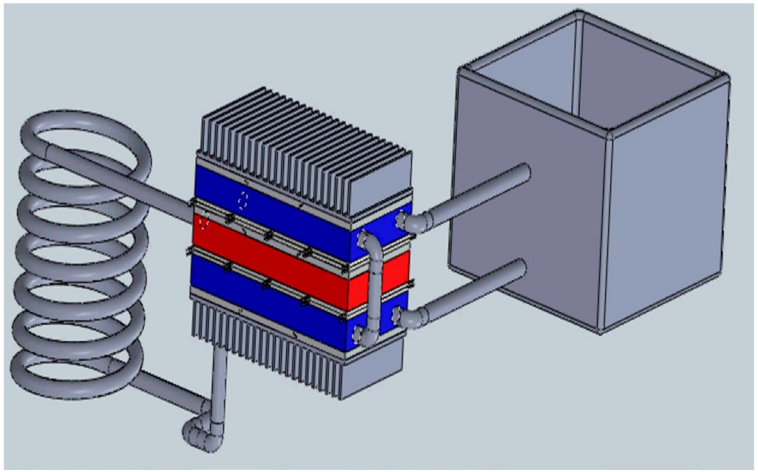


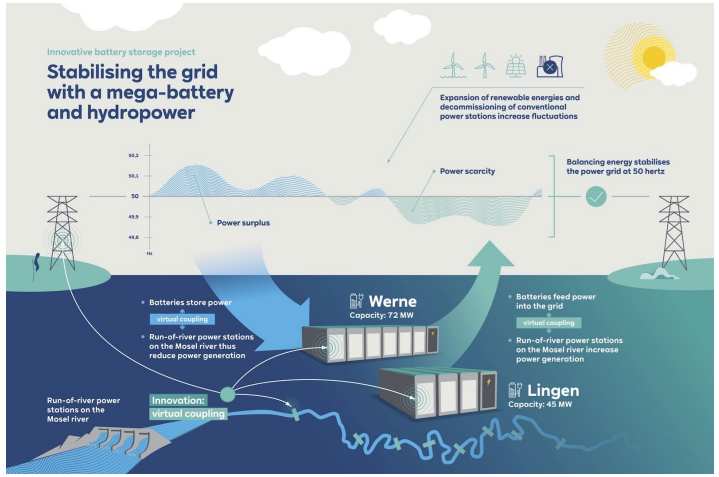
Hydropower from WDNs and WWTPs*:*

+3.1 TWh/y (Quaranta et al., 2022) (+0.8%)

Hydropower and hybridization with other energy technologies







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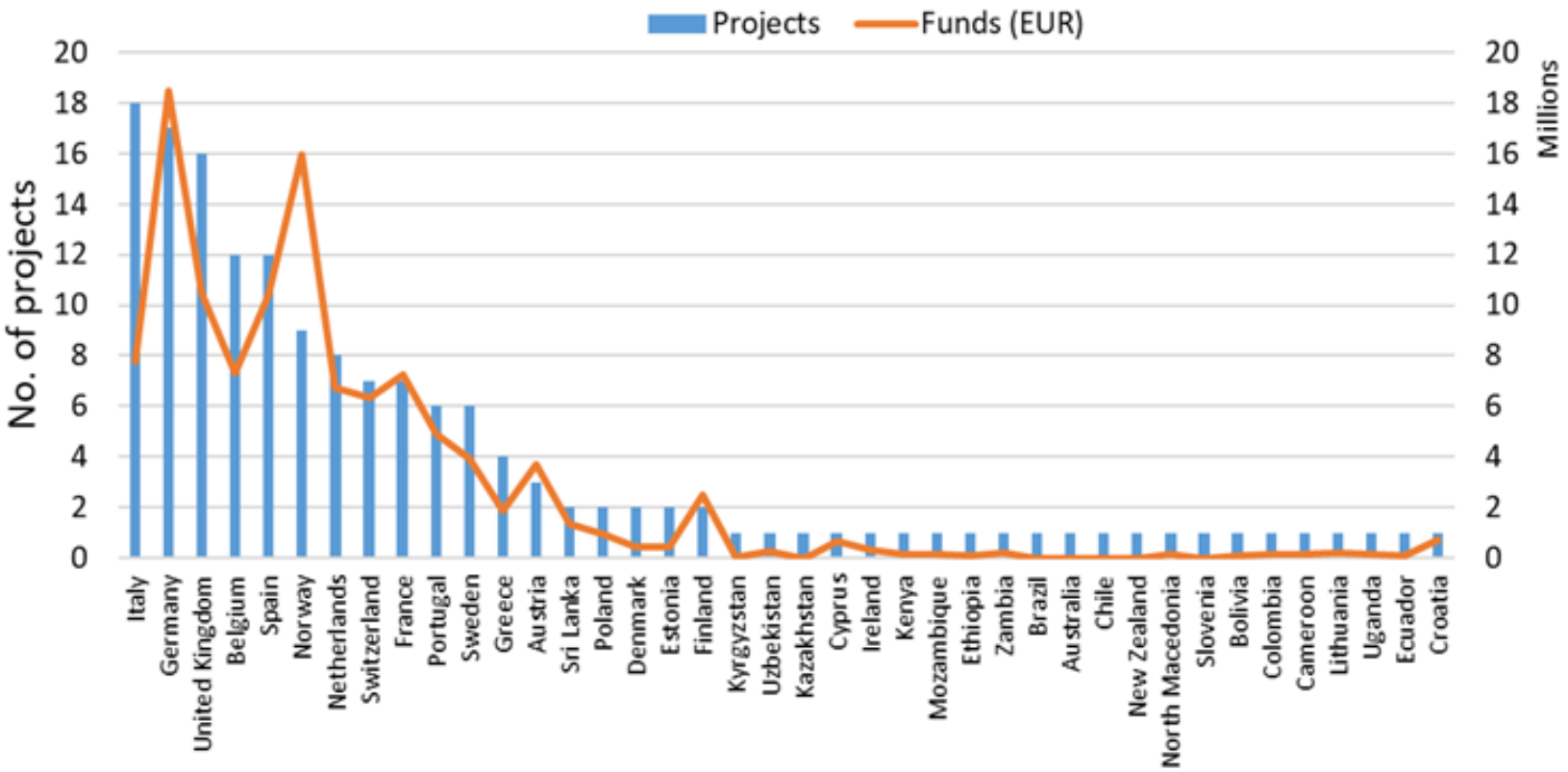
Energy need and sustainable potential: key results from scientific assessments

The discussed sustainable solutions can add 55 TWh/y (max), but, according to PRIMES, the EU needs of +90 TWh/y in 2050

Pumped hydropower installed capacity needs to increase up to 70 GW, and this cannot be solely satisfied by reservoir interconnection and upgrading.

New hydropower plants must be developed in a sustainable way. This is not an easy task!

Scientific innovation in the EU: EU funded projects 2015-2022



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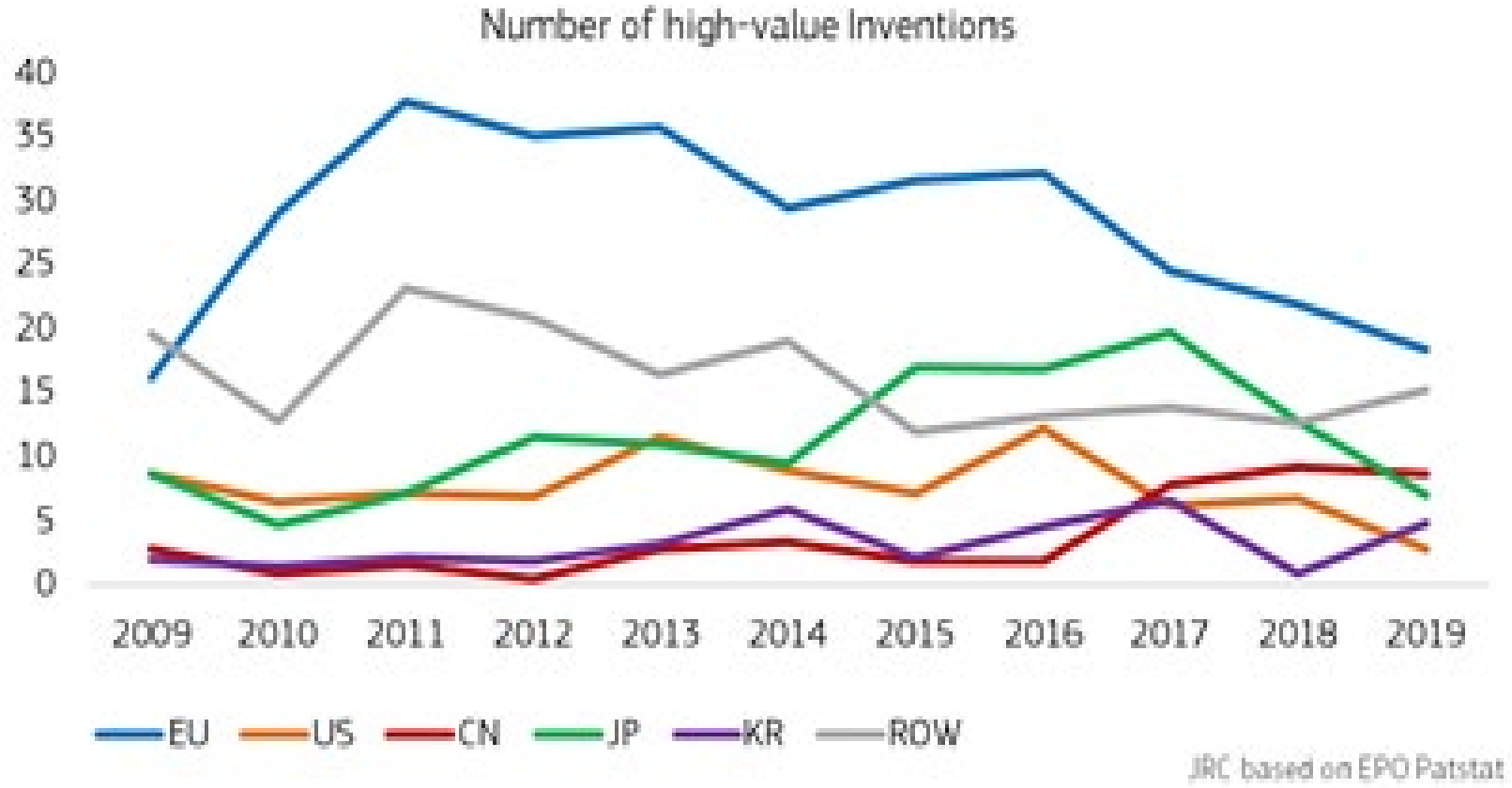
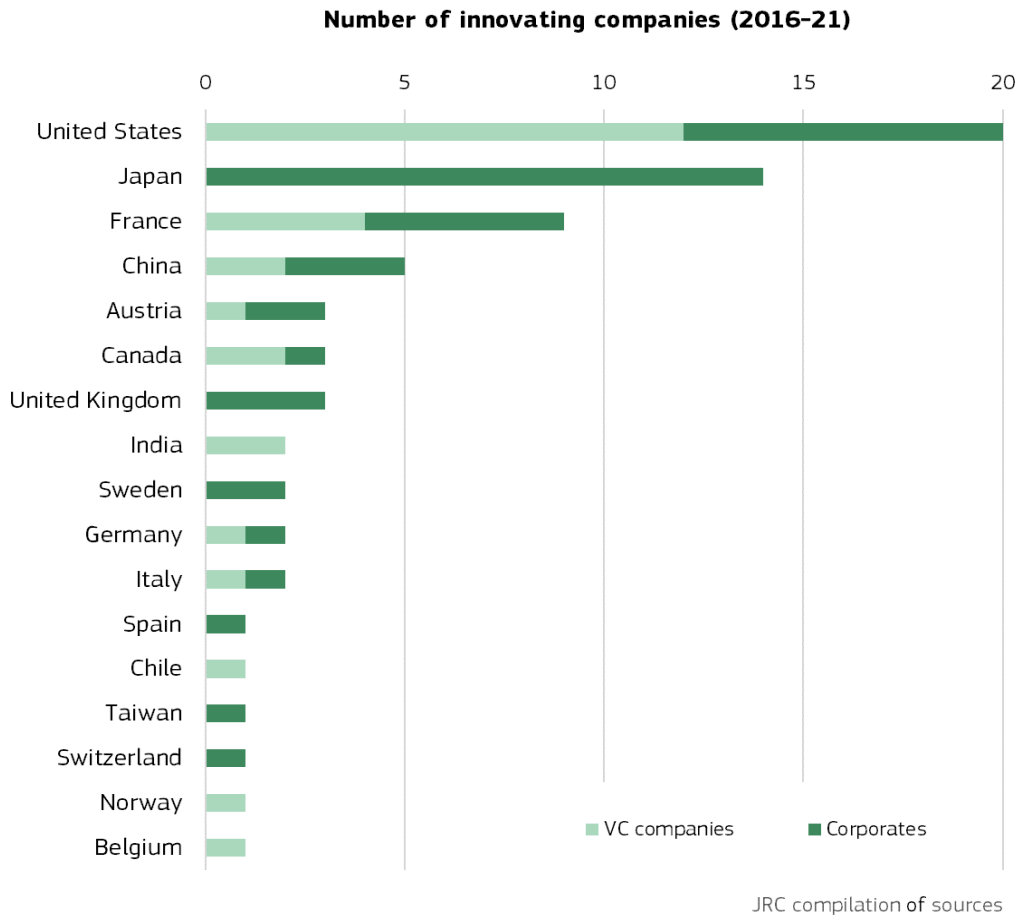
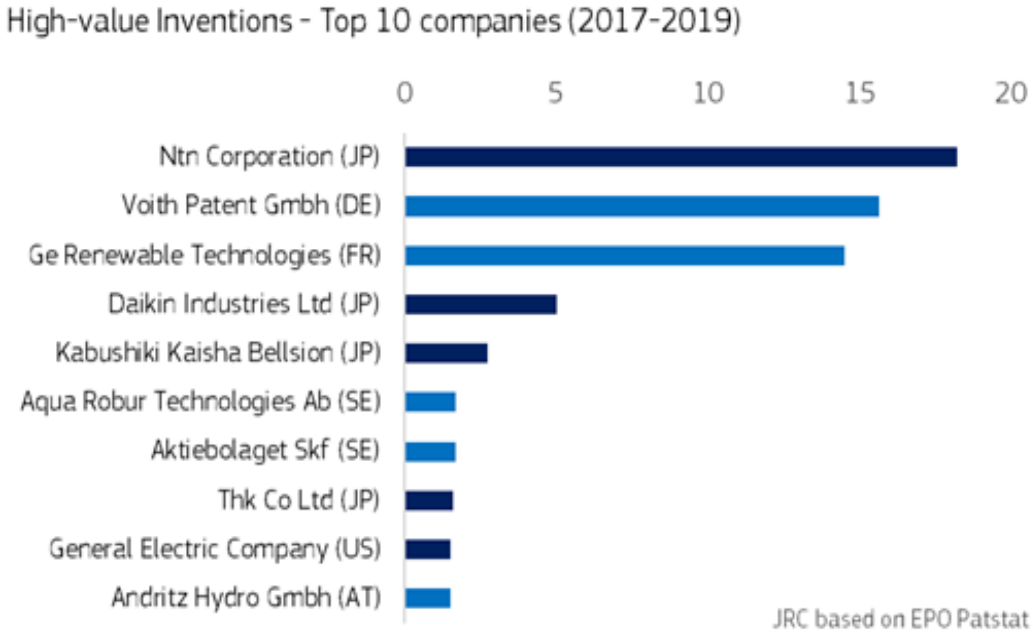
Industrial innovation in the EU



Industrial innovation in the EU





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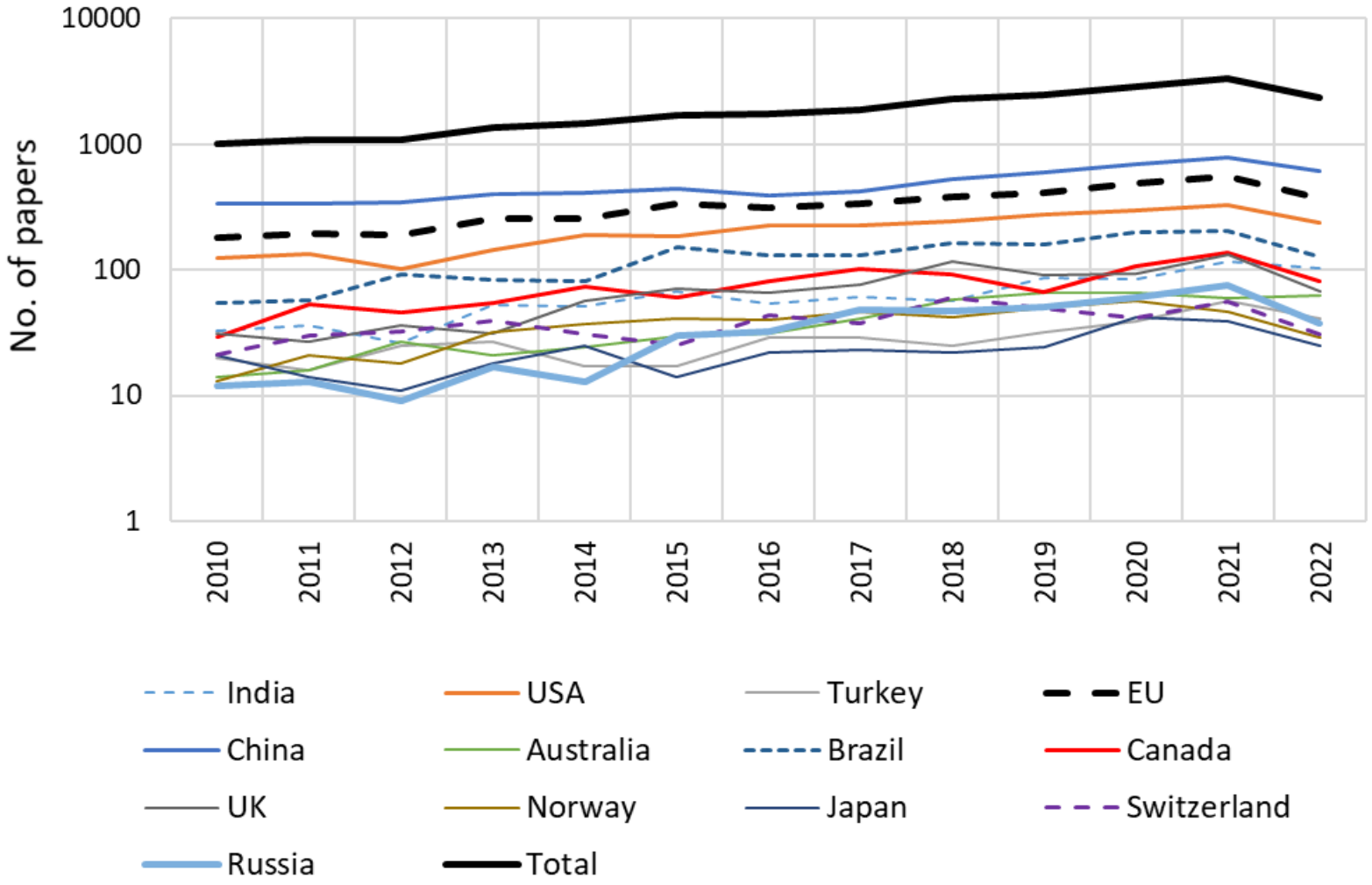
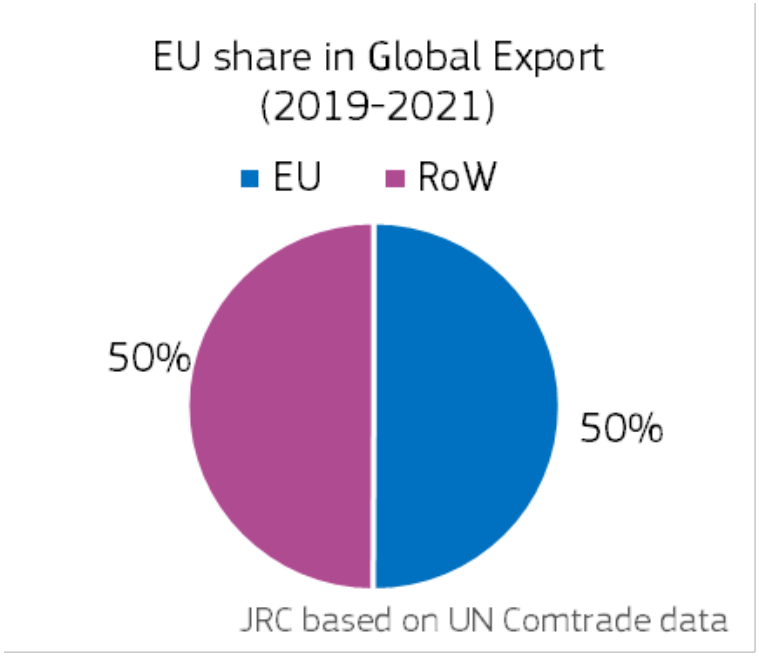
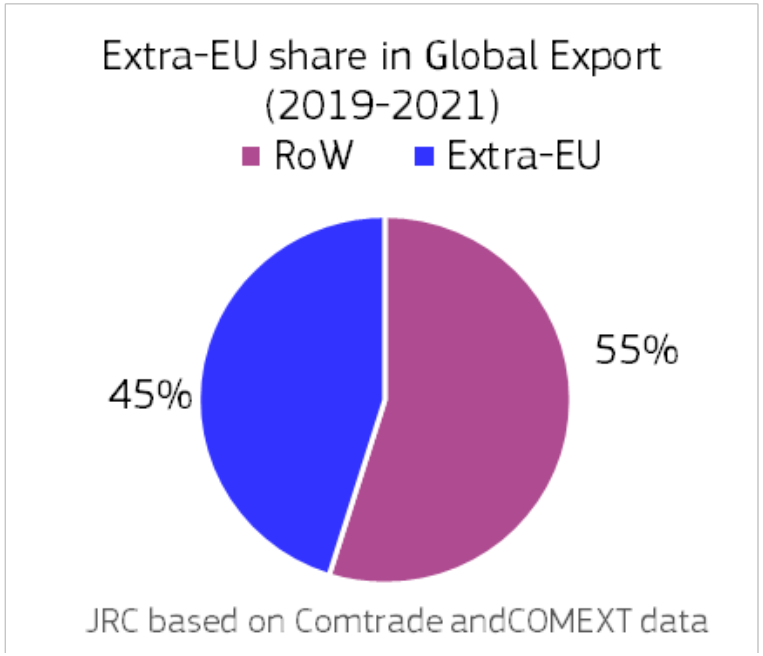
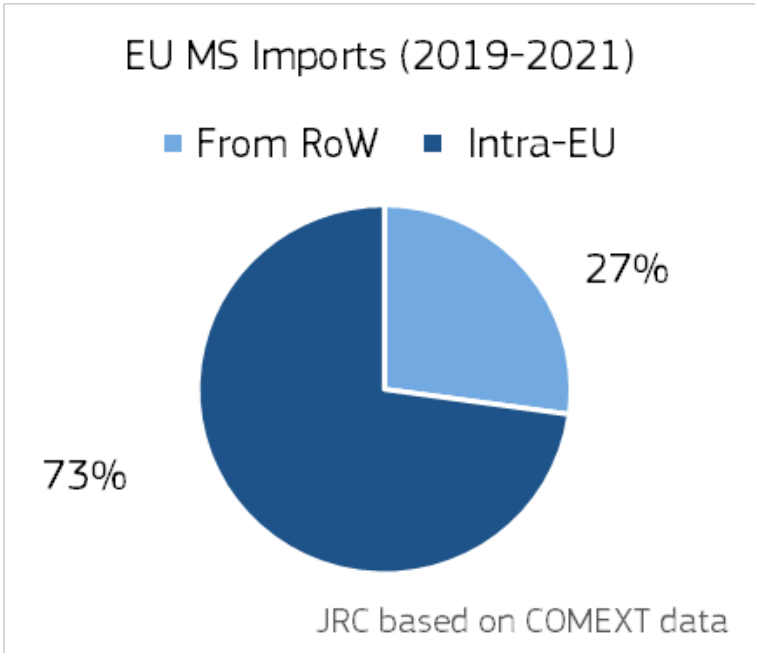
Scientific production



Export capacity and import







More details at: https://setis.ec.europa.eu/hydropower-and-pumped-hydropower-storage-european-union_en

Conclusions

Hydropower is a complex sector: need of more interaction and different kinds of expertise! Always consider all the impacts and the benefits of any energy source.

The EU27 and the Europe are global hydropower leader. Do not forget about the 38 GW of hydropower in Norway!

The EU (and Europe) needs more hydropower, and they must be developed in a sustainable way. This is not an easy task!

New projects/reservoirs should be conceived as multi-purpose ones. Digital solutions can increase efficiency and mitigate impacts.

Conclusions

More details on the EU hydropower (year 2022) here:
https://setis.ec.europa.eu/hydropower-and-pumped-hydropower-storage-european-union_en

Any comment is highly welcome!

Thank you

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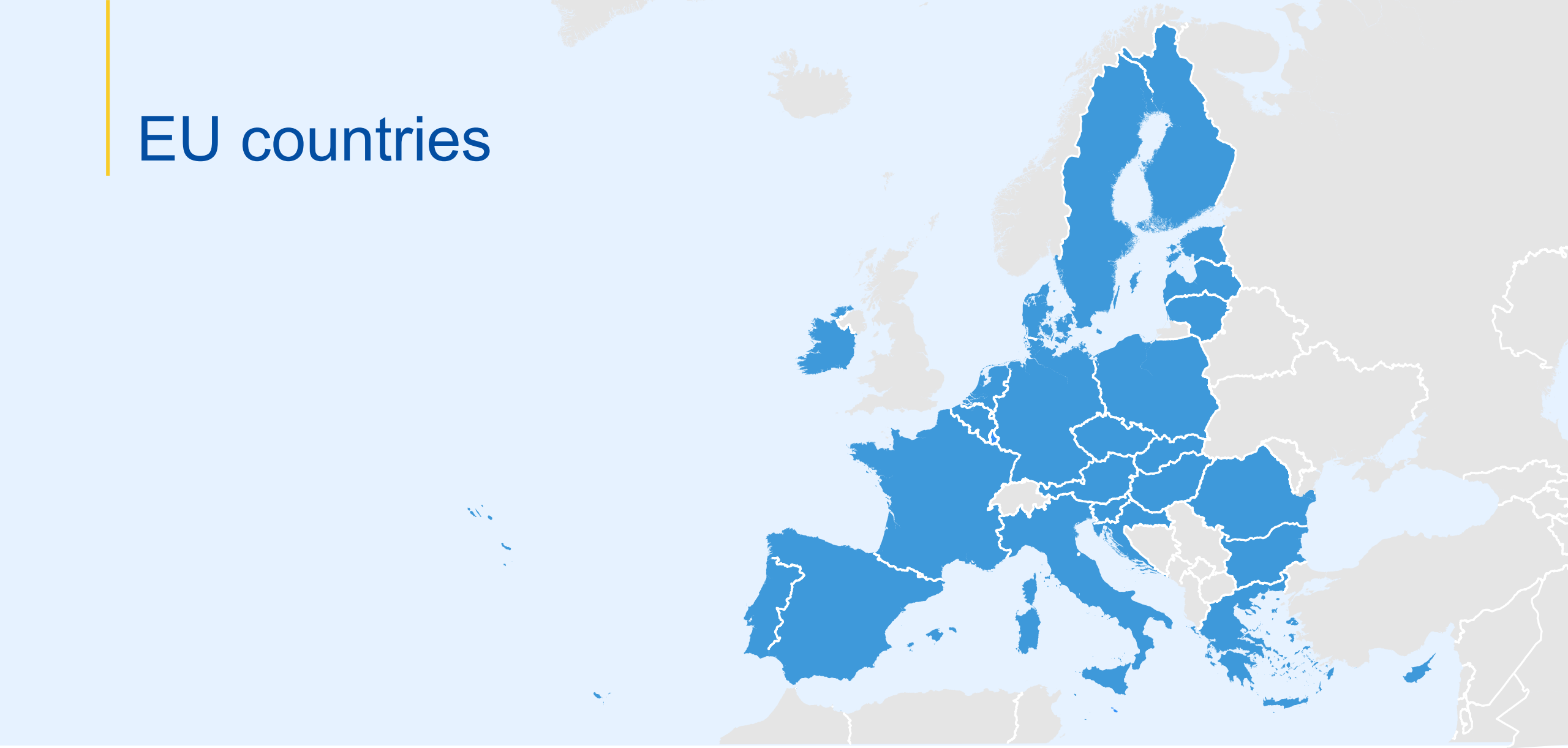
EU countries



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