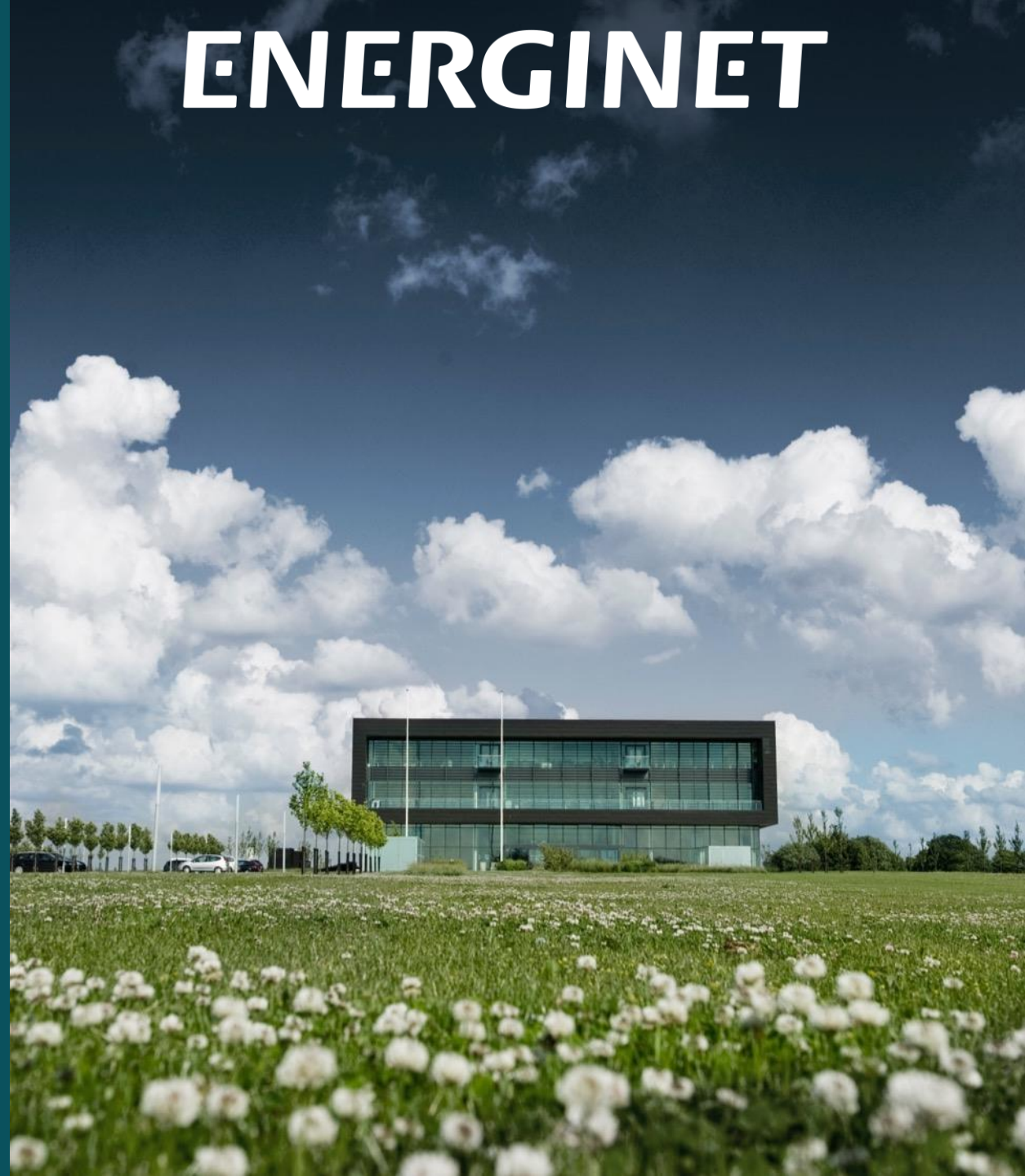


INTER-REGIONAL TRANSMISSION TARGETS IN EUROPE

28 November 2022

*Peter Markussen, Senior director, Energinet Transmission System
Operator, Denmark
(pmr@energinet.dk)*

ENERGINET



ENERGINET

THE ENERGY BACKBONE

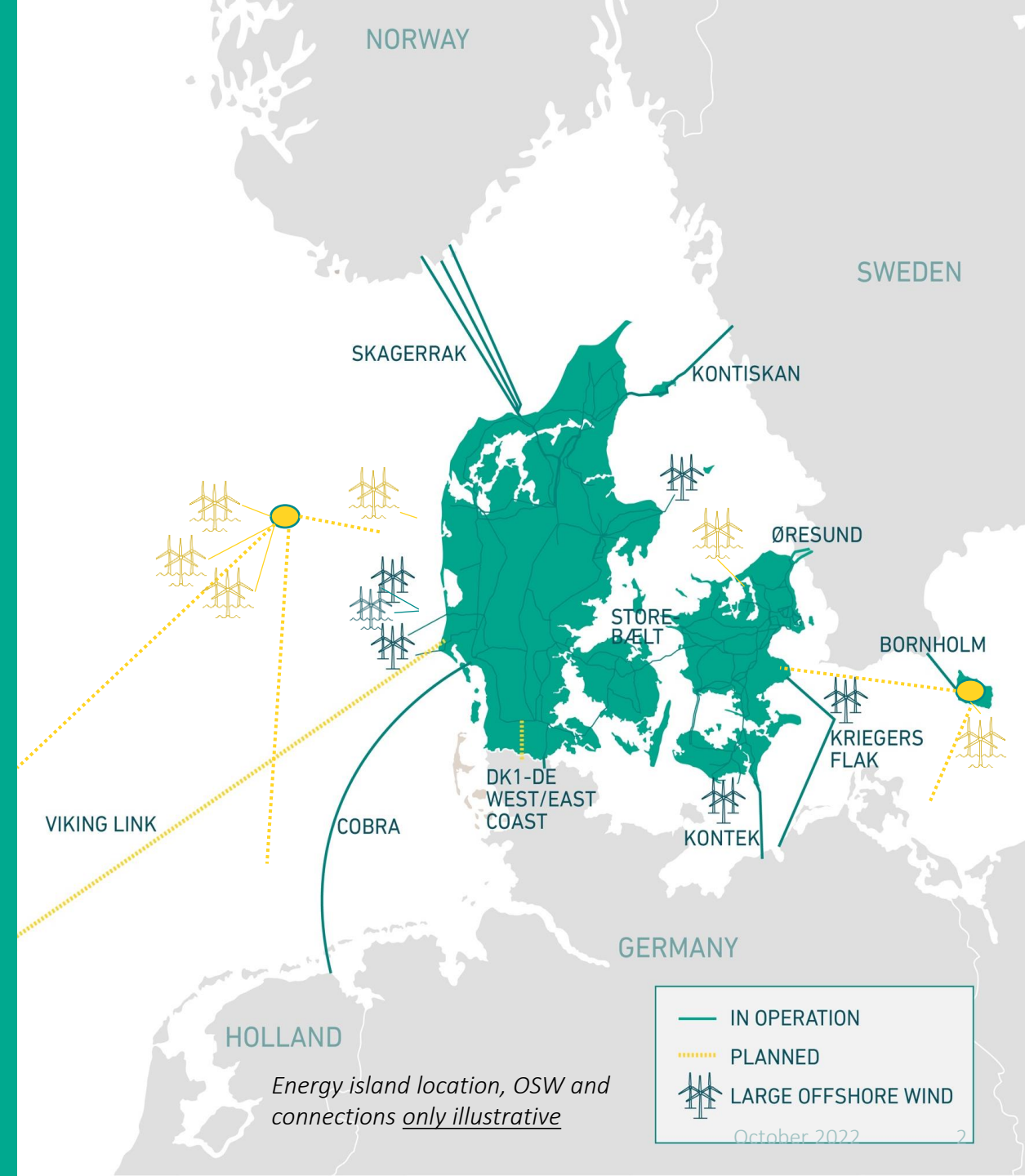
We operate and develop the transmission grids and gas pipelines in Denmark.

ENSURE BALANCE

We have the day-to-day and long-term responsibility for the overall electricity and gas system in Denmark.

WORKING FOR THE SOCIETY

Owned by the Danish Ministry of Climate, Energy and Utilities we safeguard society's interests as we move to a 100% green energy system.



WHY IS INTERREGIONAL TRANSMISSION IMPORTANT?

HIGH SECURITY OF SUPPLY

Lower risks for energy not served
Reduced dependency on imported fossil fuels

ACCELERATED GREEN TRANSITION

Reduced curtailment and CO2 emissions from fossil fuel

AFFORDABLE ENERGY

Annual 5-9 bill Euro reduced electricity production costs from common European electricity markets

HOW TO MAKE IT HAPPEN?

Focus for today's presentation

EUROPEAN LEVEL:

Harmonized system operation and electricity market
Coordination of short and long term grid planning to support national decisions

NATIONAL LEVEL:

Approval of interregional transmission capacity

TRANSMISSION SYSTEM OPERATOR LEVEL:

Unbundling and clear roles and responsibilities of transmission system operators (TSO)

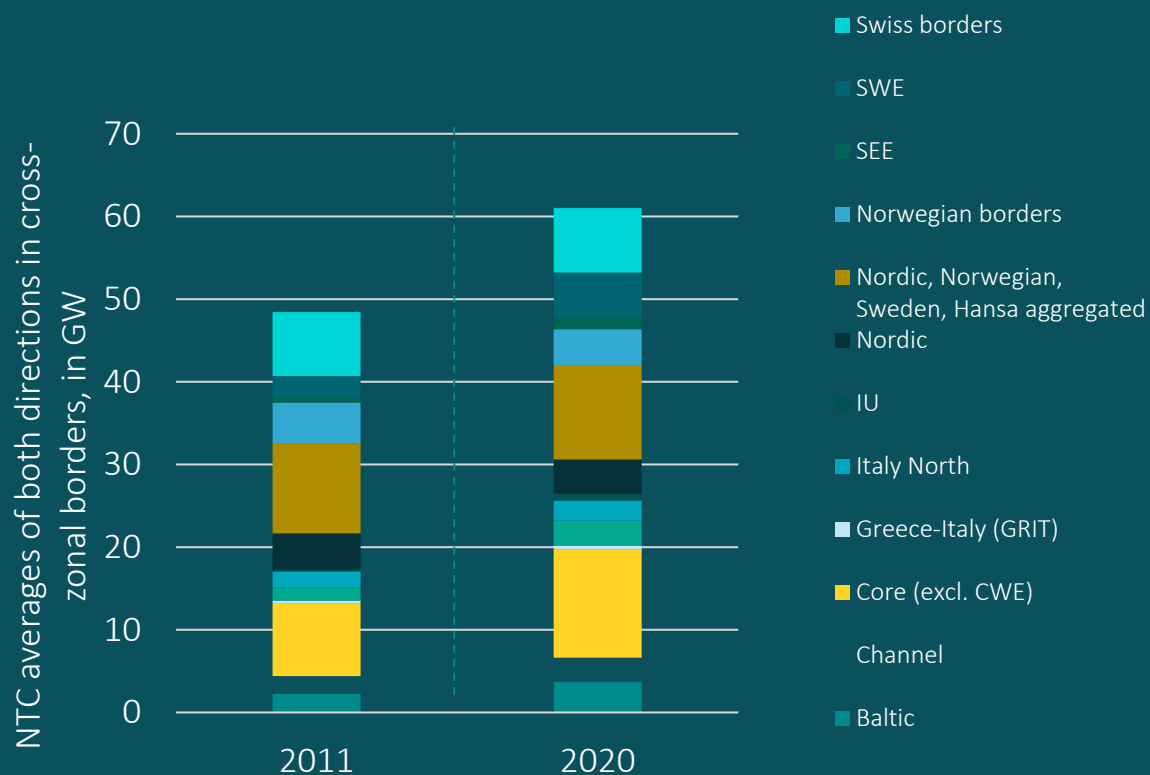
HISTORIC DEVELOPMENT

Today	Targets 2030	Target 2050
• ≈30% green electricity • ≈1000 GW VRE	• 40% green electricity • 55% CO2 reduction • 2000 GW VRE (indicative)	Climate neutral



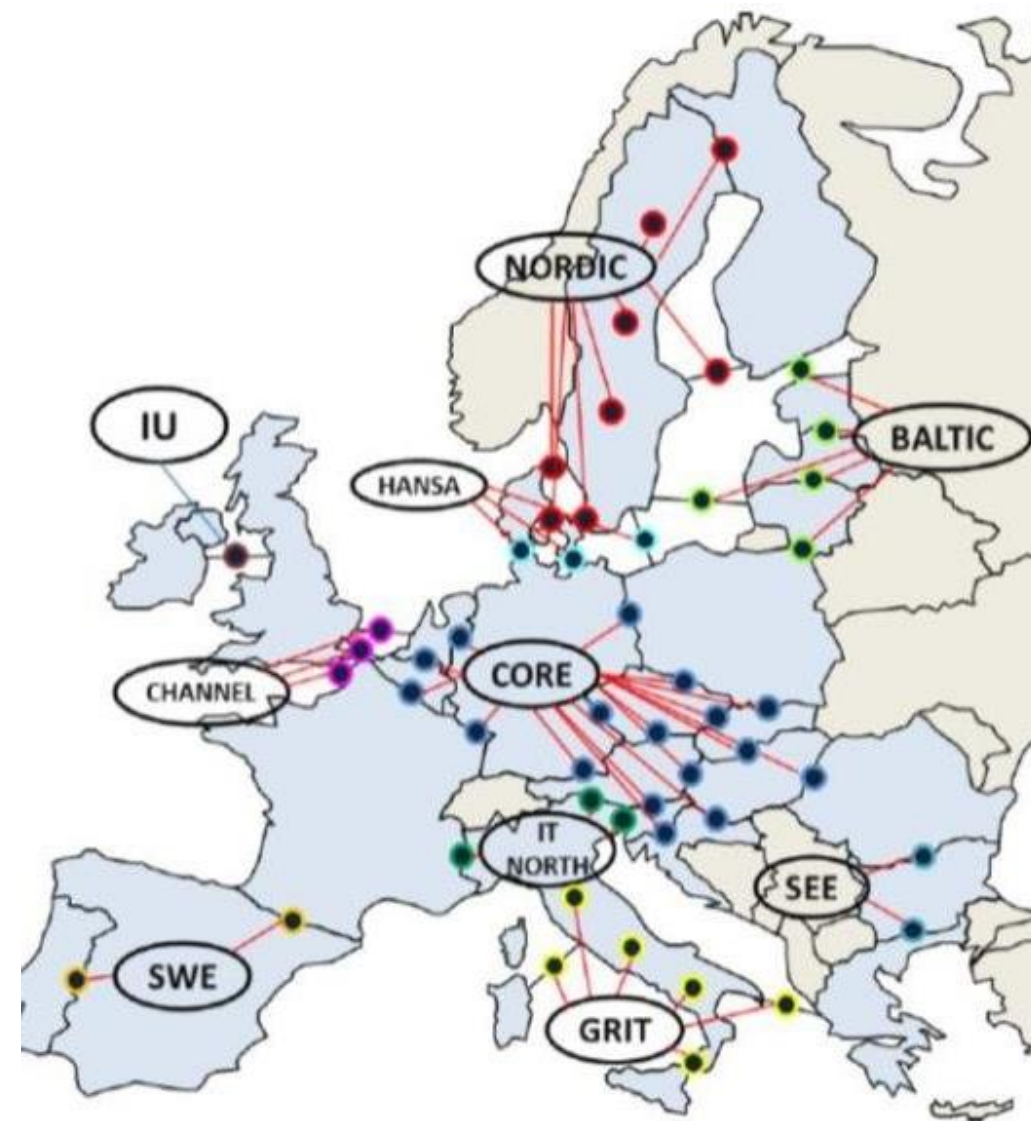
INCREASE IN CROSS BORDER ELECTRICITY TRANSMISSION CAPACITY

Net Transfer Capacity (NTC)



Source: Acer

European Capacity Calculation Regions



Source: ACER.

INCREASED CROSS BORDER EXCHANGE OF ELECTRICITY

European Union (27 countries) electricity
consumption

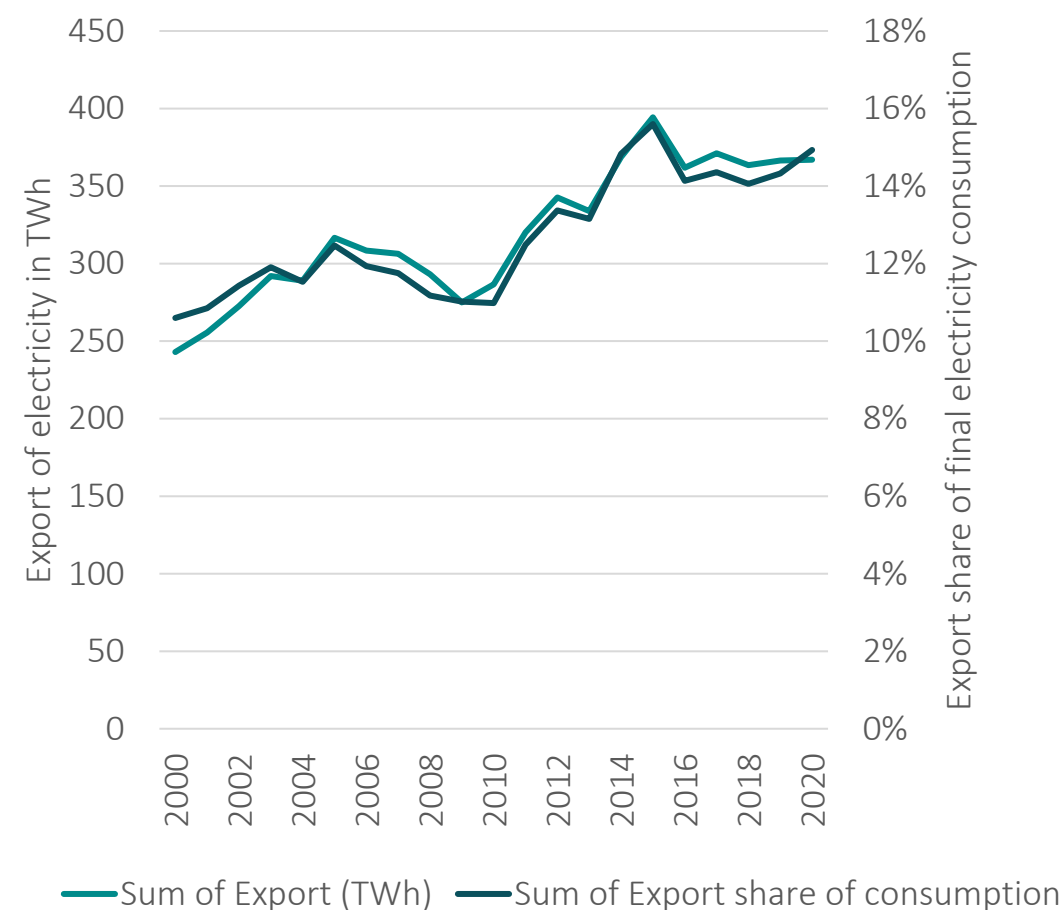
2000: 2,228 TWh

2008: 2,688 TWh (historic highest demand)

2020: 2,458 TWh

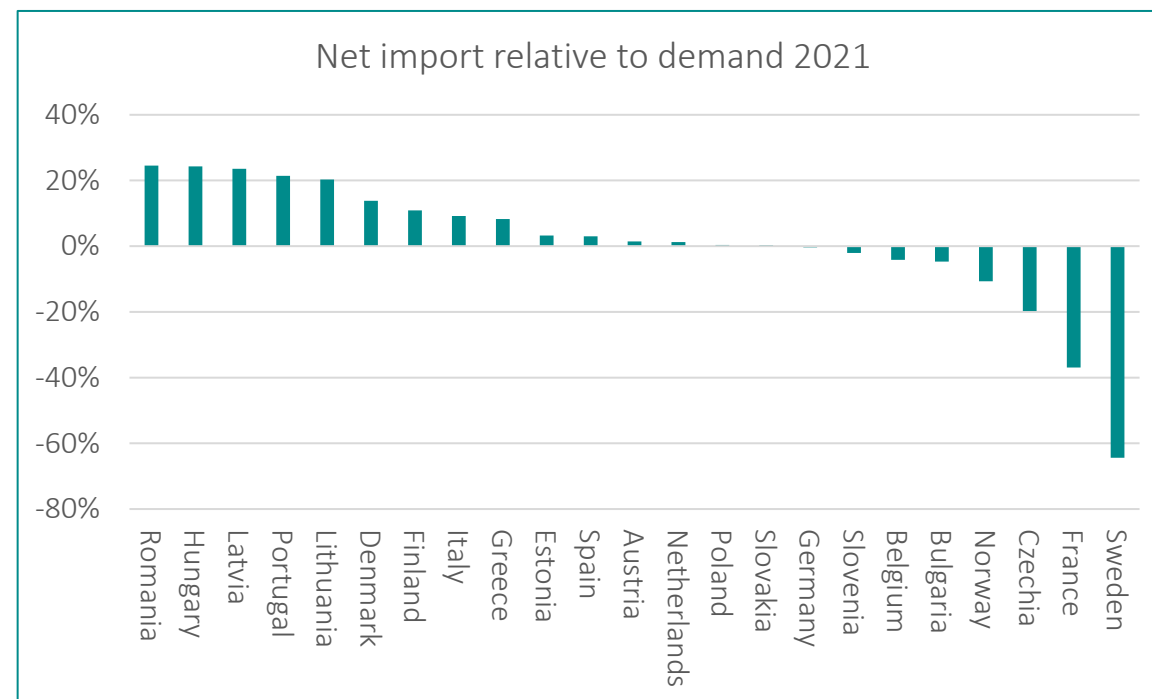
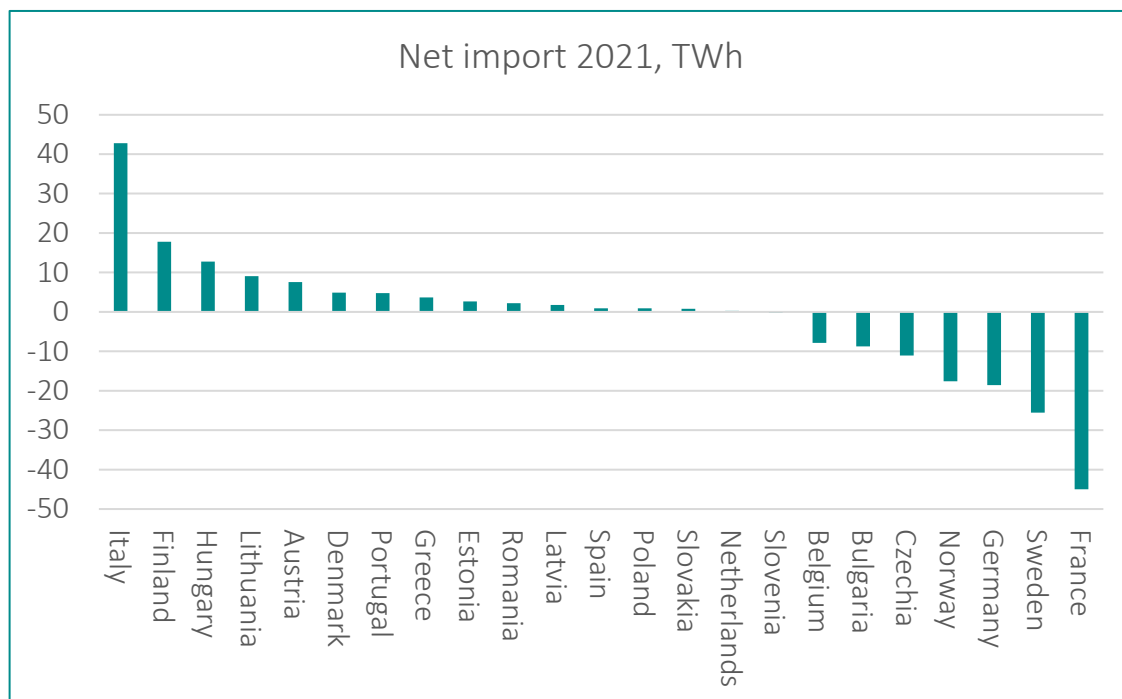
Source: Eurostat

European exports and export share of electricity
consumption in the EU



LARGE DIFFERENCES IN NATIONAL IMPORT AND EXPORT

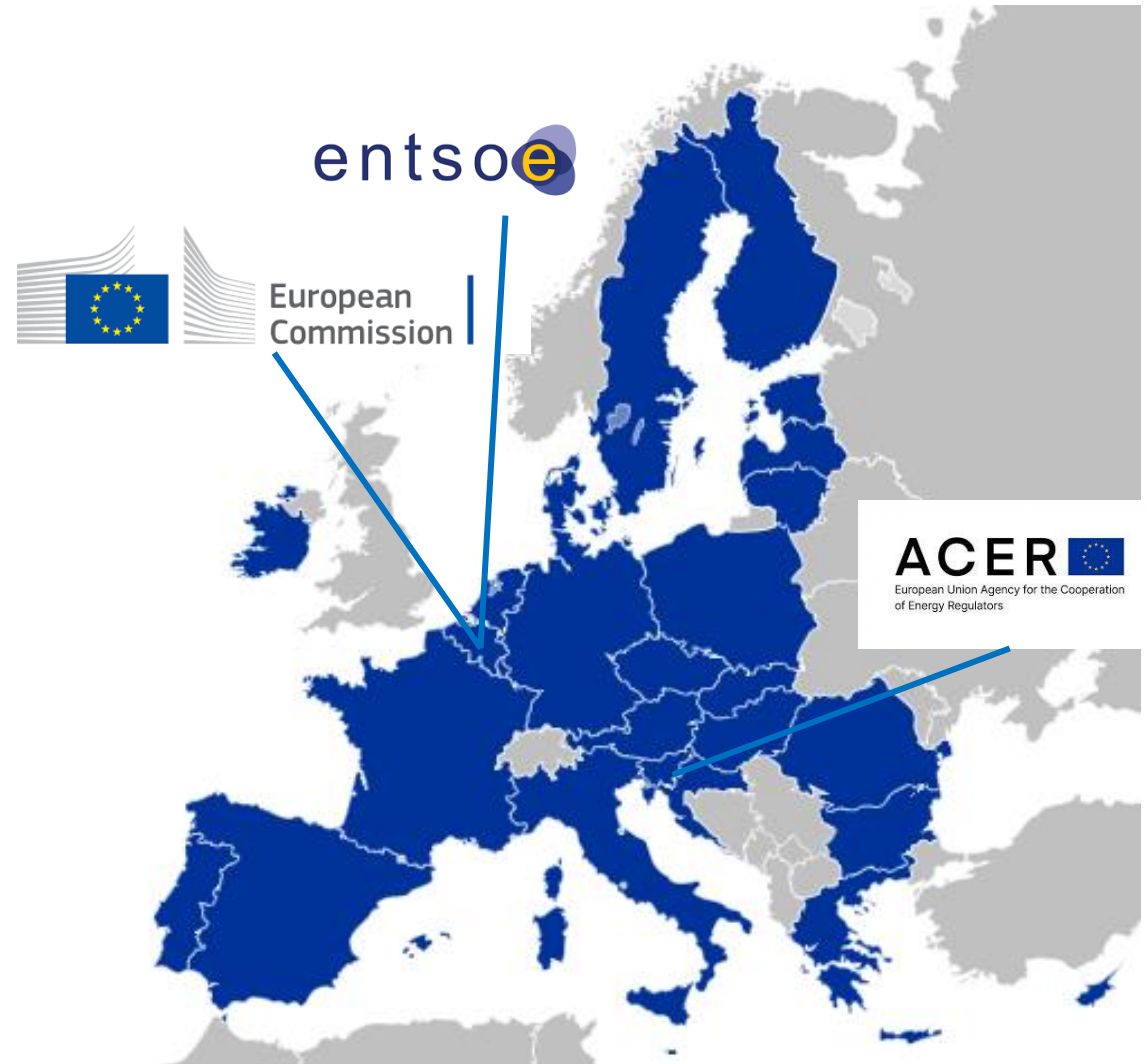
European regulation ensures reliability on cross border exchange and part of national security of supply assessments



Source: Eurostat

EUROPEAN REGULATION

ENERGINET



EUROPEAN REGULATION FOR LIBERALIZATION

European electricity sector regulation has developed over the last 30 years

The Single European Act – establishment of Internal European market (1986)

Electricity Liberalization directives (law):

- 1996: unbundling and competition
- 2003: common electricity market
- 2009: harmonization of grid codes, ACER
- 2019: efficient integration of renewables (min. 70% capacity on interconnectors)
- 2021: continued development of markets and infrastructure

EUROPEAN ENERGY AGREEMENTS

Lists not exhaustive

2013: Trans European Networks for Energy Regulation, TEN-E

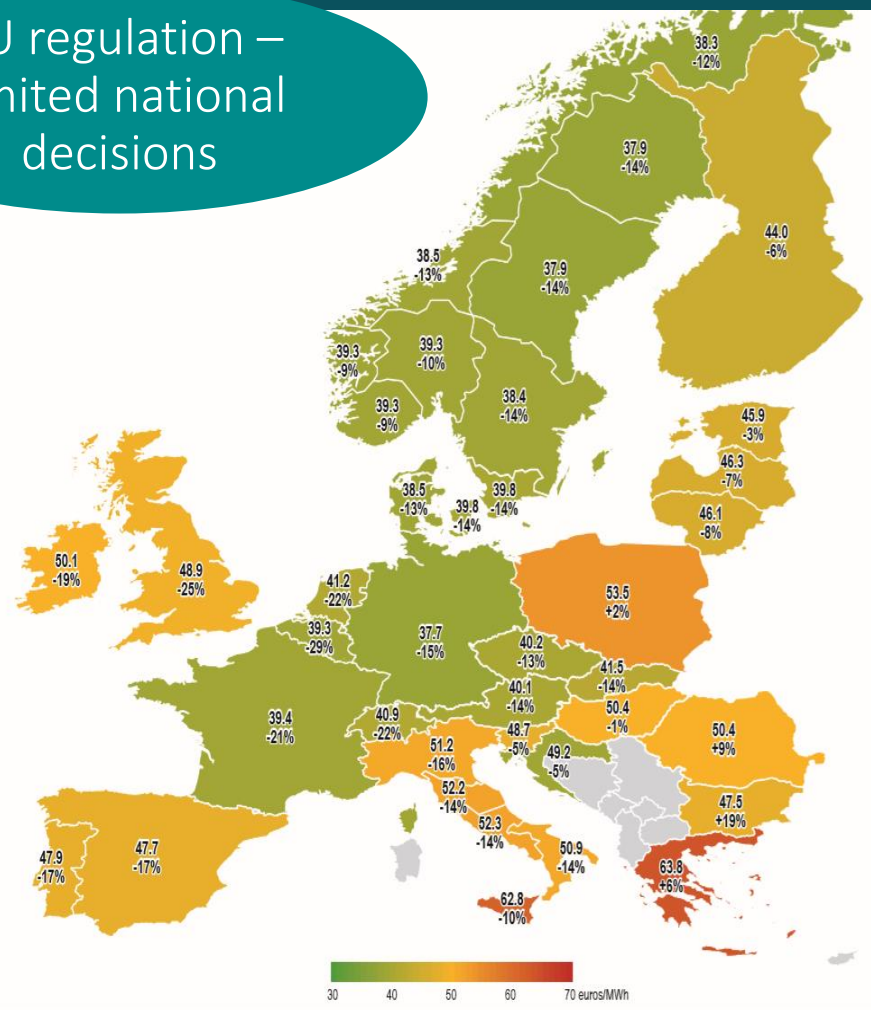
- European coordination of long term energy infrastructure planning (TYNDP)
- Identification and financing of Projects of Common Interest
- Non-binding target of minimum 10% (and in 2017 increased to 15%) of import capacity compared to total generation capacity

2019: European Green Deal

2021: RenewEurope

EUROPEAN COMMON ELECTRICITY MARKET AND SYSTEM OPERATION

EU regulation –
limited national
decisions



Source: ACER calculations based on data by the European Network of Transmission System Operators for Electricity (ENTSO-E).

EUROPEAN GRID DEVELOPMENT COORDINATION

EU coordination
National decision on
grid investments



Content of the TYNDP 2022

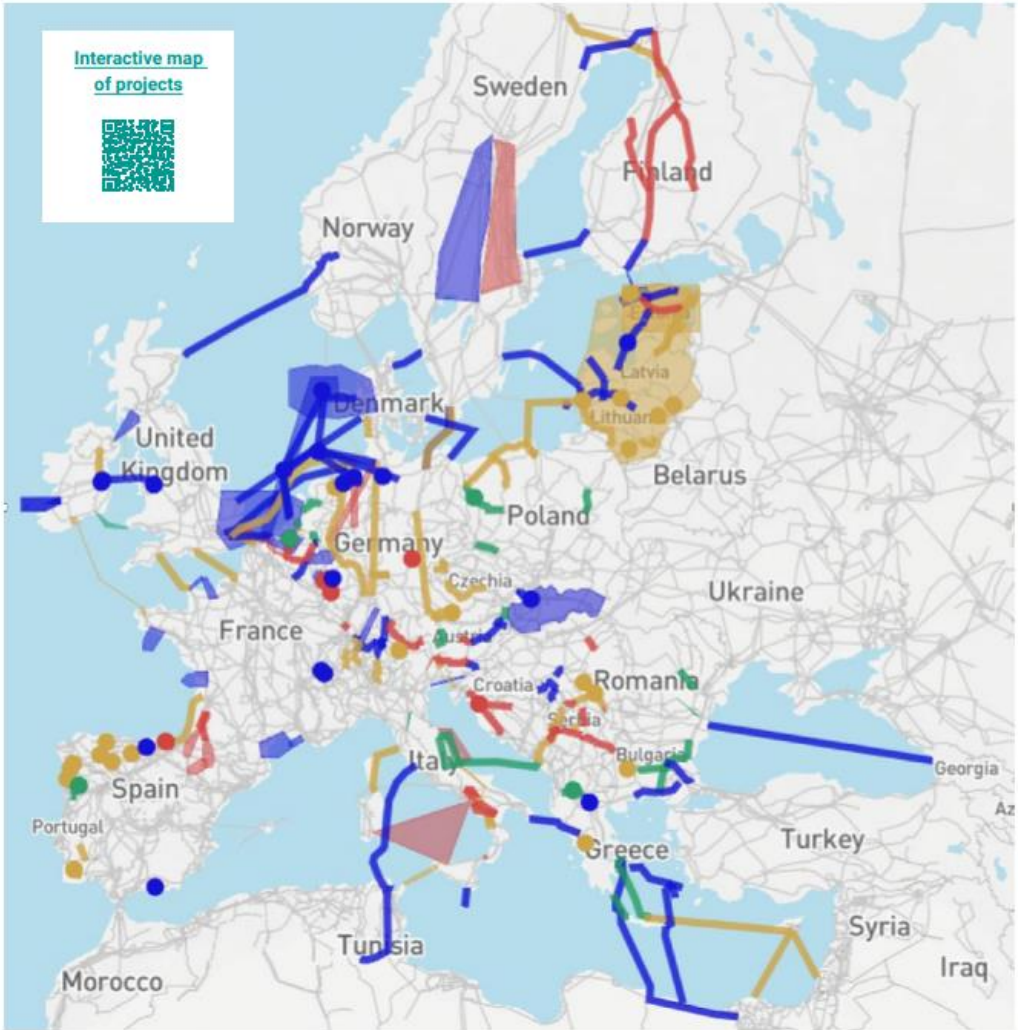
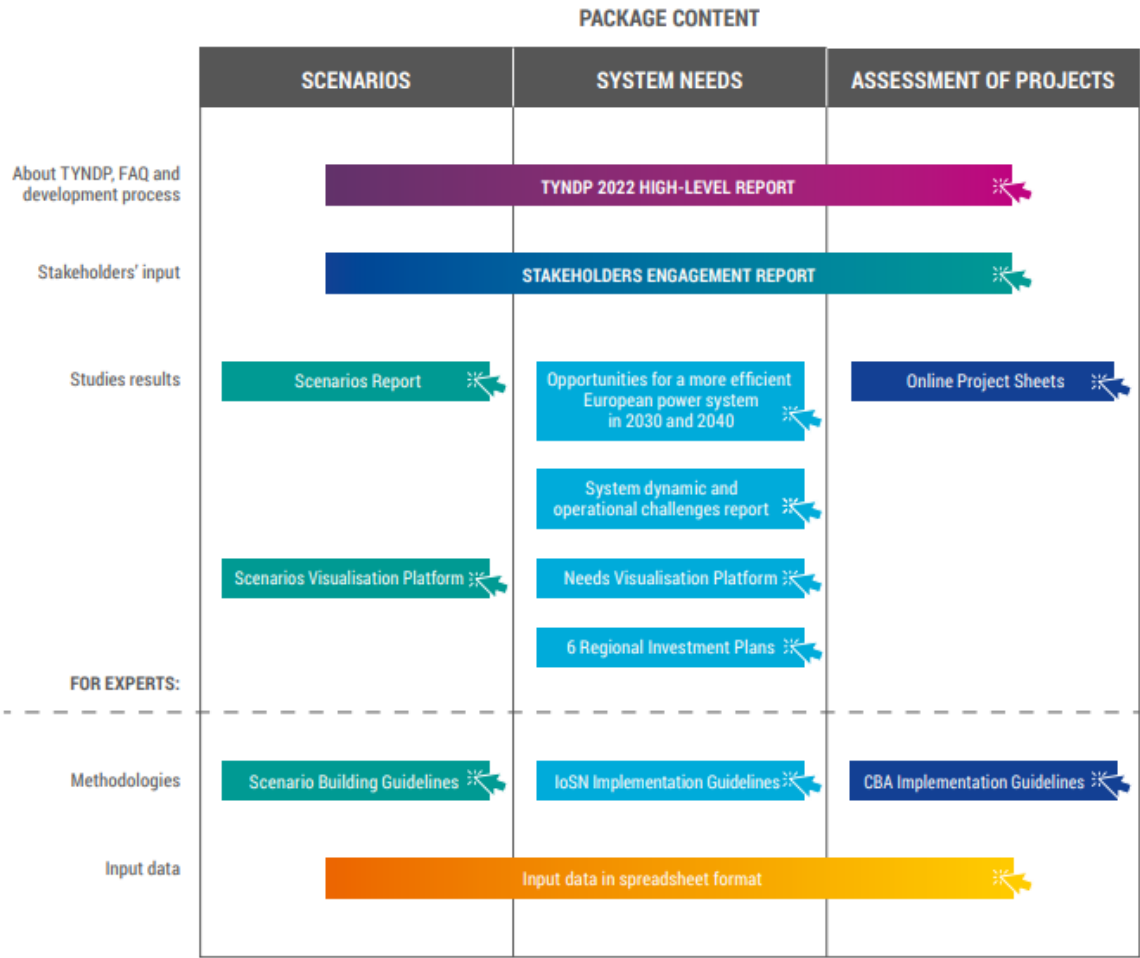


Figure 3 – Map of TYNDP 2022 transmission projects. Areas indicate projects for which the route is not yet known (green: under construction; yellow: in permitting; red: planned but not yet in permitting; blue: under consideration).

PROJECTS OF COMMON INTEREST

Projects of common interest (PCI) are selected on the basis of 5 criteria:

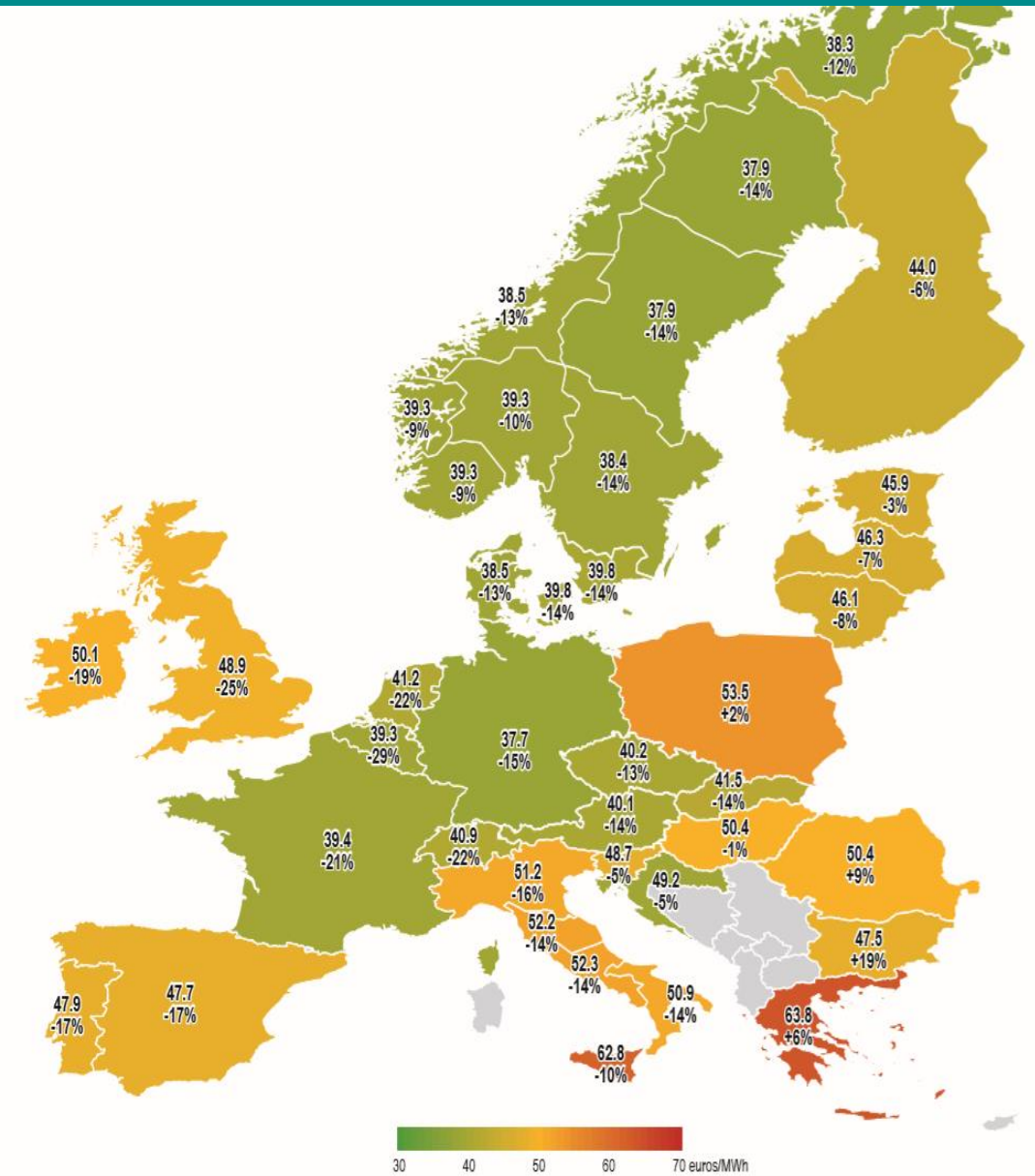
- Have a significant impact on at least 2 European Union member countries
- Enhance market integration and contribute to the integration of EU countries' networks
- Increase competition on energy markets by offering alternatives to consumers
- Enhance security of supply
- Contribute to the EU's energy and climate goals. They should facilitate the integration of an increasing share of energy from variable renewable energy sources.

BENEFITS FOR PCI

The PCIs will benefit from:

- Faster and more efficient permit granting procedures
- Improved regulatory treatment
- Possible access to financial support from the Connecting Europe Facility (CEF) - €5.85 billion budget for the period 2021-2027)

ELECTRICITY MARKETS – EFFICIENT UTILIZATION AND FINANCING OF CROSS BORDER TRANSMISSION



Source: ACER calculations based on data by the European Network of Transmission System Operators for Electricity (ENTSO-E).

RELATION BETWEEN EUROPEAN ELECTRICITY SYSTEM AND MARKET AREAS

Synchronous area:

- Frequency regulation and dimensioning

Load frequency control (LFC) block (≈country)

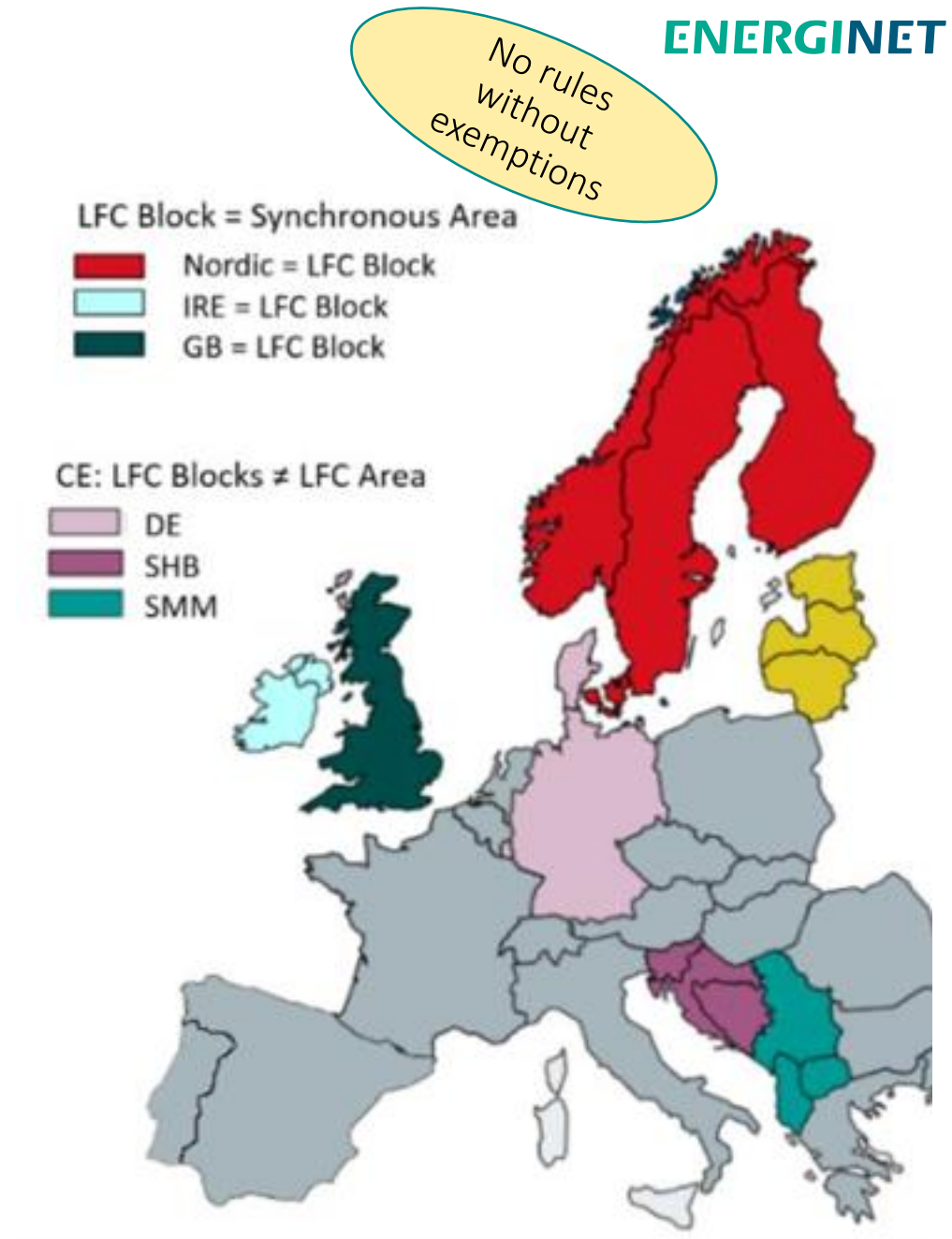
- Dimensioning of balancing restoration reserves

LFC Area (≈ TSO):

- Ensuring balancing, 15 min for restoration
- Monitoring of balancing (ACE: Area control Error)

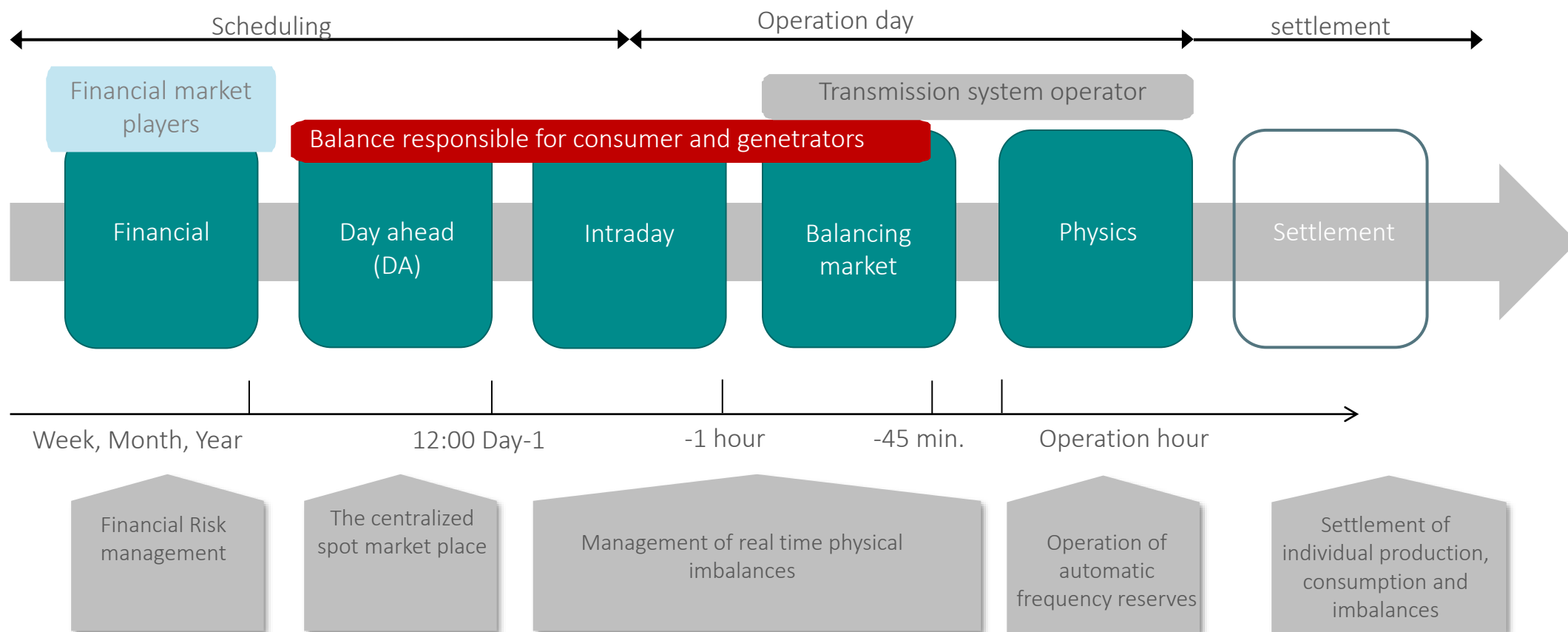
Market bidding area (≈ LFC area)

- Price areas in common European electricity market – in principle reflecting transmission congestions



MAIN MARKET OBJECTIVE IS EFFICIENT BALANCING OF EUROPEAN ELECTRICITY SYSTEM

The wholesale market is not just one market, but a number of markets based on zonal approach and marginal pricing



PRICES

DAY-AHEAD FLOWS

CAPACITIES

PHYSICAL EXCHANGE

16 NOVEMBER 2022

10-11

EUR

System price:

39.97

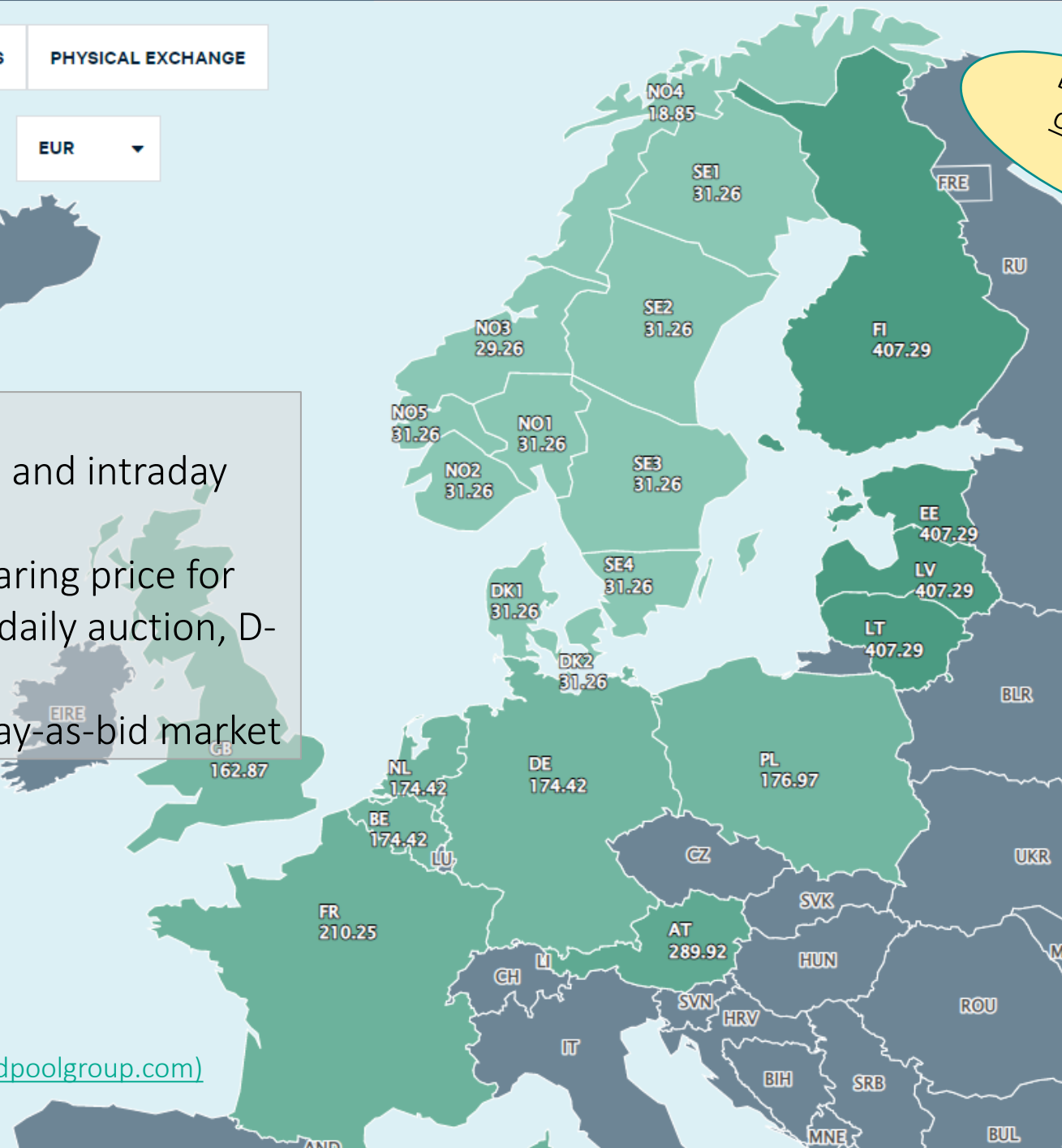
Power Exchanges:

- Handling of Day ahead and intraday market
- Day Ahead: Hourly clearing price for each hour day ahead (daily auction, D-1)
- Intra day: Continuous pay-as-bid market

[Day-ahead overview](#) | [Nord Pool \(nordpoolgroup.com\)](#)

ENERGINET

Example for
one single
hour



PRICES

DAY-AHEAD FLOWS

CAPACITIES

PHYSICAL EXCHANGE

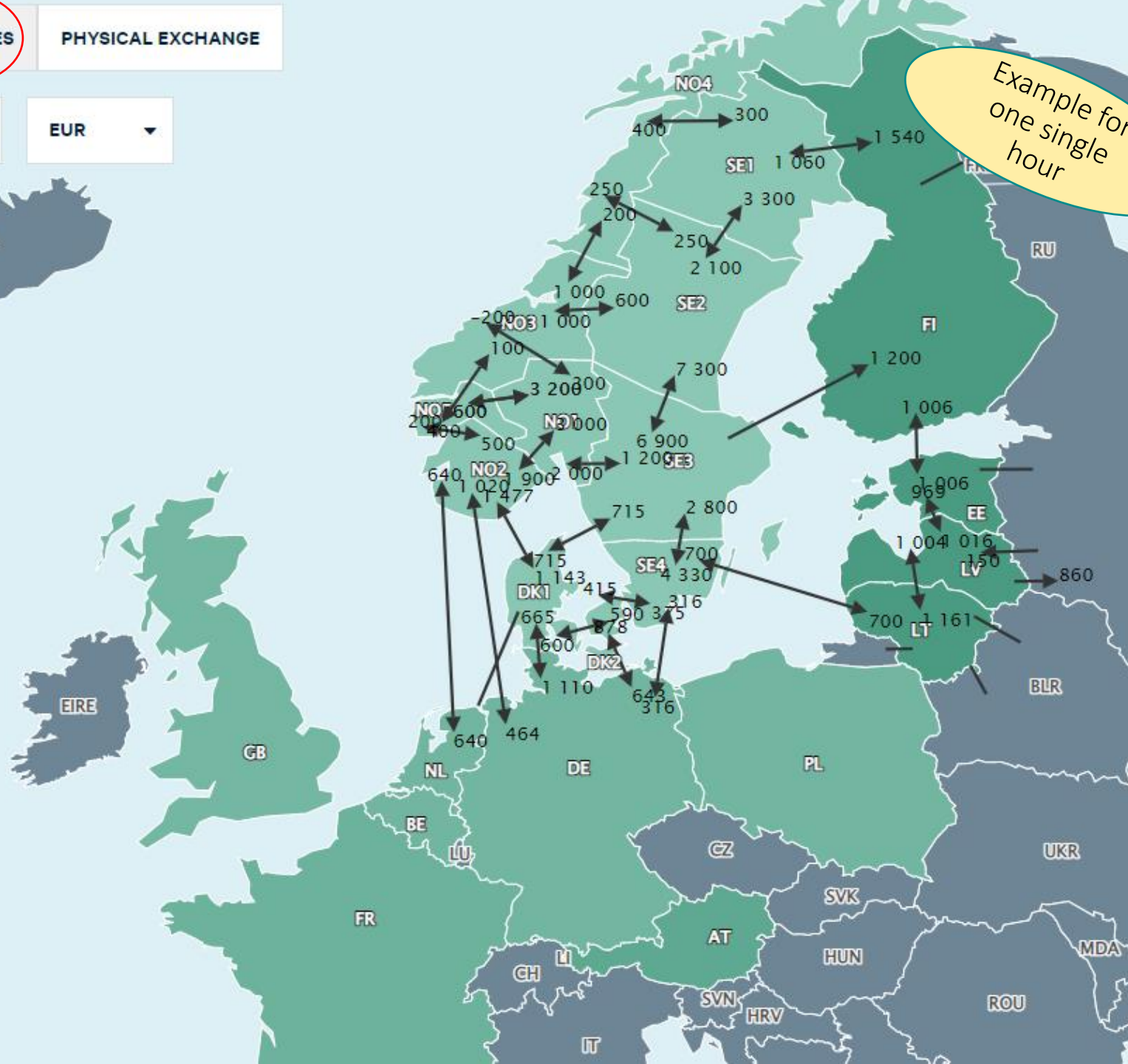
16 NOVEMBER 2022

10-11

EUR

System price:

39.97

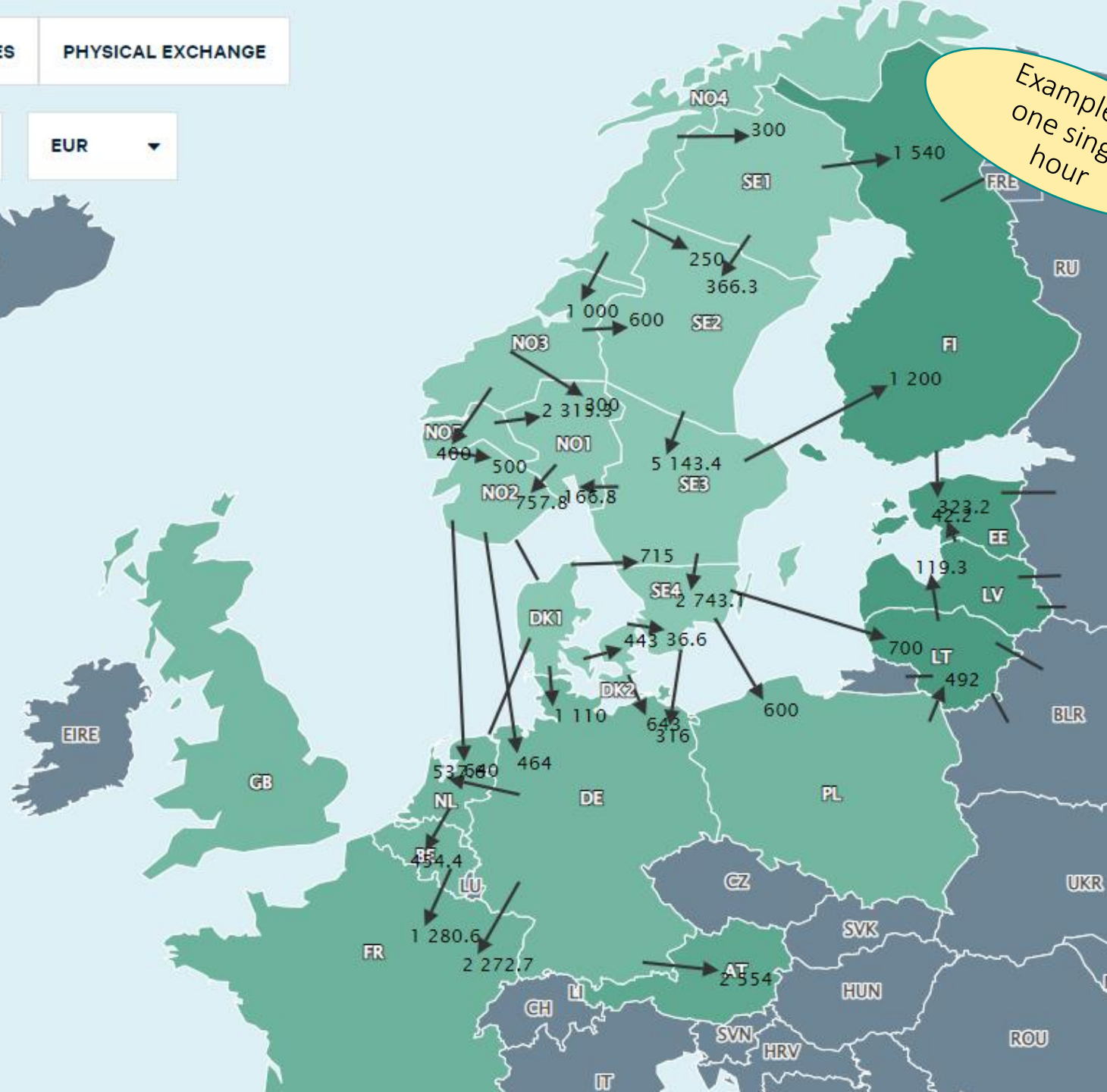


Example for
one single
hour

ENERGINET

EUR

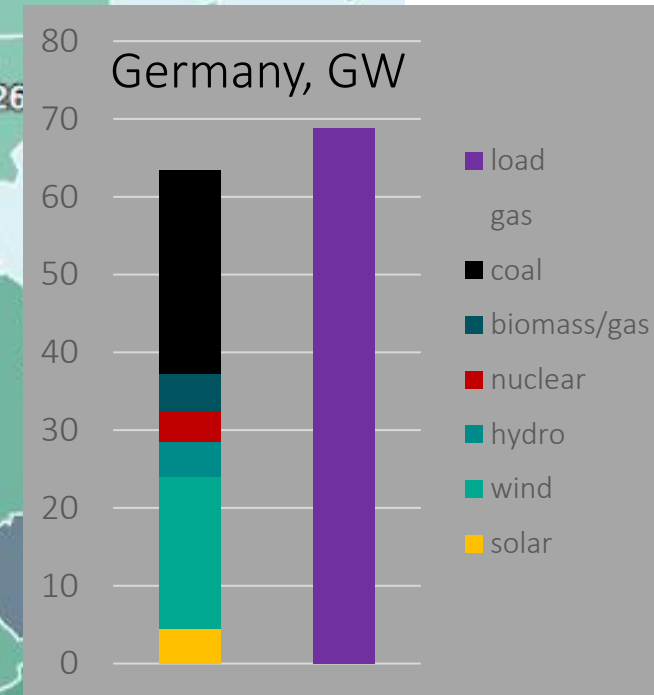
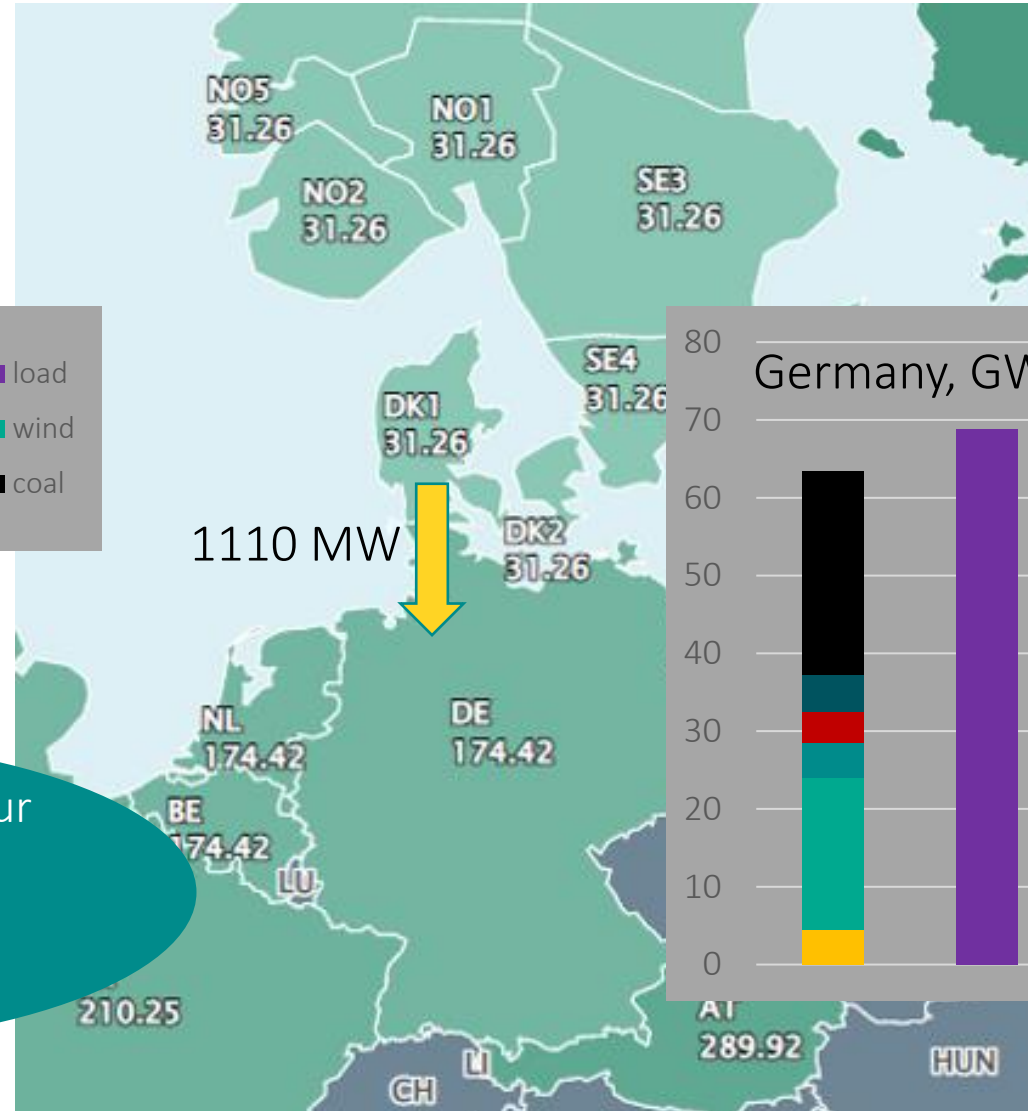
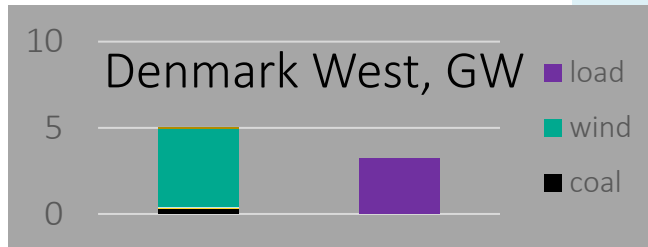
39.97



Example for
one single
hour

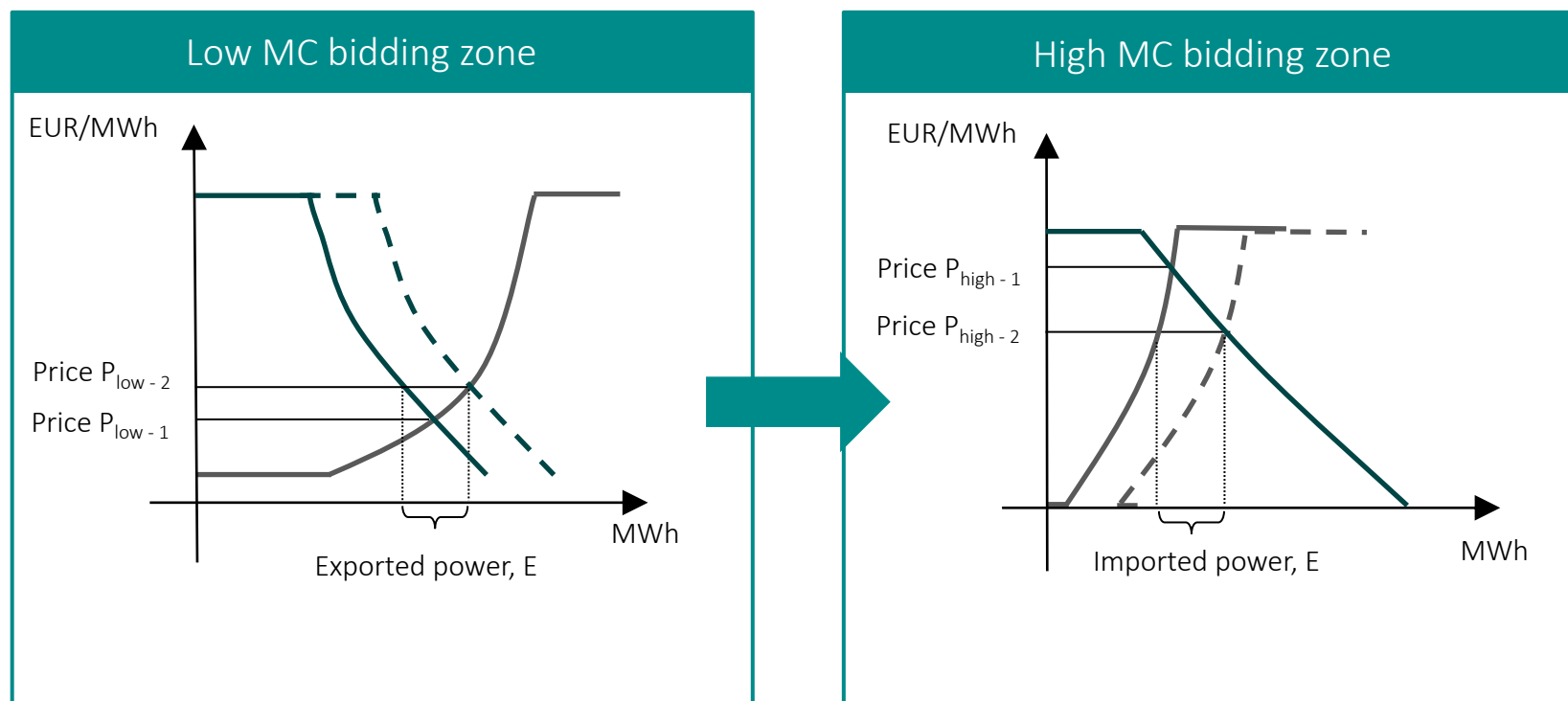
CONGESTION RENT – FINANCING OF INTERCONNECTORS

Example for
one single
hour



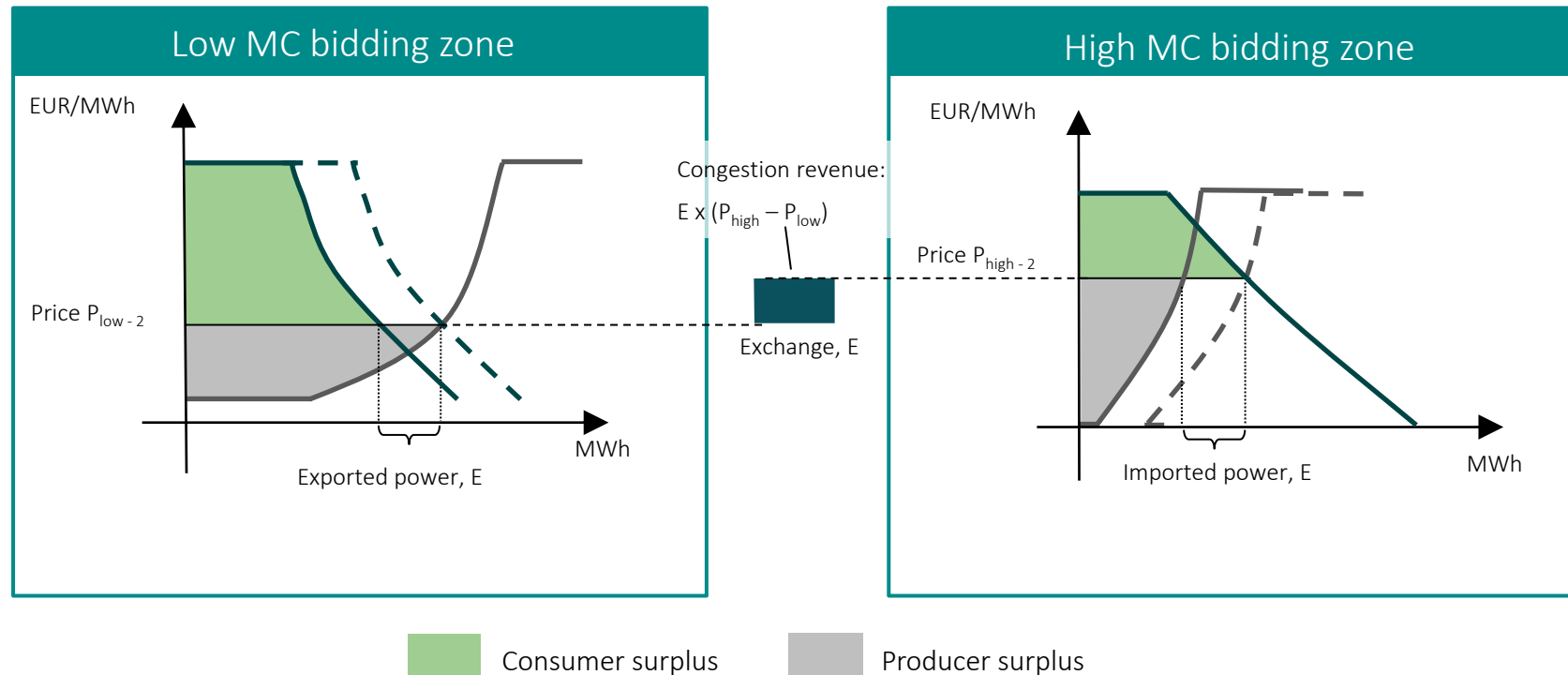
Congestion rent in one hour
16 Nov 2022:
 $1110 * (174,42 - 31,26) = 158.907$ Euro

MARKET COUPLING IN THE DAY-AHEAD MARKET



Interconnector capacity is automatically allocating to those with highest willingness to pay

CRITERIA FOR FINDING THE EQUILIBRIUM

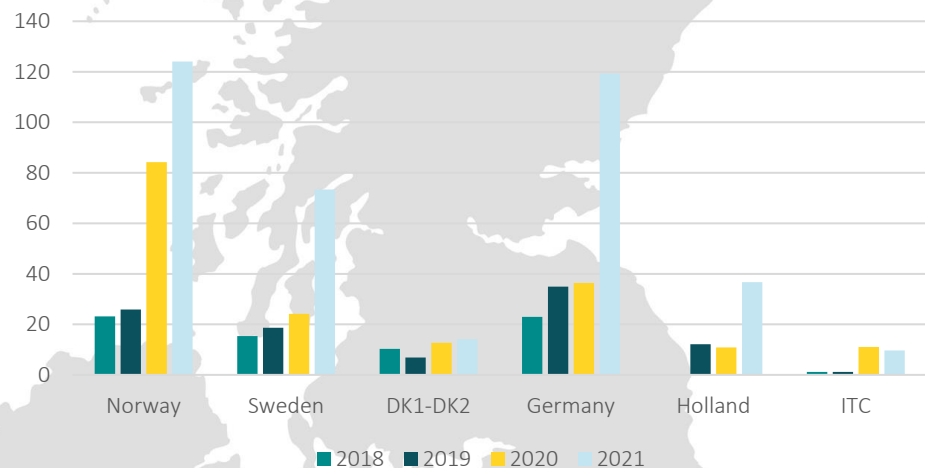


- Algorithm maximizes socioeconomic welfare taking capacity constraints into account
- Socioeconomic welfare is here the sum of consumer surplus, producers surplus and congestion revenue

FLOW ON DANISH INTERCONNECTORS

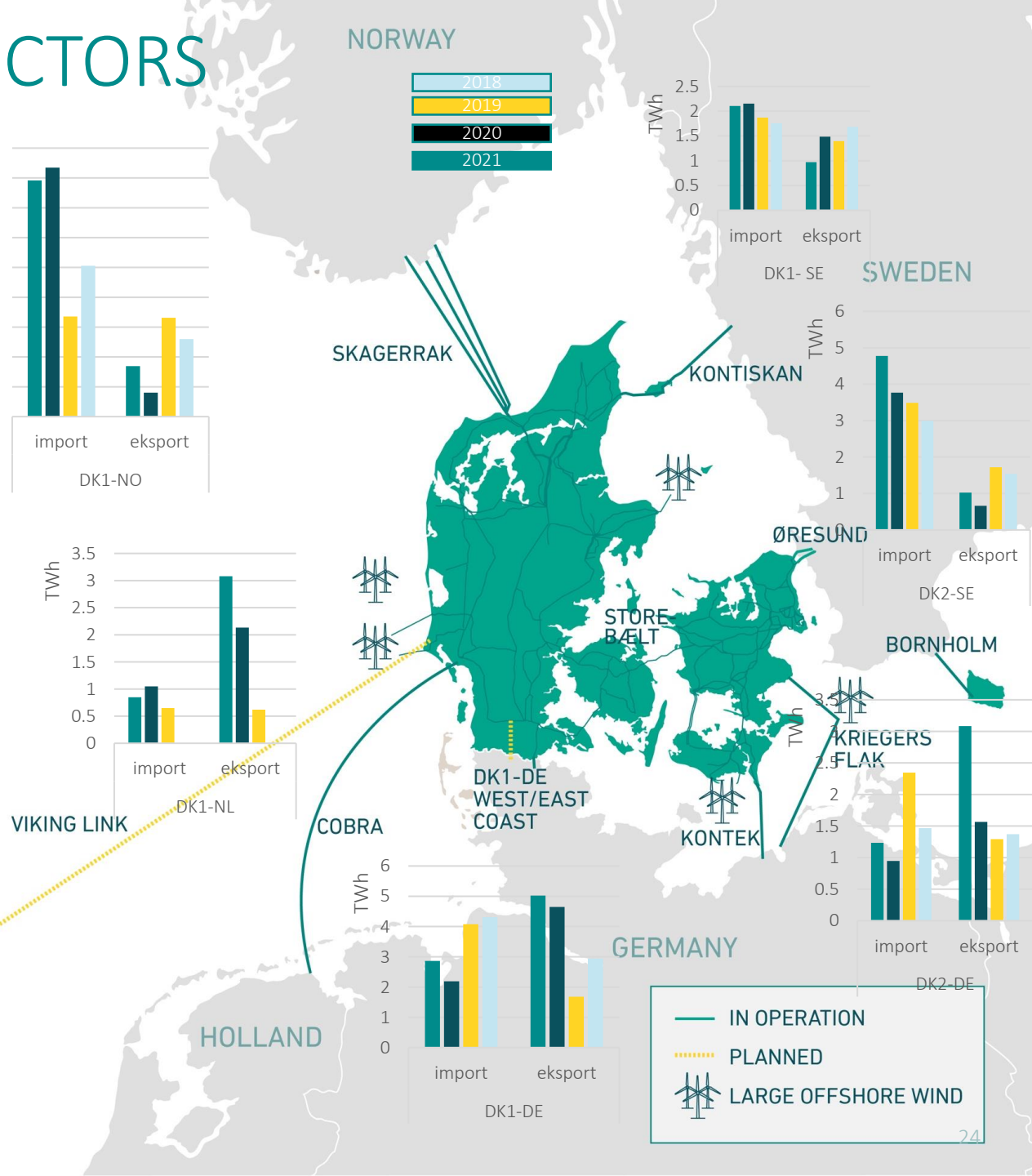
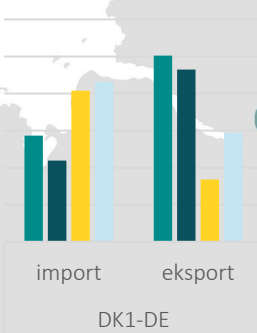
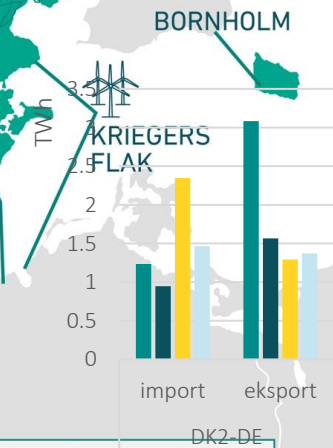
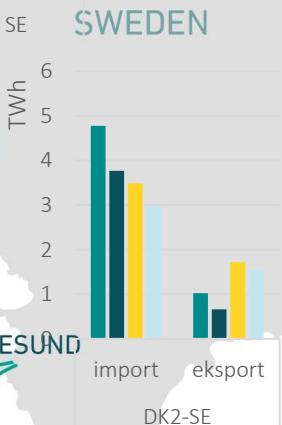
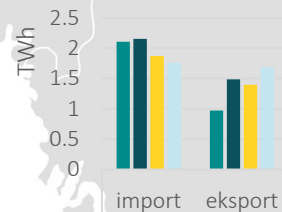
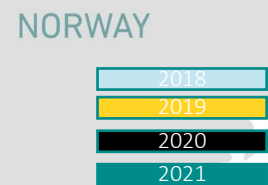
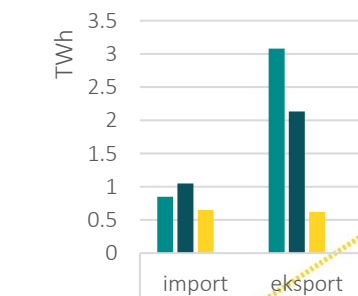
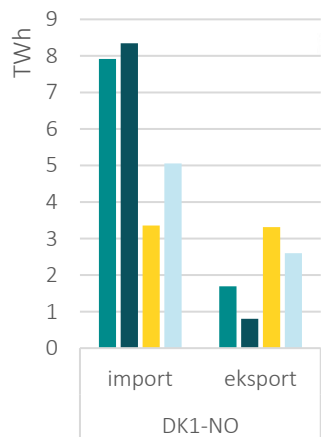
- DIRECTION CAN CHANGE FROM HOUR TO HOUR

Energinet share of congestion income from interconnectors, mio. Euro



Danish interconnectors mainly financed by congestions rent from price differences between market areas in the common European electricity market

Interconnectors also contribute to delivery of ancillary services, real time balancing and resource adequacy



70% RULE – EFFICIENT UTILISATION OF TRANSMISSION

Each TSO deliver annual report to ACER on fulfillment of 70% criteria (at the latest in 2025) respecting operational security levels)

If objective not fulfilled deliver report on background and actions and derogations and to be assessed by ACER

ACER to take dialogue with TSO and identify initiatives and solutions

[ACER Q&A - 70 percent target.pdf \(europa.eu\)](#)

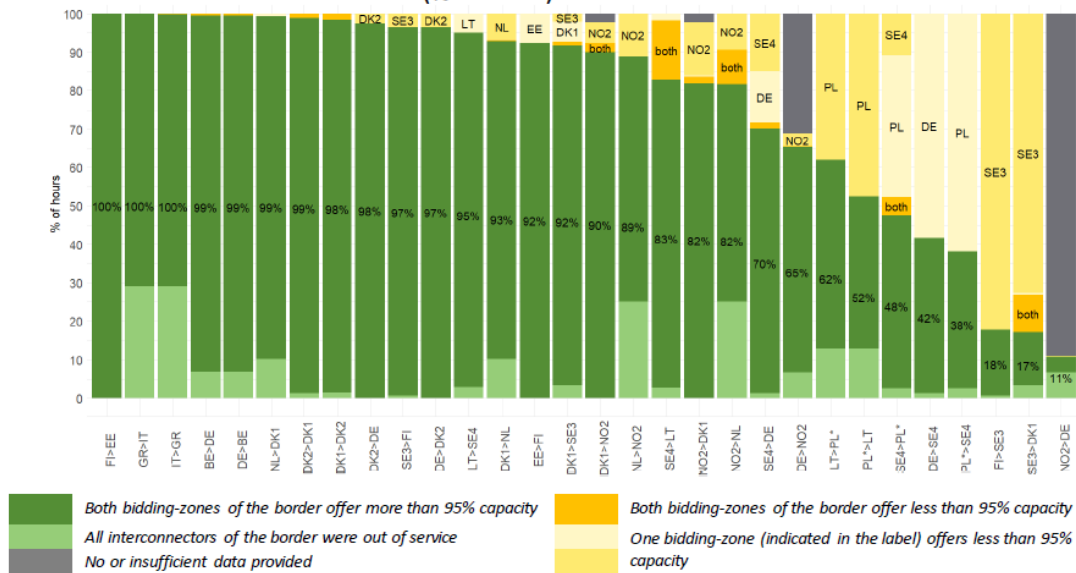
CALCULATION METHODOLOGY

- Each market bidding zone border is calculated separately (main rule)
- Based on Net Transfer Capacity (NTC) made available to the market
- Planned and Unplanned outage not included
- Calculated as hour-by-hour availability

[ACER Recommendation 01-2019.pdf \(europa.eu\)](#) – 39 pages!

ACER – MONITORING OF 70% RULE (AND MANY OTHER INDICATORS)

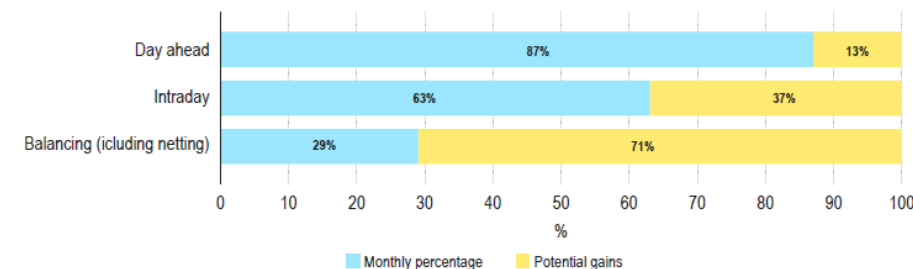
Figure 3: Percentage of the time when the margin made available is below 95% of the maximum admissible flow at the border – 2021 (% of hours)



Source: ACER calculation based on TSO data.

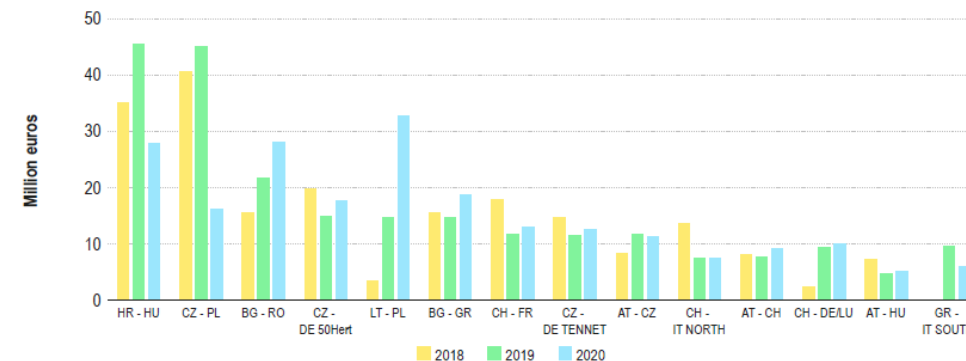
INCREASING THE COMMON SOCIO ECONOMIC BENEFIT

Figure ii: Level of efficiency in the use of interconnectors in Europe in the different timeframes – 2020 (% use of available commercial capacity in the 'right economic direction')



Source: calculations based on national regulatory authorities, ENTSO-E and Vulcanus data.

Figure 25: Estimated social welfare gains still to be obtained from further extending DA market coupling per border – 2018–2020



Source: ACER calculations based on ENTSO-E, NRAs and Vulcanus data.

Note: Only non-coupled borders are shown. The borders within the Core (excl. CWE) region with 'multilateral' technical profiles are not included in this figure, because the methodology applied to the other borders, based on NTC values, is not applicable to these (excl. CWE) borders for this calculation (DE/LU-CZ, DE/LU-PL, PL-SK).

SHORT TERM ADEQUACY FORECAST, SUMMER 2022

Example

- With increased interdependency in Europe adequacy assessments on European level
- Level of security of supply a national decision
- Capacity markets/strategic reserves approved by EU Commission

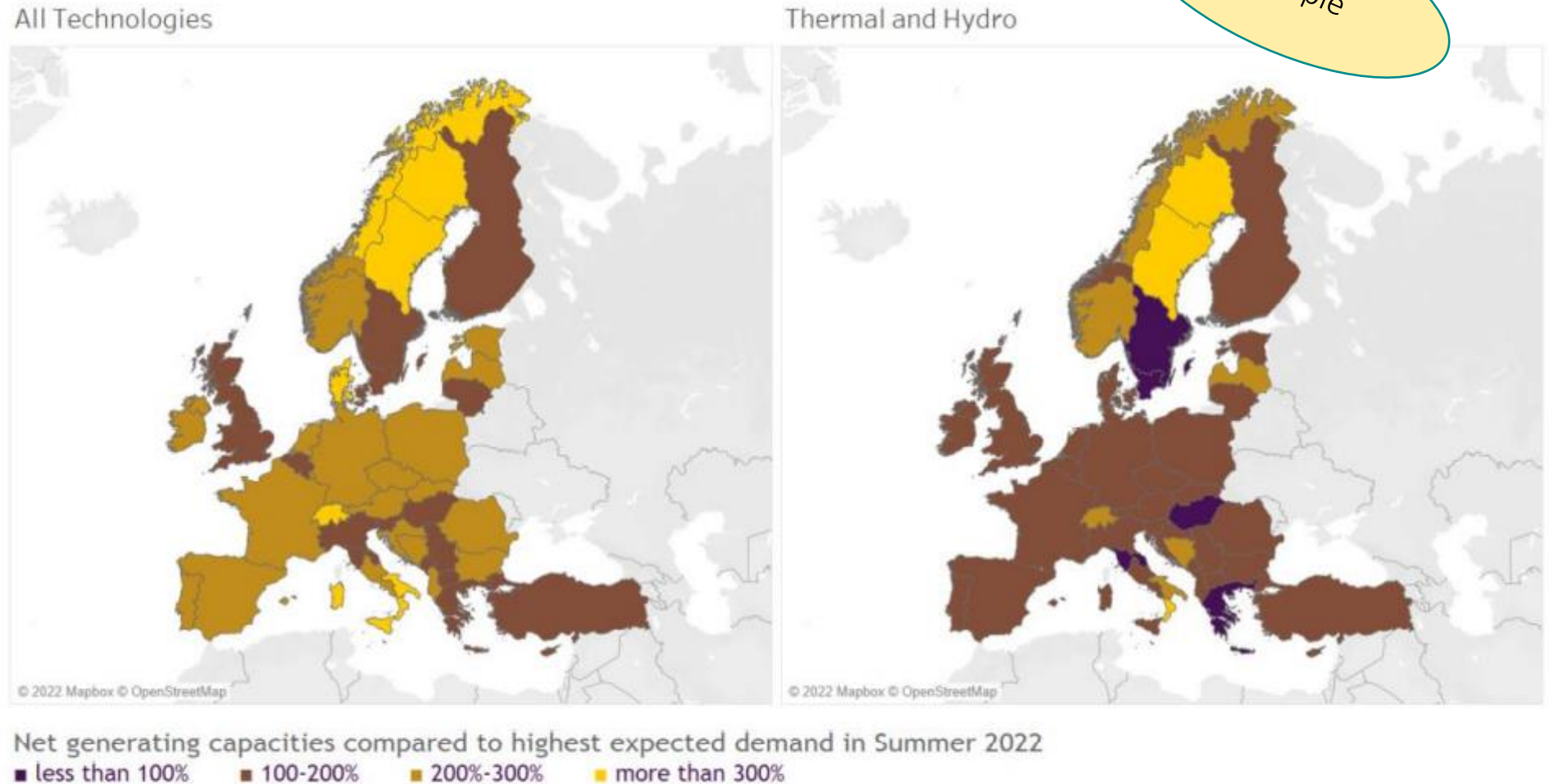
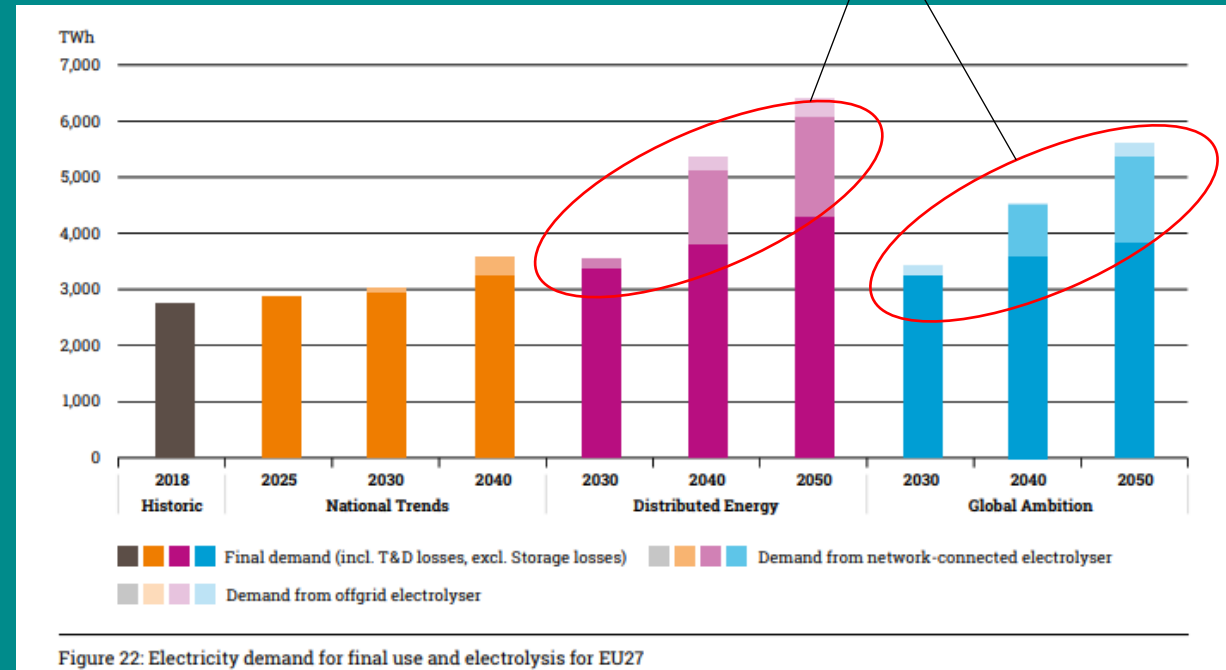


Figure 1: Net generating capacity overview – comparison with highest expected demand

[1 Summer-Outlook-Report 2022.pdf \(windows.net\)](#)

DEVELOPMENT BEYOND ELECTRICITY (ONSHORE) TRANSMISSION

Electricity for
hydrogen in TYNDP
2022 scenarios



EUROPEAN COORDINATION INCLUDING GAS AND HYDROGEN

FUTURE COORDINATION OF GAS, ELECTRICITY AND HYDROGEN INFRASTRUCTURE

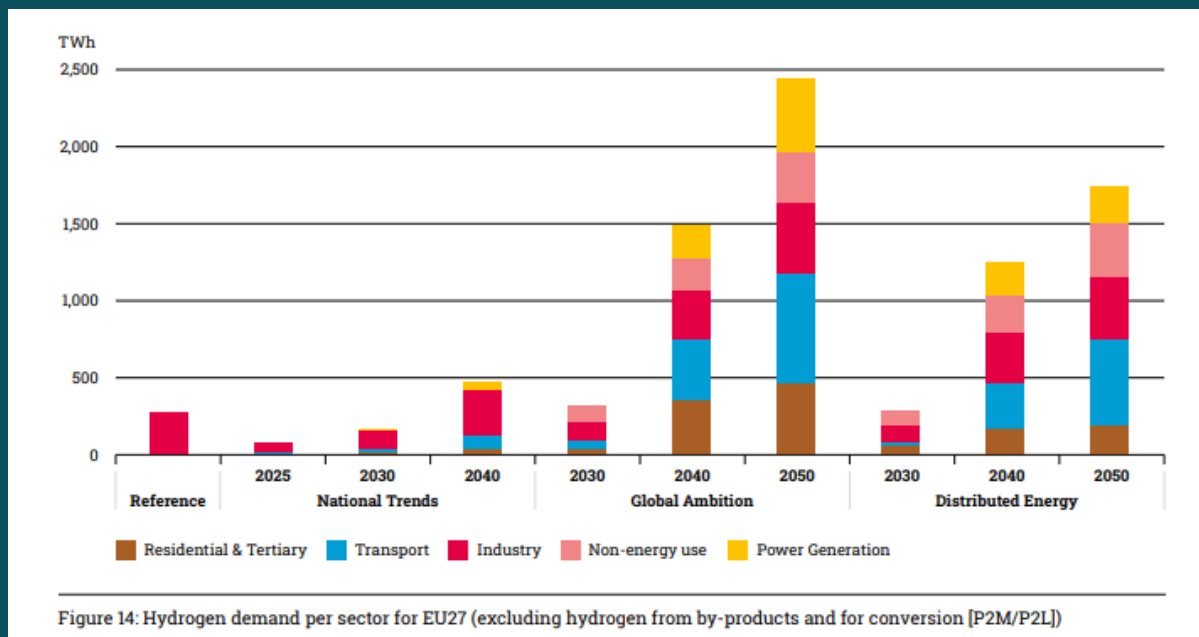


Figure 14: Hydrogen demand per sector for EU27 (excluding hydrogen from by-products and for conversion [P2M/P2L])

[TYNDP 2022 Scenario Report | Version. April 2022](#)
entsos-tyndp-scenarios.eu



OFFSHORE WIND CONCEPTS ANALYSED IN NORTH SEA WIND POWER HUB



North Sea Wind Power Hub

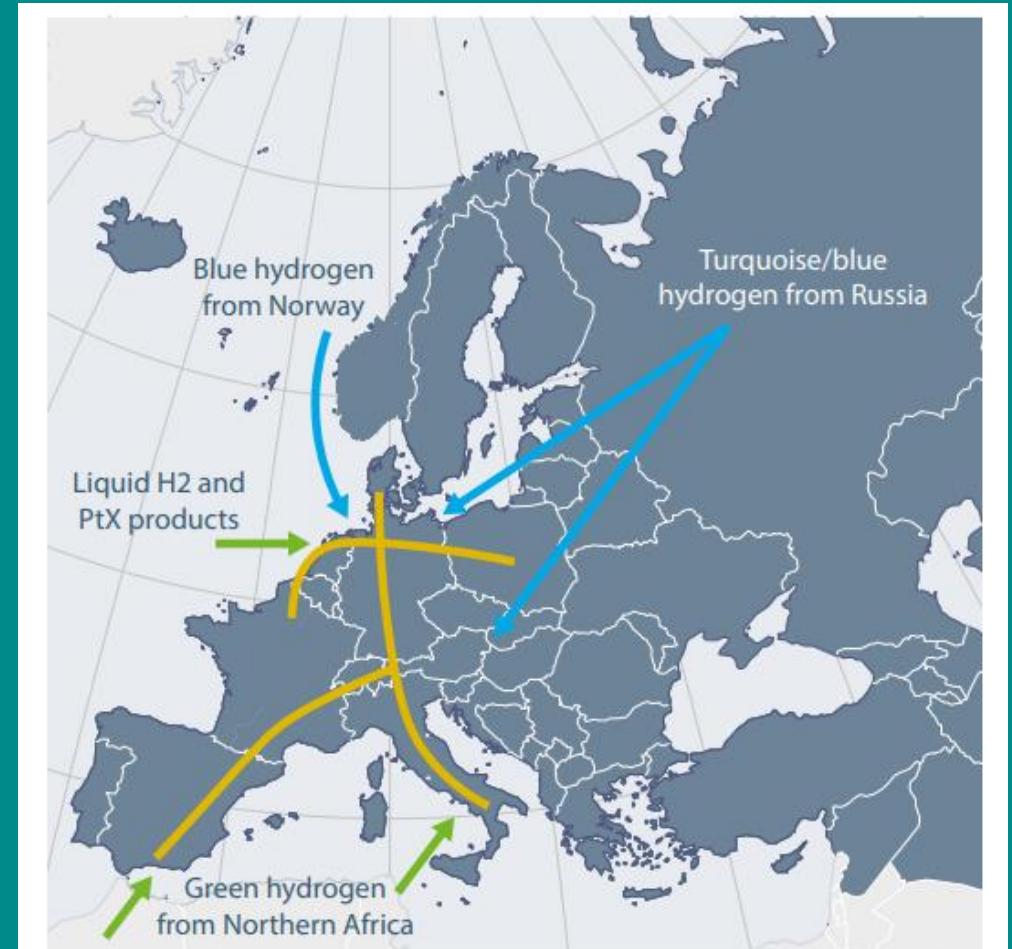


Illustration of possible hydrogen import routes for blue and green hydrogen to Europe via pipelines and ship. The yellow line illustrates one European 'hydrogen backbone'.¹⁷

ALL SOLUTIONS NEEDED....

Types of solutions



Construction solutions



Operation solutions

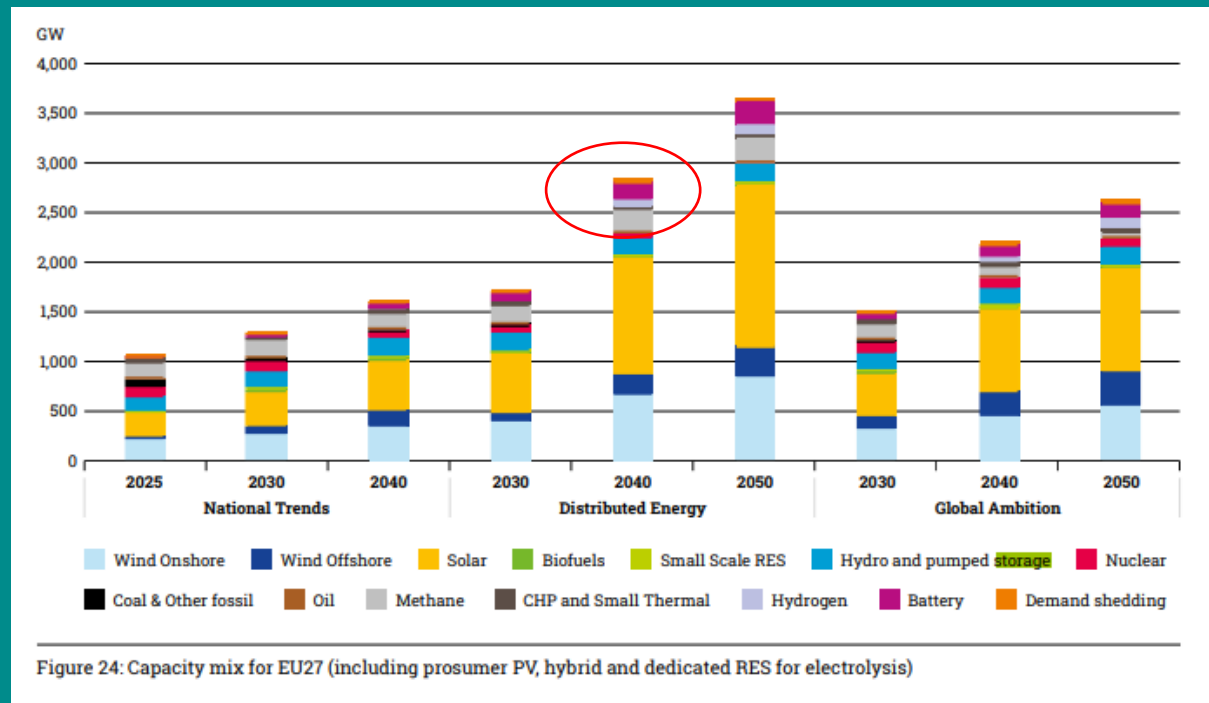


Market solutions

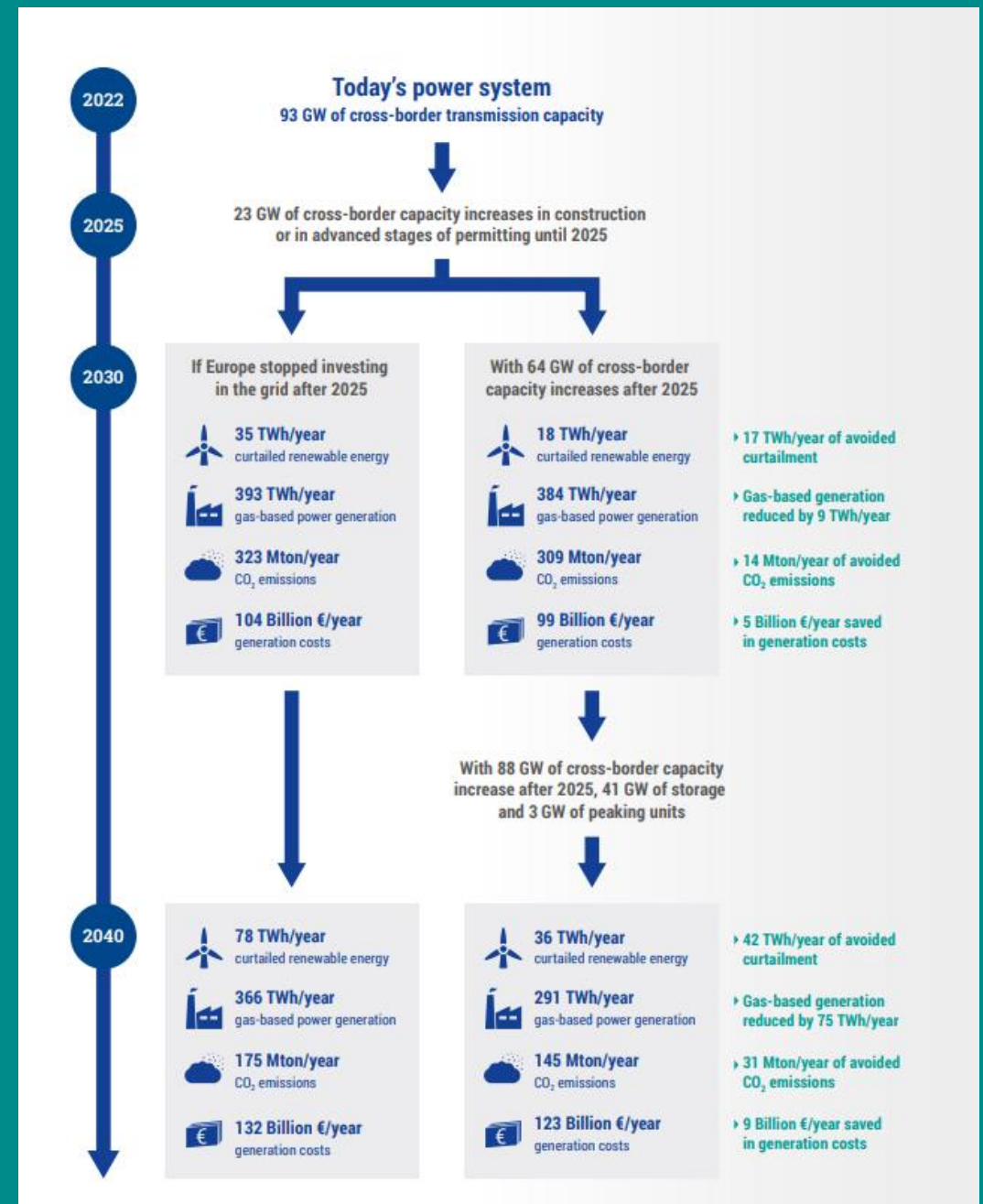


Initiatives based on dialog with
actors and third-party solutions

STORAGE AND FLEXIBILITY



SUM UP



SUM UP

- Increasing transmission capacity and cross border electricity exchange has been **high EU priority** for last 30 years
 - **Large socio economic benefit** and improved **security of supply** from transmission across countries
 - Most important regulation:
 - **Electricity market and system operation** guidelines gives financial incentives
 - European regulation and coordination creates **transparency** and platform of over-national agreements
 - In **green transition** need to think energy systems and infrastructure together for security of supply and affordability
- How to accelerate and support long distance transmission onshore and offshore?
 - How to ensure internal national grid build out?
 - How to support sector coupling and flexibility?

The challenges



LEARNINGS BETWEEN US AND EUROPE

THE CHALLENGES ARE THE SAME –
THE DIFFERENCES ARE THE
INSPIRATION

Organisation:

- US is a mix of RTO, ISO and national balancing authorities (room for many different solutions)
- Private owned transmission companies (move fast)

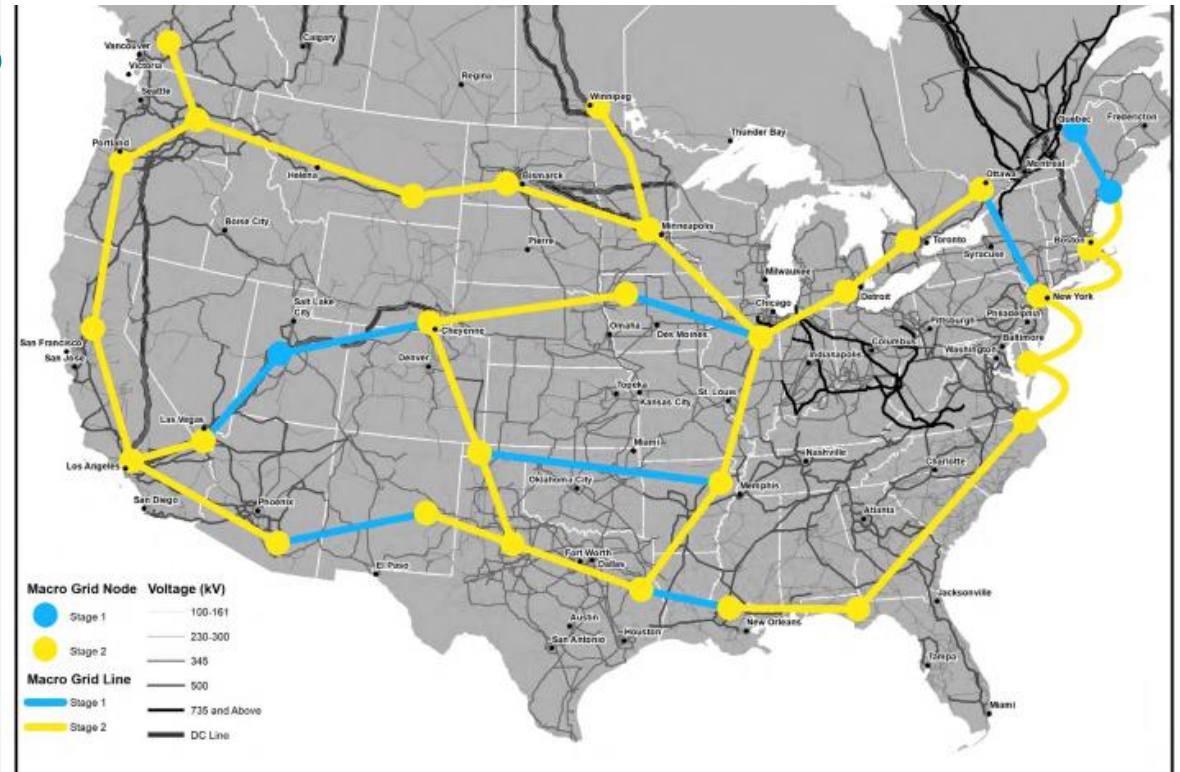
Financing:

- Federal regulation of tariffs (harmonized across the country)
- Inflation Reduction Act – support for interregional transmission (financial support)

Planning:

- First step taken for national transmission development plan (long distance and not just cross border)

Examples for
illustration



BACK UP

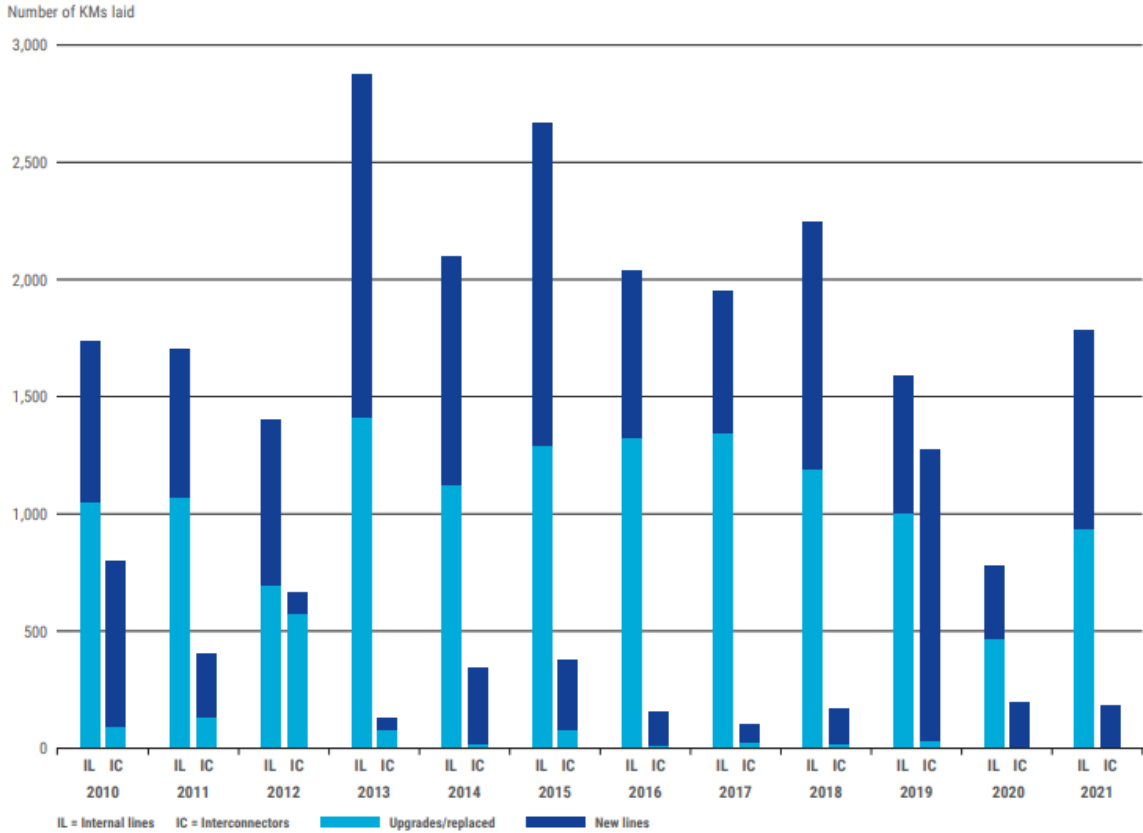


Figure 10 – Projects commissioned each year from 2010 to 2021 in km of line

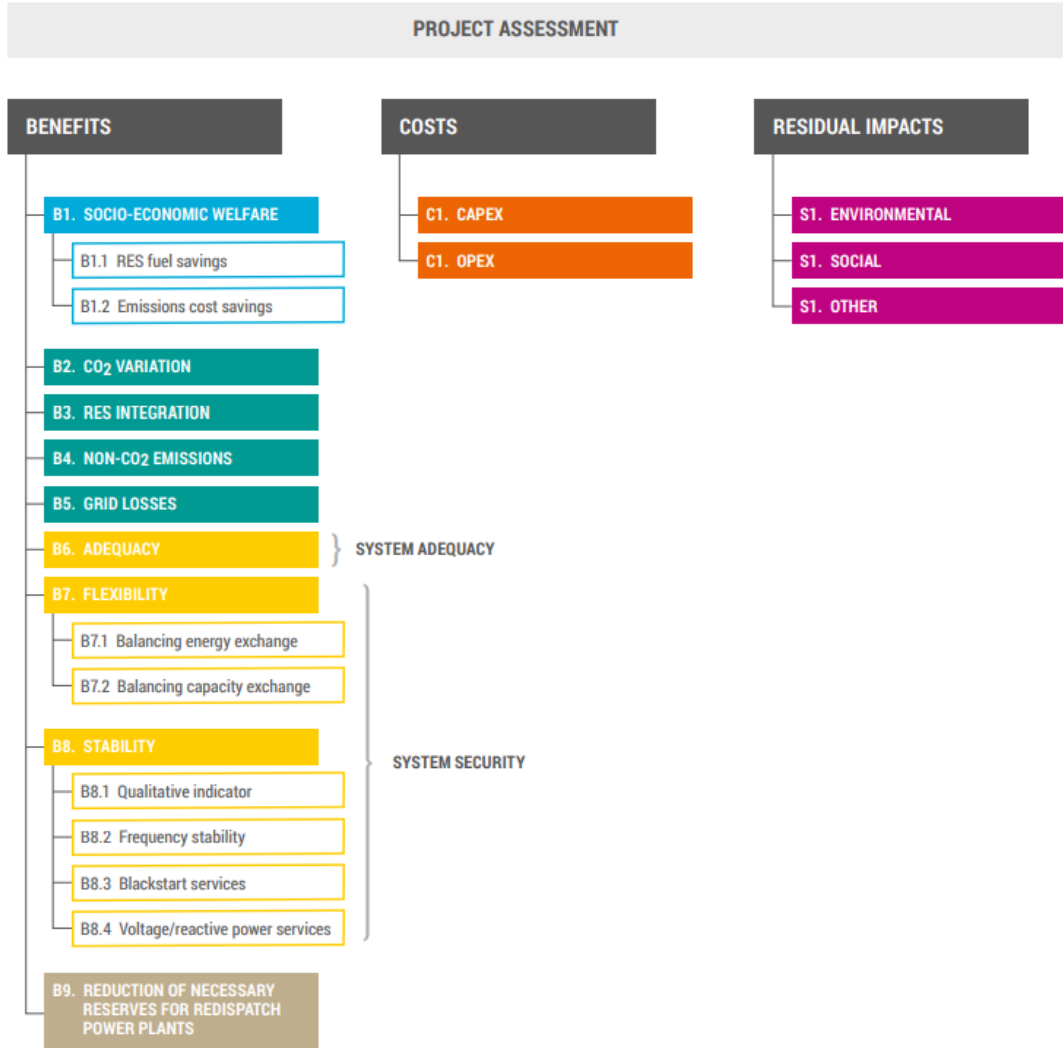


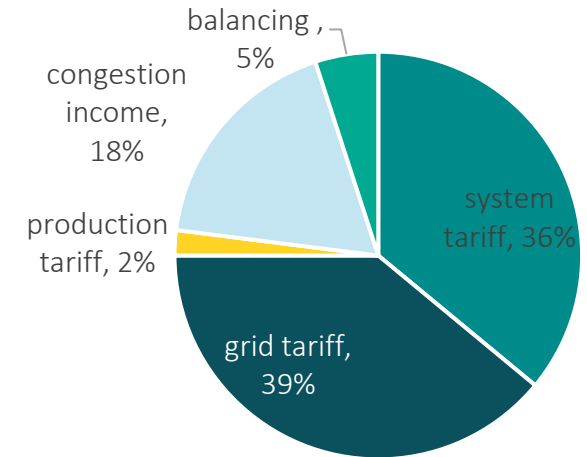
Figure 11 – Assessment framework categories of TYNDP projects

ENERGINET - FINANCING OF GRID AND SYSTEM OPERATION

- Energinet electricity system operation and transmission grid are non-profit regulated
- Financed mainly by a electricity consumption tariff and congestion income from interconnectors.
- Tarif is appr. 14 Euro/MWh (appr. 30% of electricity market price in 2019)
- Tariff is divided in system tarif and grid tarif
- Tariff is expected to increase pr. MWh with increased grid investments and system costs.
- Grid investments are financed by bank loans and depreciated based on expected lifetime

ENERGINET

Financing,
630 mill. Euro,
2019



Costs,
630 mill. Euro,
2019

