
Making Future

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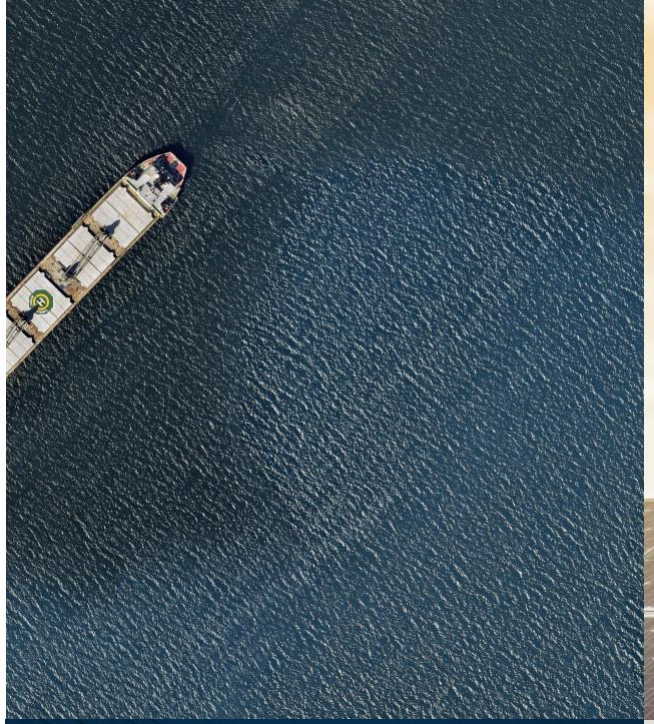
Future of Interconnectors (FIC)

Phase #1 stakeholder webinar 5th October 2022

NGESO & AFRY

Agenda



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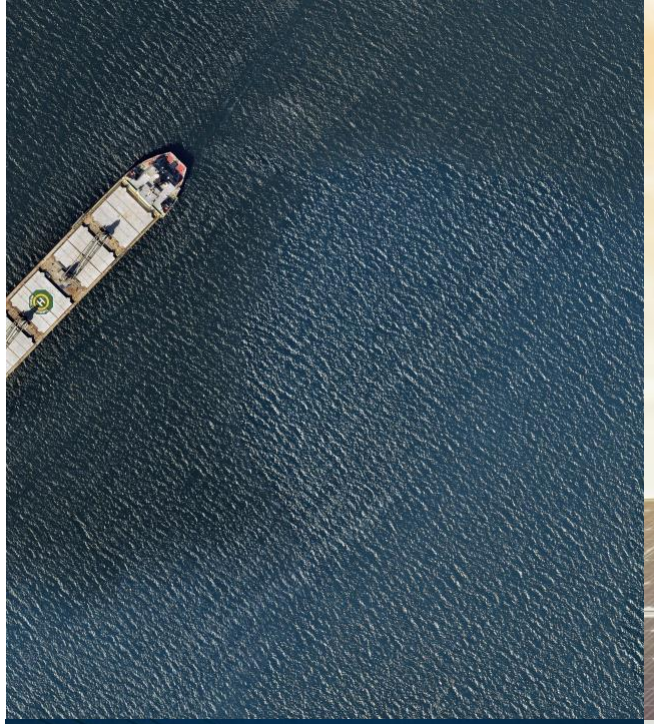


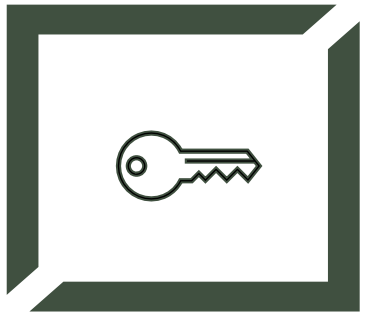
The system is evolving towards net zero and interconnection capacity is scaling up – creating both challenges and opportunities

Net zero creates challenges for the system

- Flexibility
- Operability
- Adequacy

Interconnection capacity expected to increase

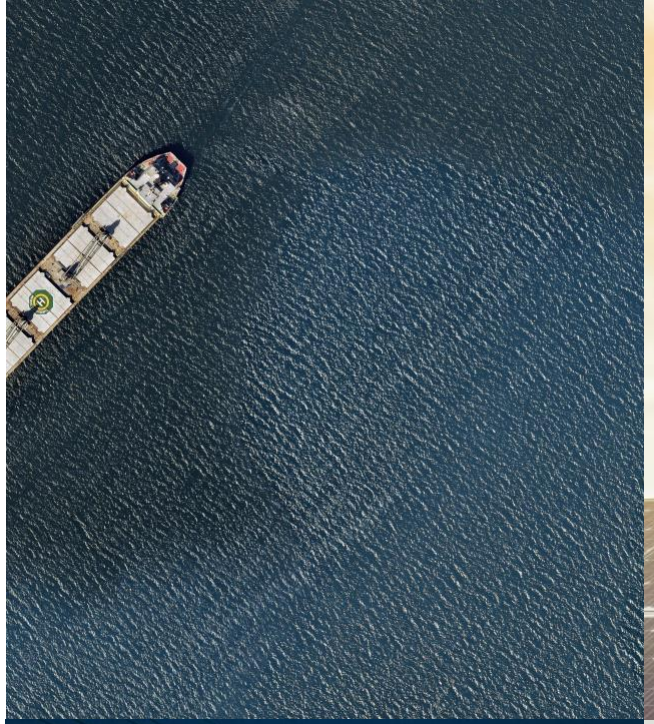
- Today: 8.4GW
- Gov. ambition: 18GW by 2030
- FES 2022: 13-25GW by 2035



Interconnectors can play an important role in managing the system

- Generate challenges *and* opportunities
- Potentially important role in transition to net zero, but…
- Dependent on a solid regulatory framework and efficient markets

Agenda

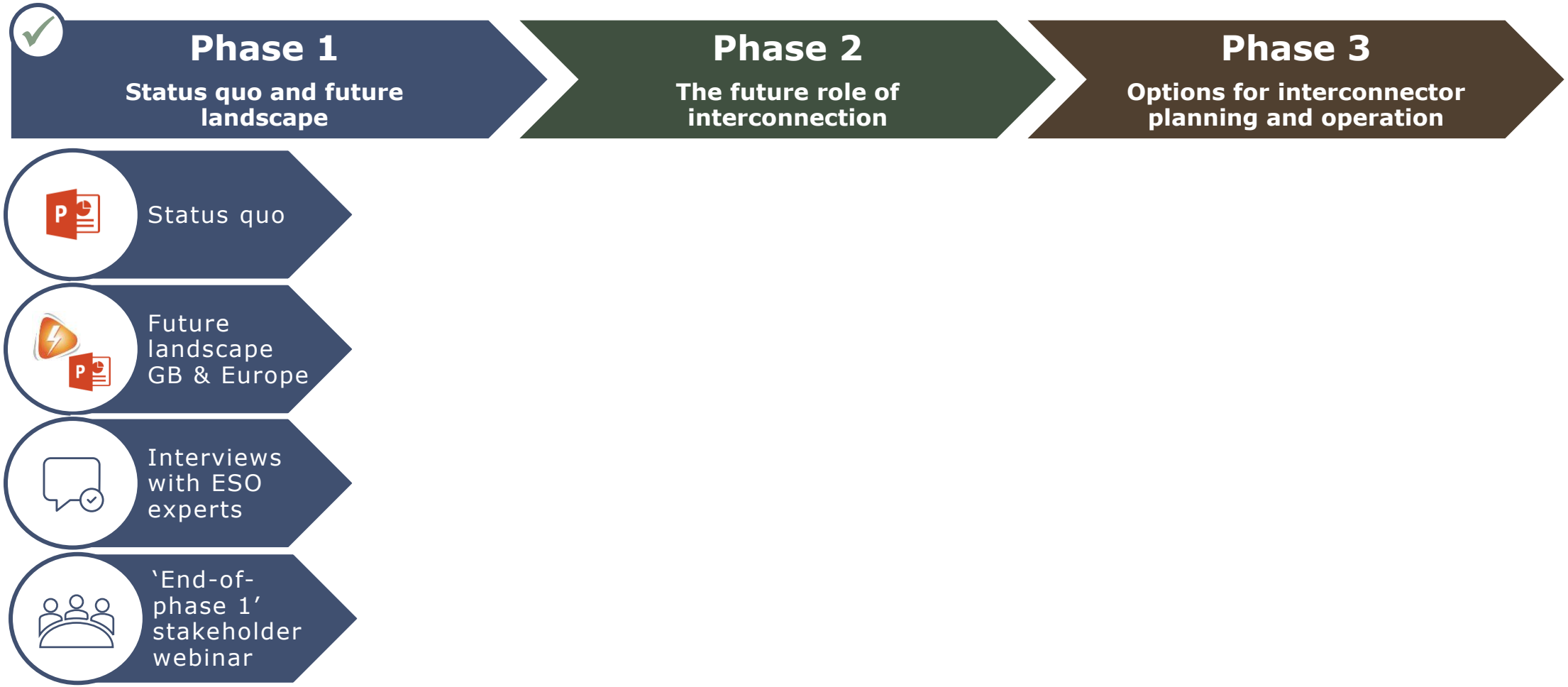


SCOPE AND TIMELINE

The project will be run as three distinct phases

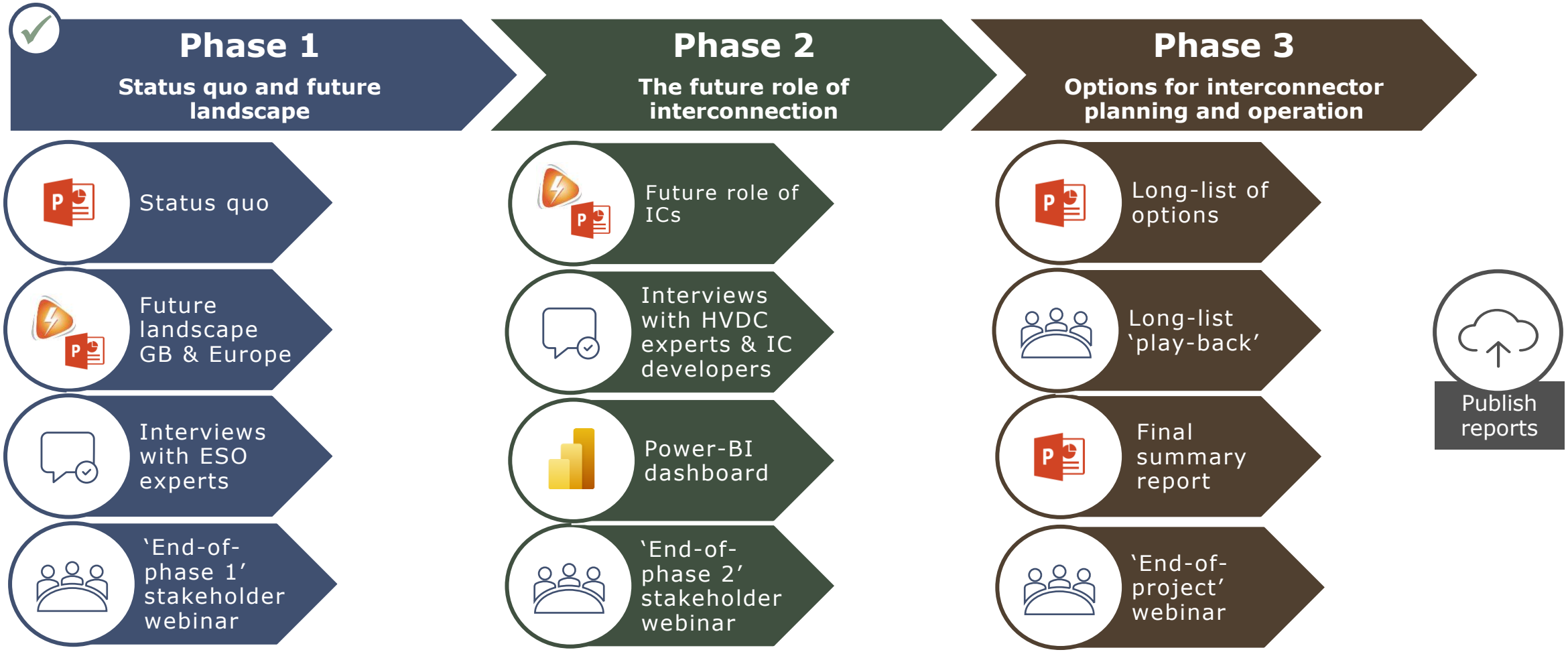
SCOPE AND TIMELINE

This stakeholder webinar sums up the results from Phase 1



SCOPE AND TIMELINE

The project will produce 5 reports



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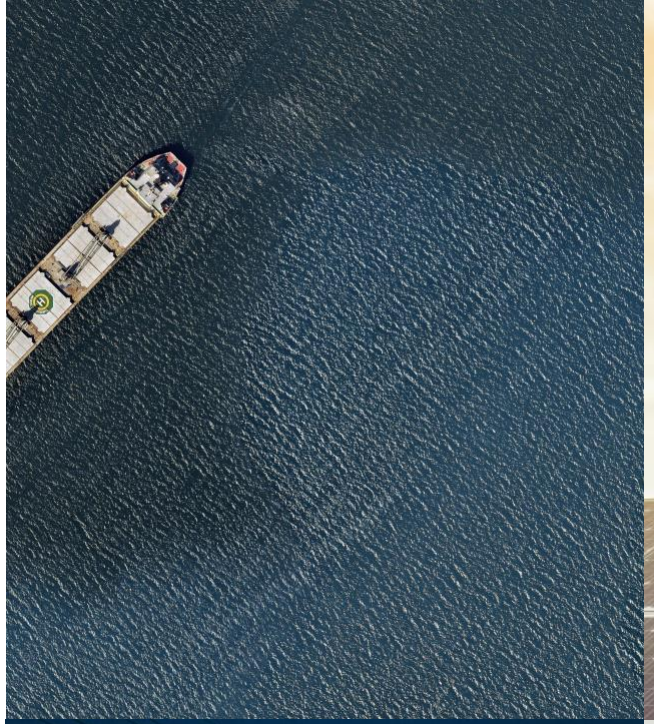


STATUS QUO

While some regulatory regimes and market mechanisms have been established, there are several challenges ahead that need to be addressed

Established

- Interconnection operation is a defined licensable activity, with the interconnector licence providing a clear regulatory framework for GB interconnectors
- The cap and floor regime was implemented in 2014 to support interconnector investment
- Following Brexit, EU regulation either amended in UK legislation or fully replaced by the TCA
- Decision to transfer to loose volume coupling

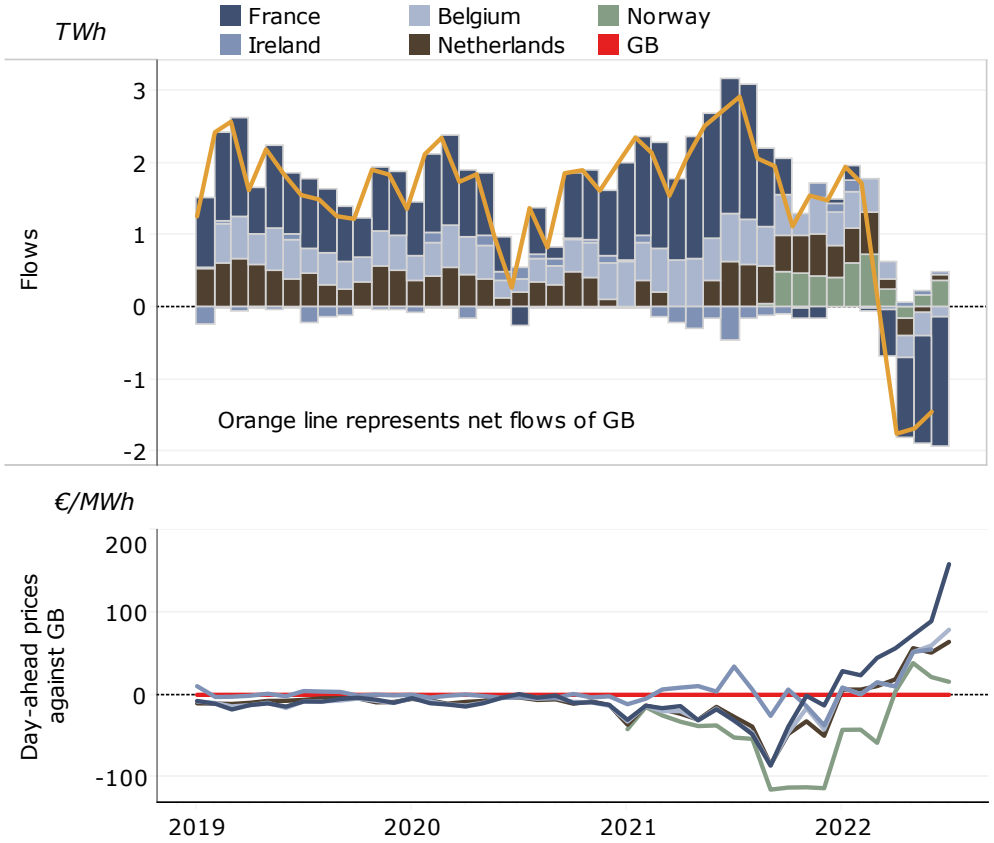
Challenges

- Each connected market has different regulatory arrangements, calling for different frameworks for development and operation of projects.
- Market arrangements post-Brexit vary between interconnectors, both in terms of timing and methodology, causing complexity
- TCA has limited term, and interconnector capacity allocation and calculation methodology beyond this remains unsettled. MPI's also remains unsettled.
- Interconnectors not eligible as BMU, thus needing bespoke market arrangements to utilise IC capabilities for system balancing purposes

STATUS QUO

GB has historically been a net importer from the continent, until recent changes in the fundamentals which have led to GB being a net exporter

MONTHLY NET FLOWS AND AVERAGE DAY-AHEAD PRICE DIFFERENCE BETWEEN GB AND INTERCONNECTED COUNTRIES

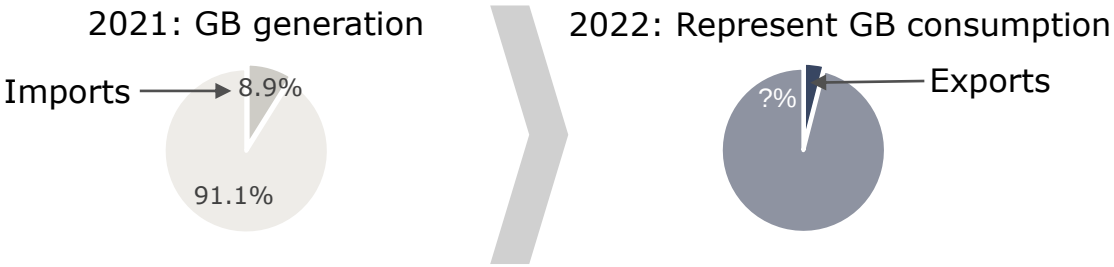


Note: Positive flows represent imports into GB, negative flows represent exports out of GB
Source: Flows from Elexon, Day-ahead prices from Entso-e and N2EX for GB

Fundamentals changing the flows

Currently caused by extreme prices in continental Europe

Impact



Importing country

Electricity generators: Reduced profit margins

Consumers: Cheaper electricity bill

Exporting country

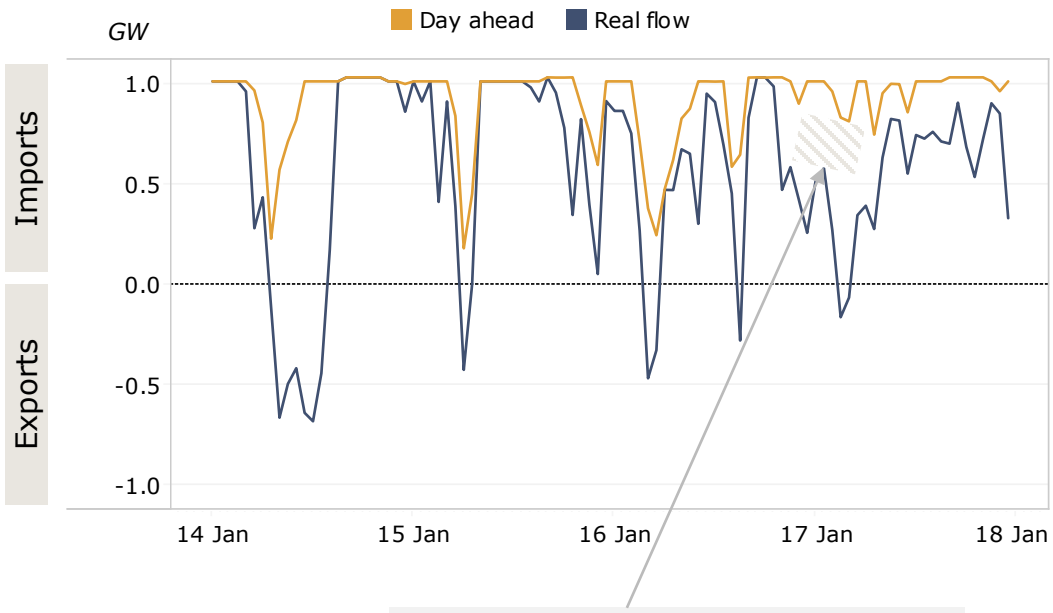
Electricity generators: Increased profit margins

Consumers: Larger electricity bill

STATUS QUO

Despite great similarity between day-ahead and real flows, there are periods that show significant deviation

HOURLY COMPARISON OF SCHEDULED DAY-AHEAD FLOWS AND REAL FLOWS ON THE NEMO IC IN A PERIOD IN JANUARY 2021



Example where NGESO decreased 0.3GW imports through 'Trades' in the hours over midnight

Intraday trading changing scheduled flow

- Intraday trading adjustments, due to:
  - Variable RES generation
  - Trading strategies and other market fundamentals
- NGESO 'Trades'

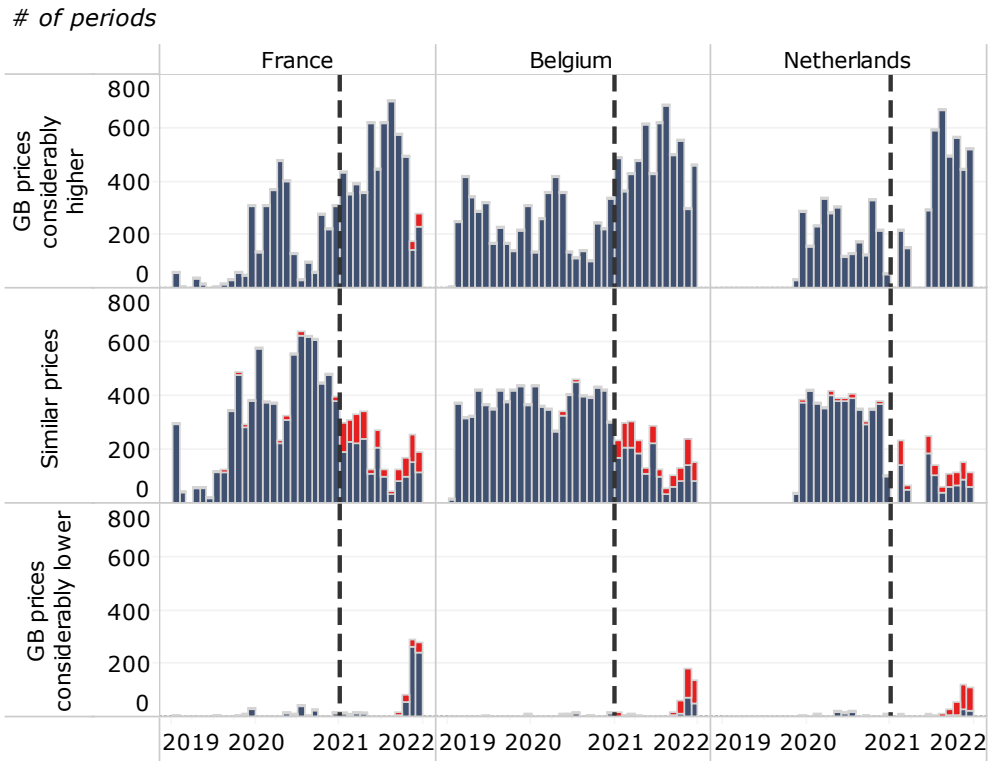
Difficult to plan for SO

- System operations becomes more challenging

STATUS QUO

Day-ahead scheduling and trades appear to have been impacted by the market decoupling in 2021

MONTHLY OVERVIEW OF PERIODS WITH ADVERSE FLOW - INCREASED SINCE DE-COUPLING



Red bars represent adverse flow
Blue bars represent flows going towards high priced area

Note: The vertical dashed line shows when market decoupling happened

Implicit markets fundamentally less likely to cause adverse flow

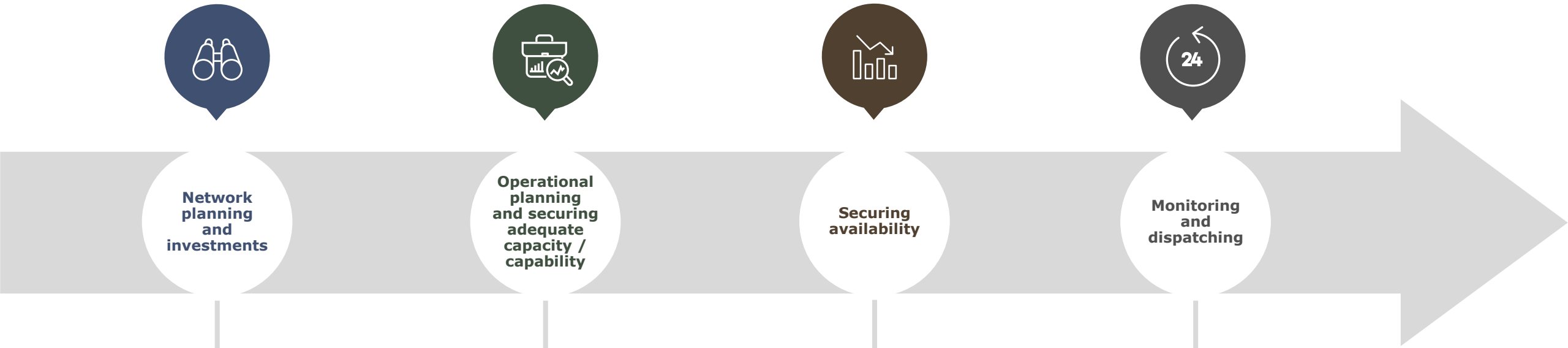
- **Implicit auction:** Algorithms calculates prices and flows
- **Explicit auctions:** Flow relies on business decisions

General patterns since de-coupling

- Adverse flow on interconnectors with explicit auctions
- Adverse flow more likely in periods with small price spread (<10€/MWh)
  - Why?: Smaller margins (less gains from arbitraging) and more likely to change close to real time
- Volatile price signals, where high price area change to low price area and vice versa - can cause adverse flow due to ramping constraints or simply because prices are more difficult to predict and act on

STATUS QUO

NGESO’s system planning and operations span from years ahead to real-time



Years ahead

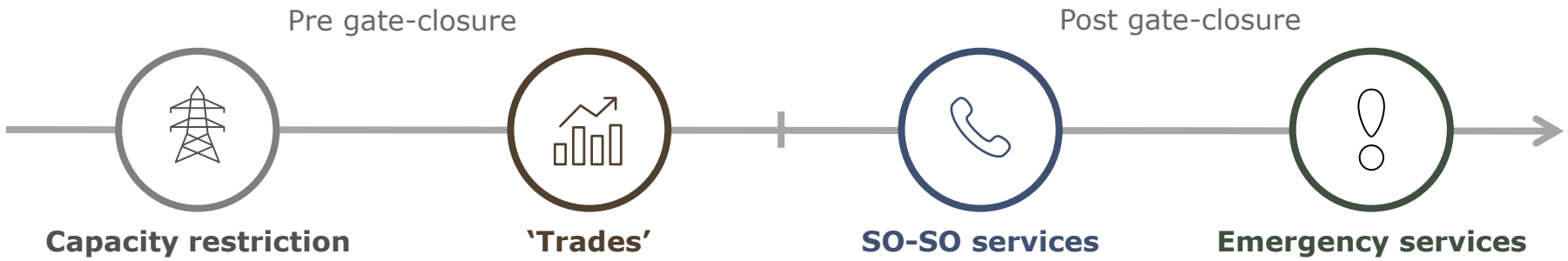
Year(s) – months ahead

Weeks, day-ahead & intraday

Real-time

STATUS QUO

Although ICs cannot participate in the BM, NGESO control room has several mechanisms designed to utilise IC capabilities for system security purposes



Source: NGESO

STATUS QUO

Insight into the future landscape of interconnectors help informing investment decisions, regulatory requirements and market needs

Reports providing insights into the future

FES

ETYS

NOA

NOA for ICs

SOF

HND

TA

Helps informing decisions towards 'net zero'

- How much interconnector capacity is required?
- Where in GB should they be located?
- Which areas should GB connect to?
- Highlights need for regulation as impact becomes clearer
- Understanding future physical opportunities and constraints drives market decisions

STATUS QUO

To unlock the full capability of interconnectors, there are challenges to be addressed to meet future need for Flexibility, Adequacy and Operability

KEY TAKEAWAYS

LOOKING AHEAD

Flexibility

- Hour-by-hour variations due to variable RES is likely to increase, and interconnectors can provide flexibility, provided; efficient markets; and reduced technical constraints
- Flexibility to manage seasonal variations and extreme weather periods depends on several factors driving the prices in the connected areas

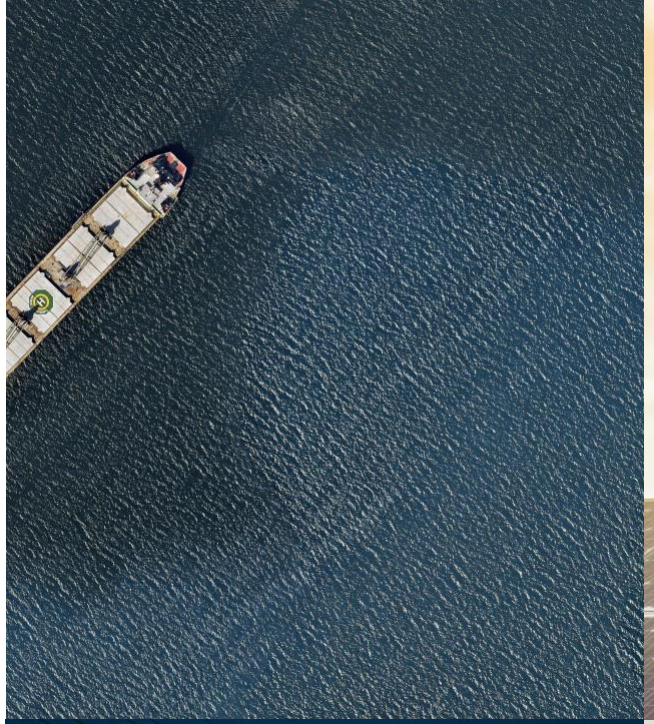
Operability

- Markets need to be reformed to unlock the full capability of interconnectors
- Limitations of the transmission system may constraint use of interconnectors

Adequacy

- Interconnectors can be an important source of energy in GB in peak load periods, as interconnector capacity continue to rise
- Reliable source *only* if the connected TSO does not limit the capacity in period of stress, therefore regulation and bilateral agreements must be robust

Agenda



Q&A

Contact us

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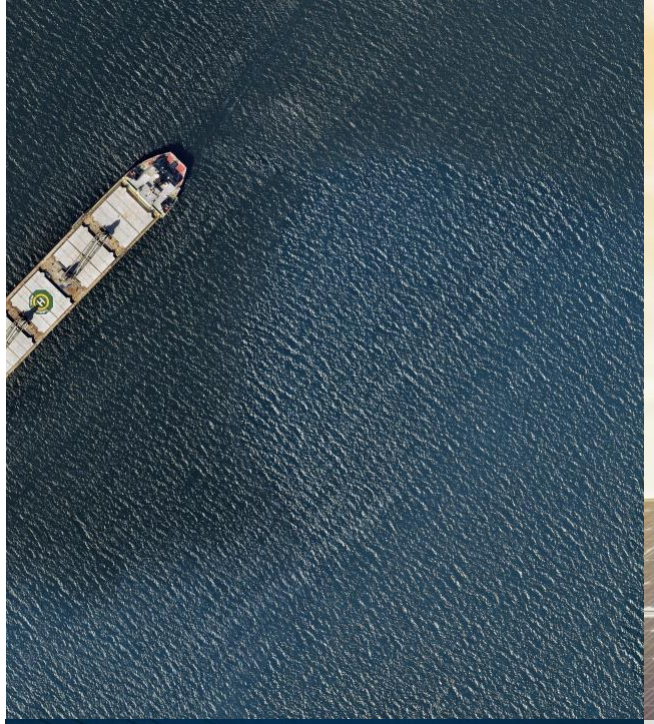
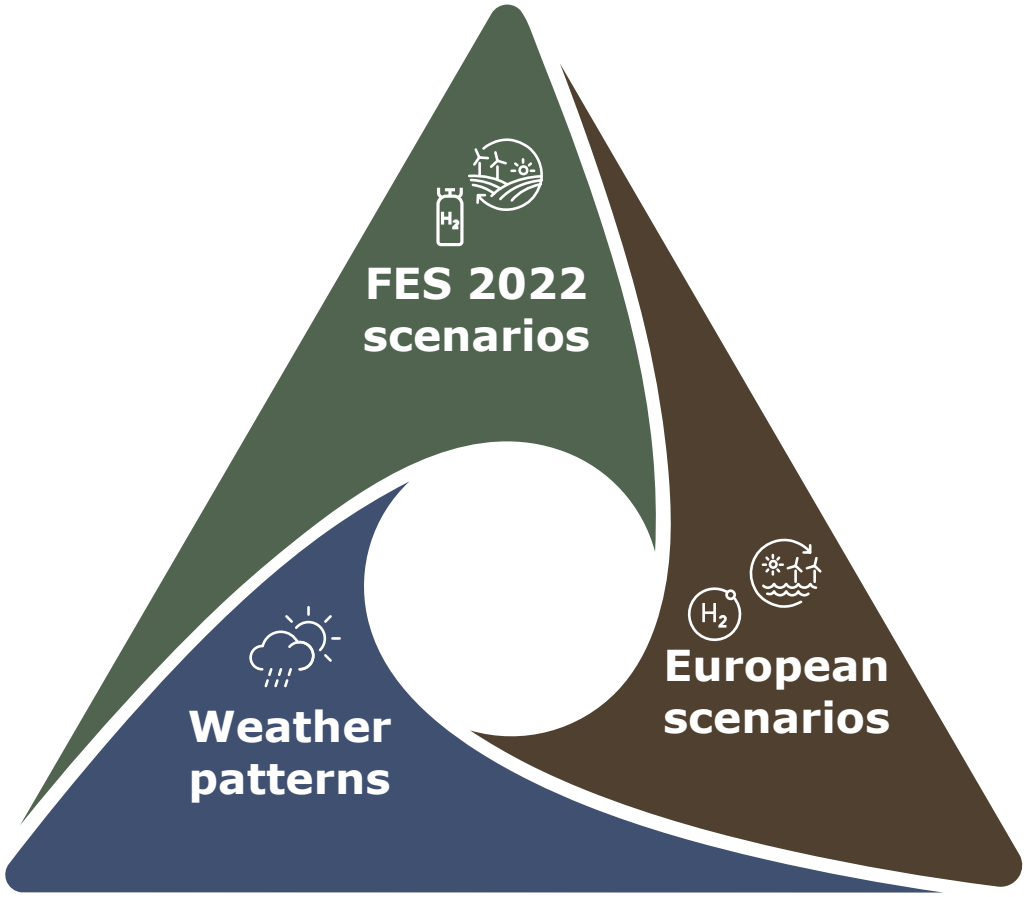


The future outlook for GB and its interconnectors vary as a combination of decarbonisation pace (generation mix and demand) and weather patterns[1]



FES 2022 scenarios

These scenarios, developed by NGESO, describe 4 future energy pathways for supply and demand in GB.

In three of these scenarios GB becomes economy-wide Net Zero by 2050 and Net Zero in the power sector by 2035, while one scenario falls short of achieving these targets.

European scenarios

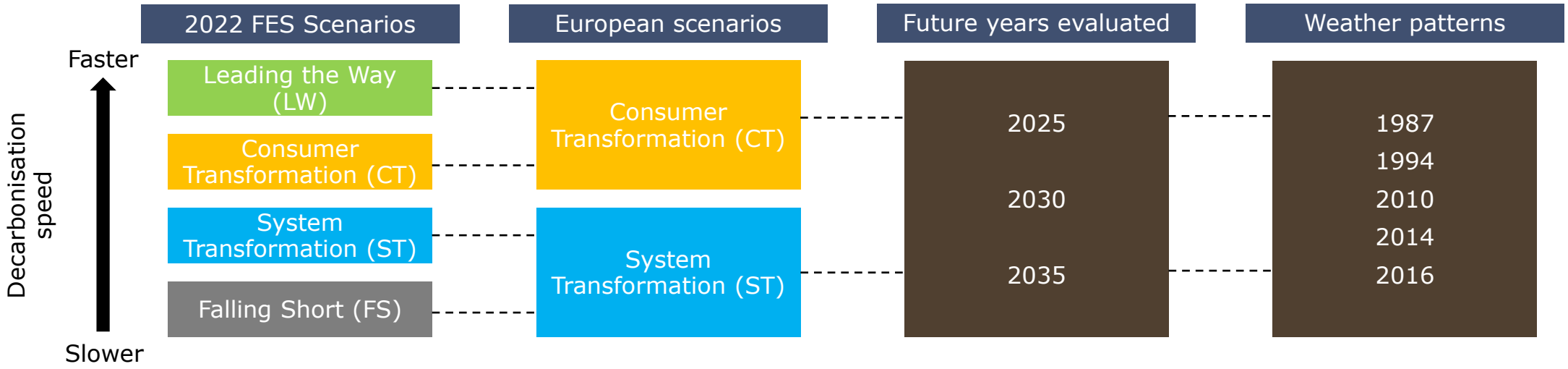
These scenarios, developed by AFRY as an additional project commissioned by NGESO, consist of 2 pathways in which neighbouring European countries become Net Zero by 2050 at the latest.

Weather patterns

Flows across interconnectors are greatly impacted by weather conditions in interconnected countries. Weather impacts demand patterns, hydro inflows and availability of renewable generation (e.g. wind and solar).

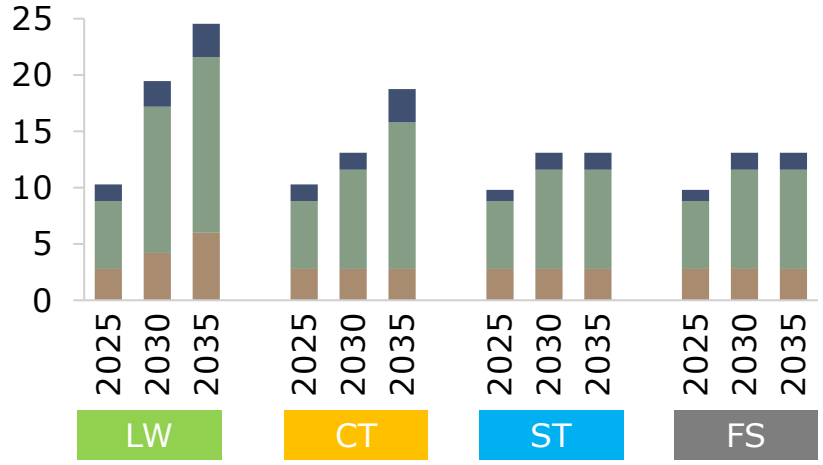
1. Whilst this was the focus of our modelling, in reality, interconnector deployment and cross-border flows will be impacted by other factors, such as policy and regulation.

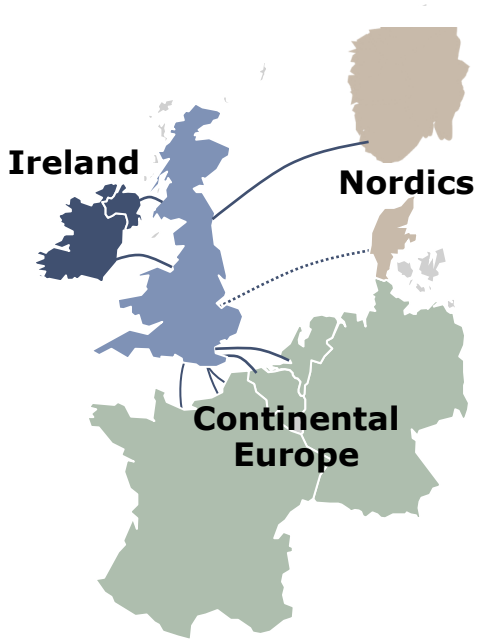
A total of 4 scenarios are modelled for 3 future years, based on the 5 historic weather patterns selected



Interconnector capacities between GB and connected markets vary across scenarios depending on flexibility requirements

TOTAL INTERCONNECTOR CAPACITY TO GB (GW)





- The FES scenarios include existing interconnectors and a pipeline of other projects, most of which come online between the mid-2020s and mid-2030s

- The growth of IC responds to flexibility needs
  - Greater need in LW due to more RES penetration
  - Lowest need in FS as more dispatchable sources remain in GB

FUTURE LANDSCAPE – INTERCONNECTOR BEHAVIOUR IN GREAT BRITAIN

What role does interconnection play in the future challenges of a net zero energy system?

Net zero creates challenges for the system

- Flexibility
- Operability
- Adequacy

Flexibility

Interconnection helps to balance an increasingly dynamic system in terms of where and when electricity is generated

Operability

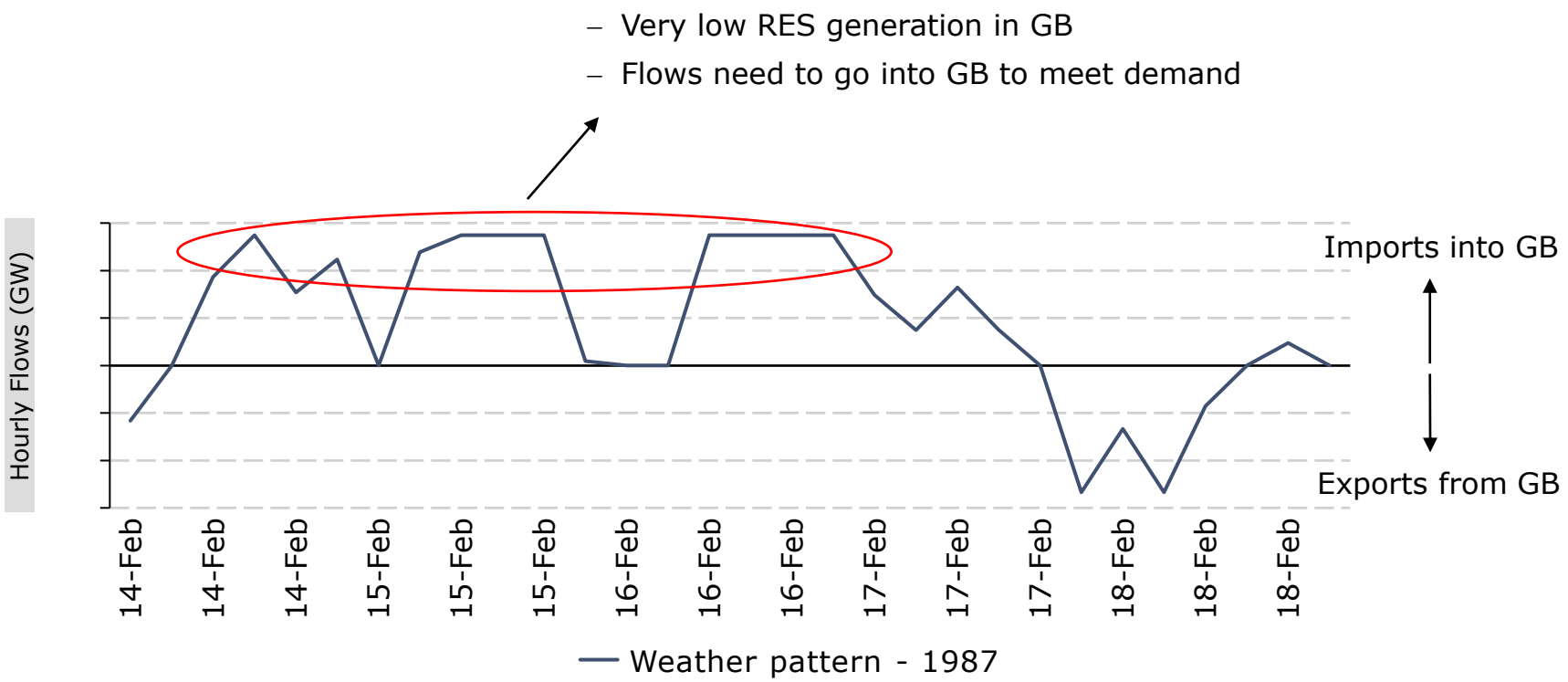
Accessing imports/exports from ICs allows to manage network constraints to keep it operating on safely levels

Adequacy

Interconnectors can bring energy into GB at moments of highest system stress, increasing the energy security

FUTURE LANDSCAPE – INTERCONNECTOR BEHAVIOUR IN GREAT BRITAIN

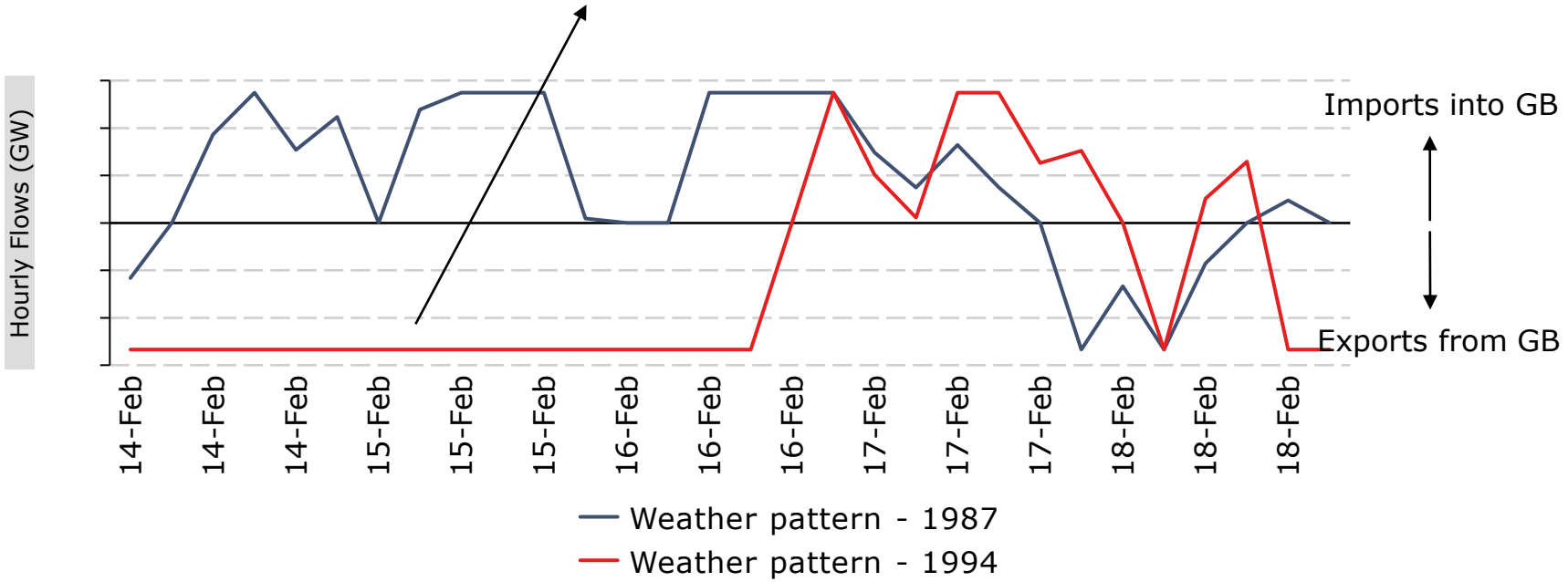
ICs add flexibility to the network as they can distribute intermittent generation across wide geographical locations and weather conditions



FUTURE LANDSCAPE – INTERCONNECTOR BEHAVIOUR IN GREAT BRITAIN

ICs add flexibility to the network as they can distribute intermittent generation across wide geographical locations and weather conditions

- High availability of RES generation means GB can cover its entire demand with RES
- Exports surplus of generation to neighbouring countries



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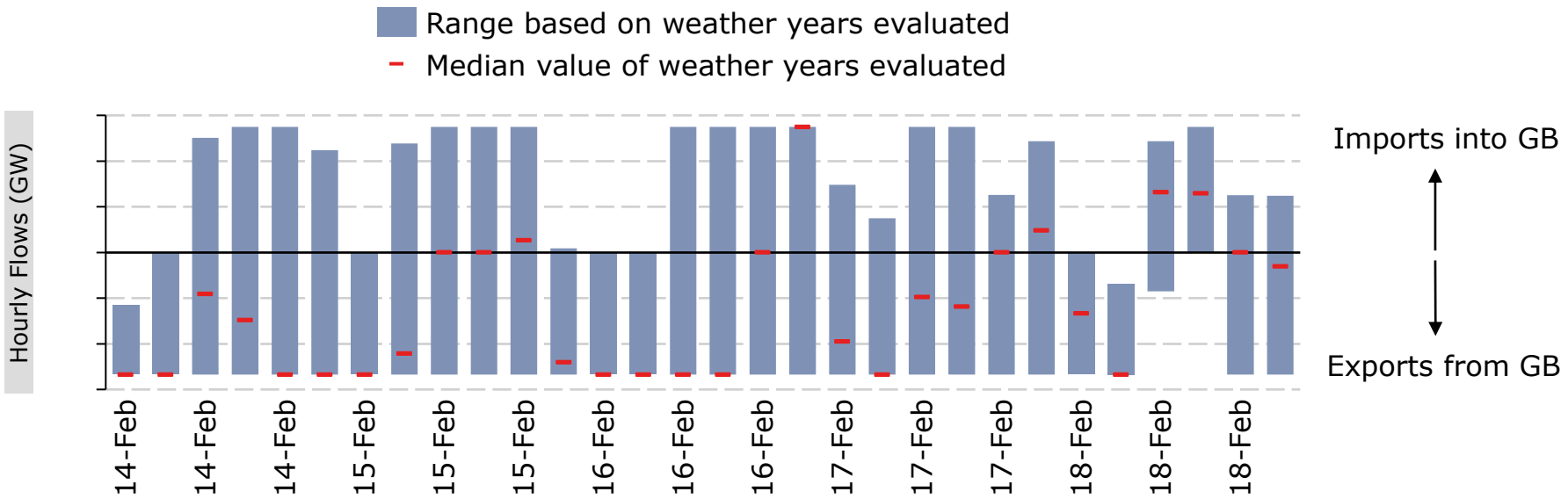
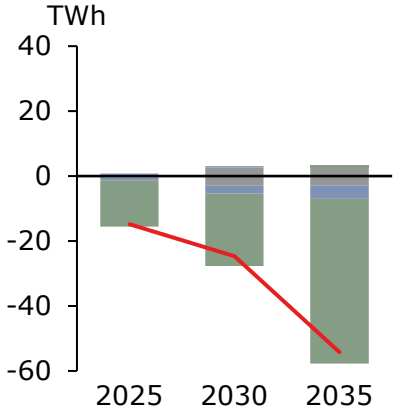


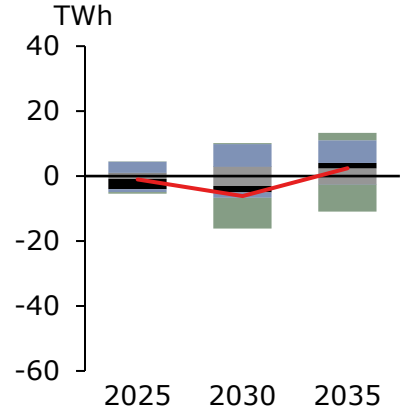
FUTURE LANDSCAPE – INTERCONNECTOR BEHAVIOUR IN GREAT BRITAIN

ICs can modify their position on real-time in order to replace curtailed energy due to network constraints, helping NGESO to operate the system



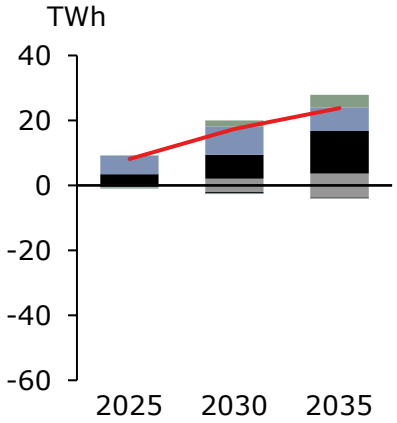
Scotland

- Mostly wind curtailment as network limitations prevent this energy to be accommodated on the system



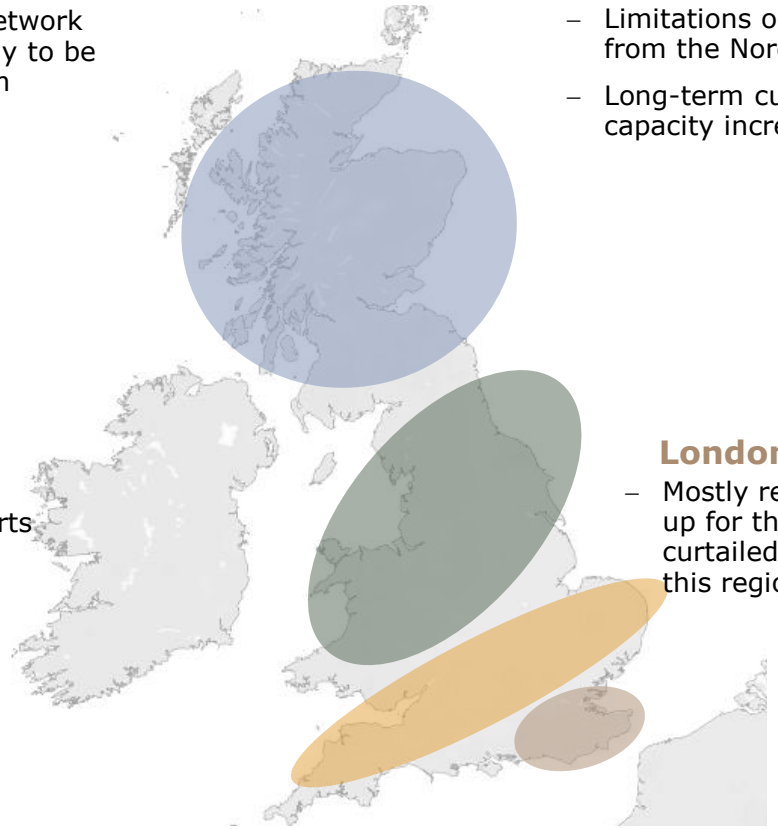
North England

- Limitations on cheaper imports from the Nordics
- Long-term curtailment as RES capacity increases in the future



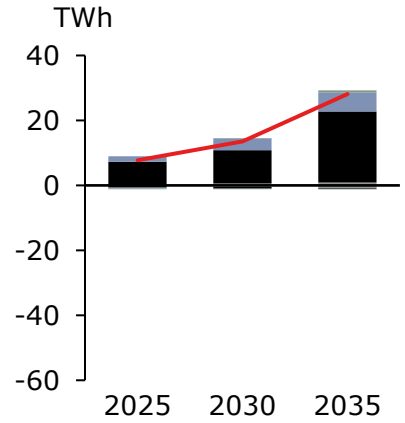
South England

- Mostly thermal and increased imports and/or reduced exports cover up for the energy that cannot flow to this region



London & Southeast

- Mostly reduced exports make up for the volume of energy curtailed that cannot reach this region



Storage | Interconnectors | Thermal | RES | Net volume

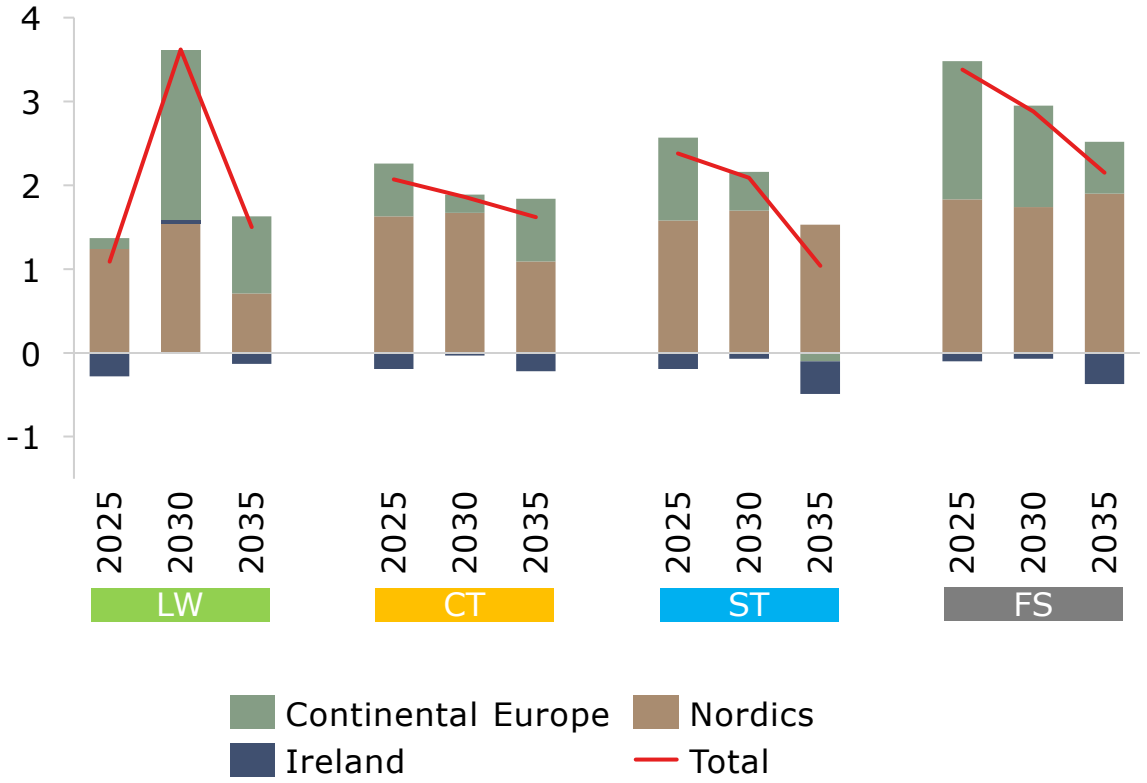
Note: These results are for the Consumer Transformation scenario and the 2016 weather pattern. Only this scenario is shown to describe the future trends

nationalgridESO AFRY

FUTURE LANDSCAPE – INTERCONNECTOR BEHAVIOUR IN GREAT BRITAIN

Interconnectors remain an important source of energy into GB in the periods of highest needs, strengthening the overall adequacy of the system

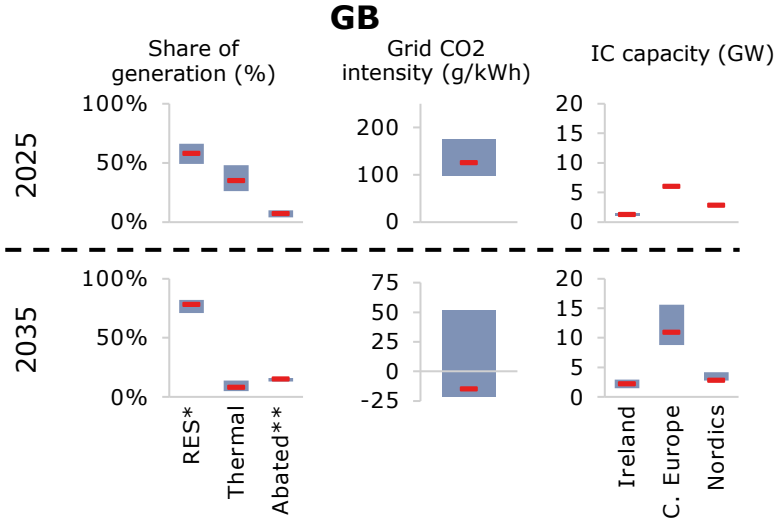
AVERAGE CONTRIBUTION TO GB'S TIGHTEST PERIODS BY IMPORTING REGION (GW)

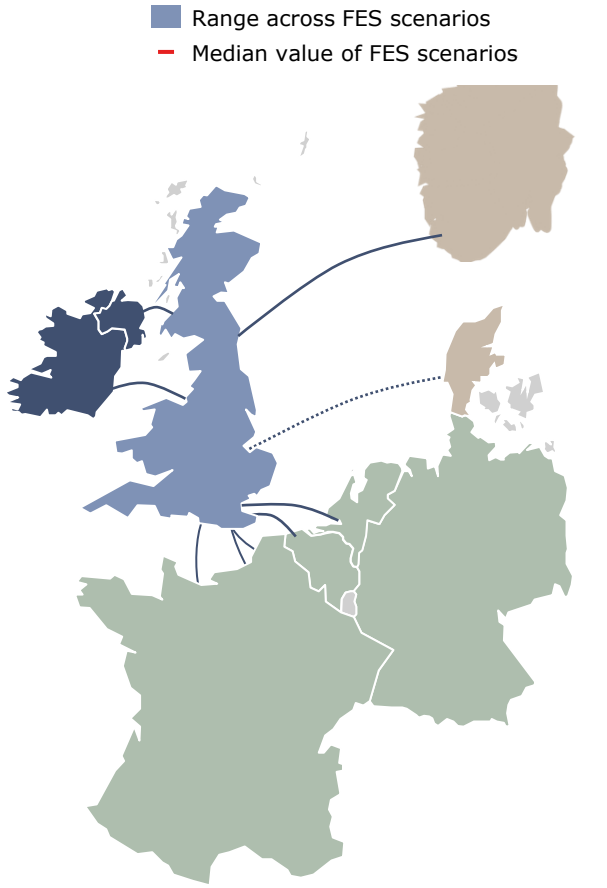


COMMENTARY

- Periods of highest needs are defined as the 100 hours with lowest reserve margins in GB; this is across all weather patterns evaluated
- General decreasing trend on provision of adequacy as Continental Europe shuts down dispatchable plants and replaces them with RES
- Large jump in LW by 2030 responds to significant decommissioning of nuclear and CCGT plants, thus reducing the local availability of dispatchable sources

GB is a net importer across the FES scenarios in 2025, however as the energy system evolves, GB transitions to become a net power exporter





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**Abated technologies include nuclear and thermal generation with CCS or hydrogen-fired

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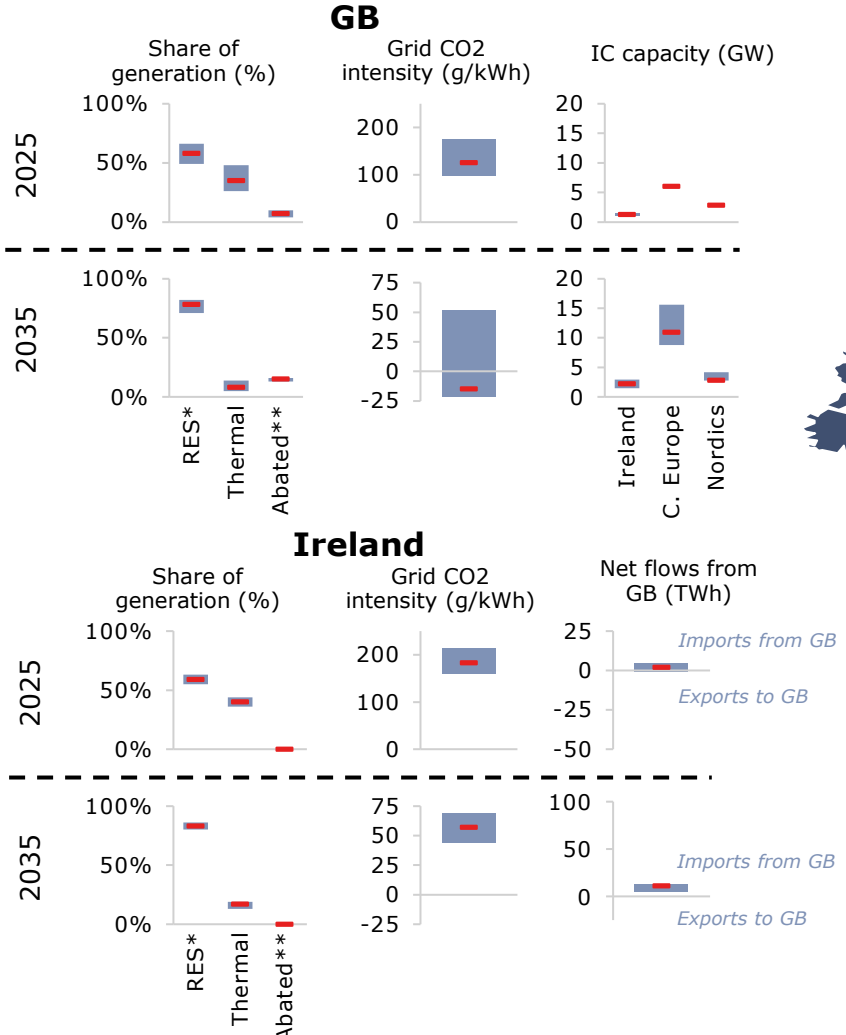

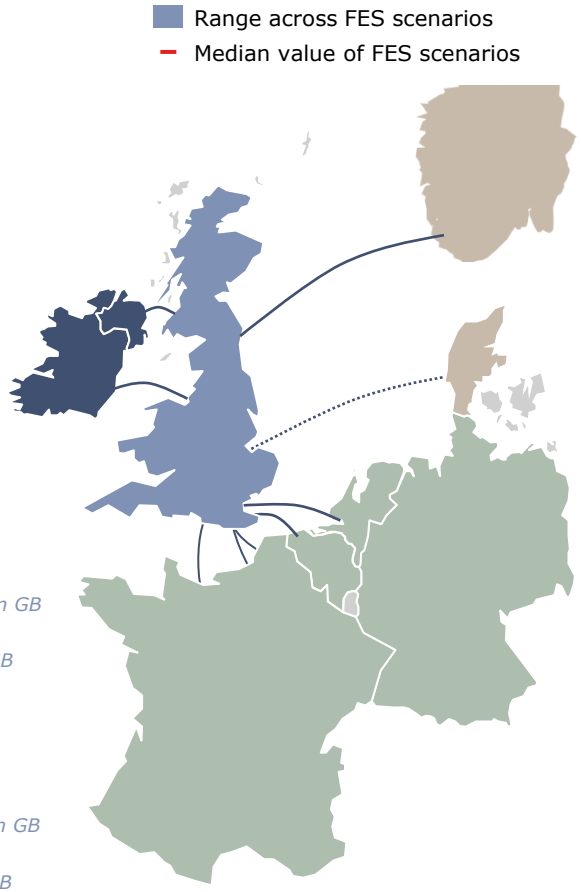

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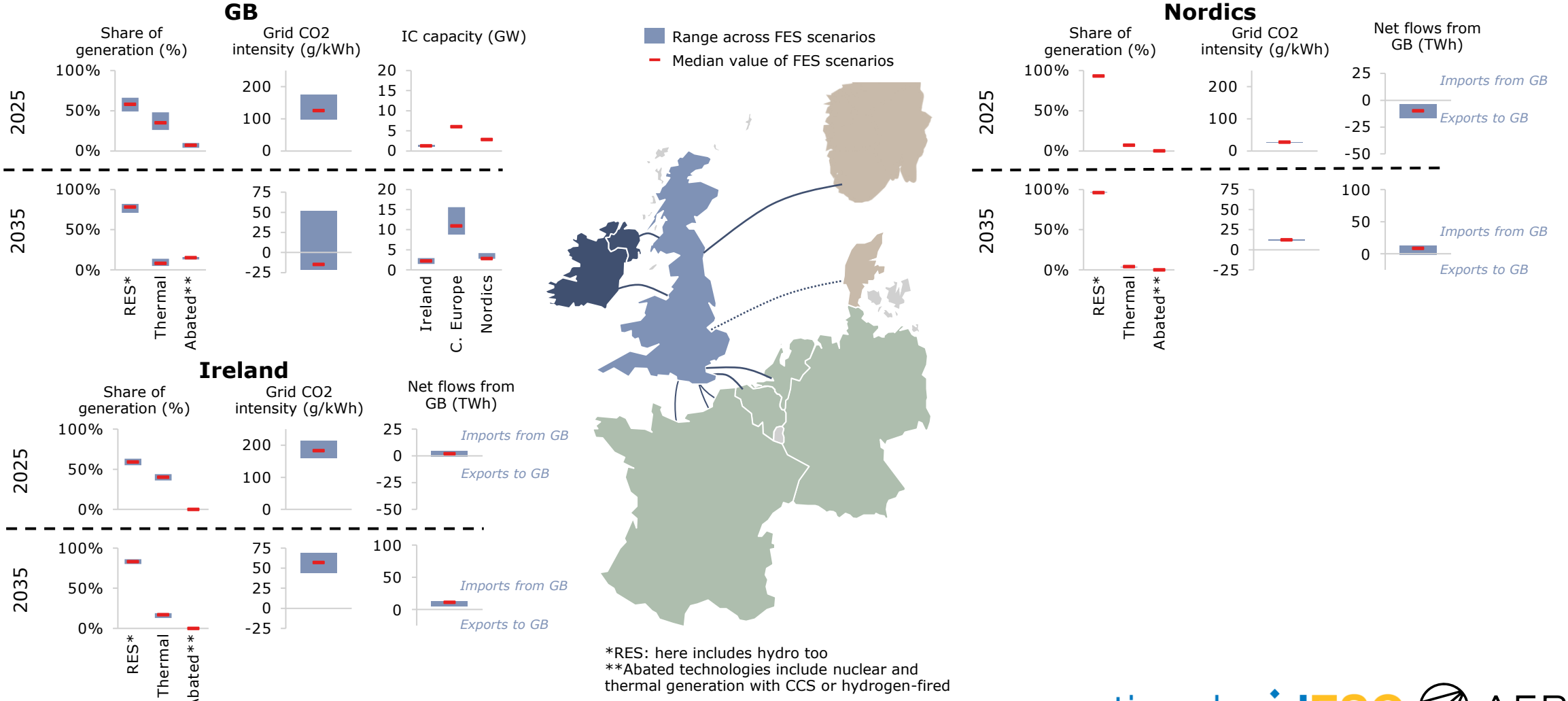

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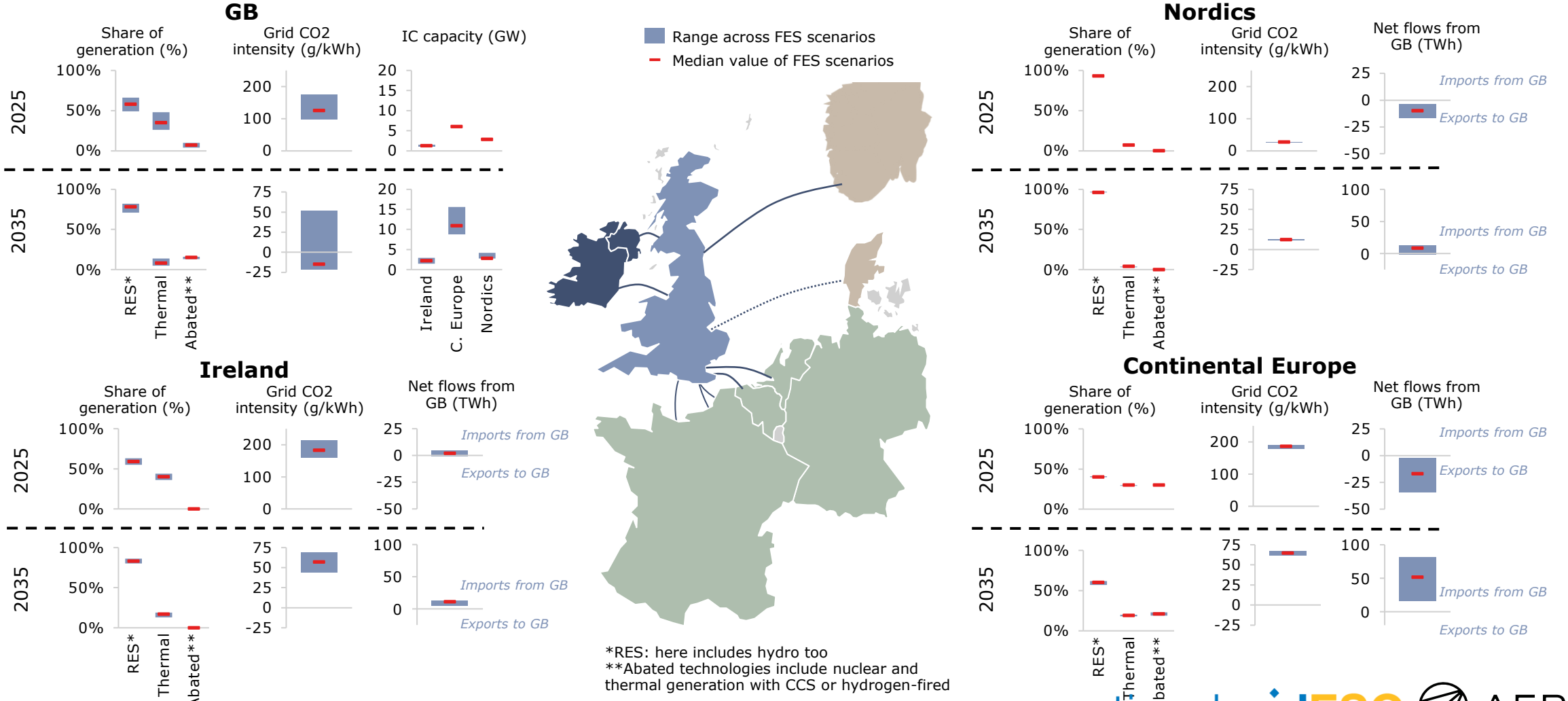

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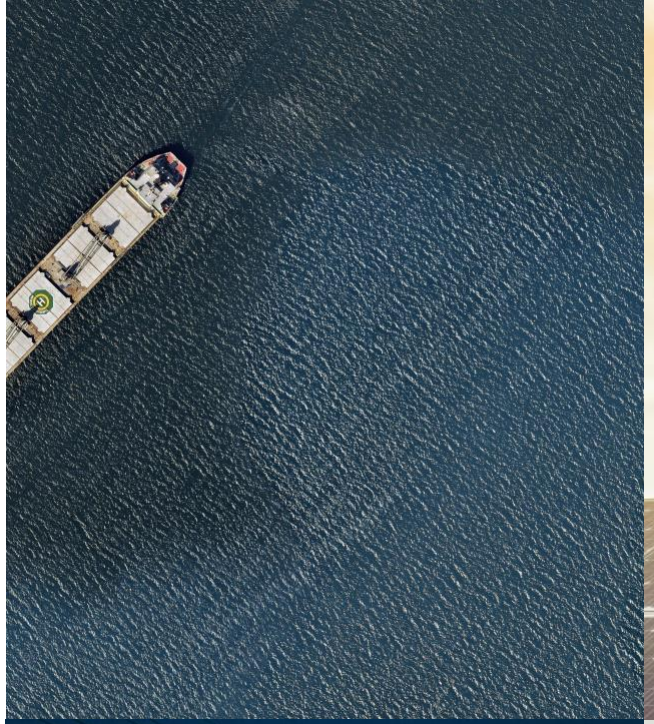

SCOPE AND TIMELINE

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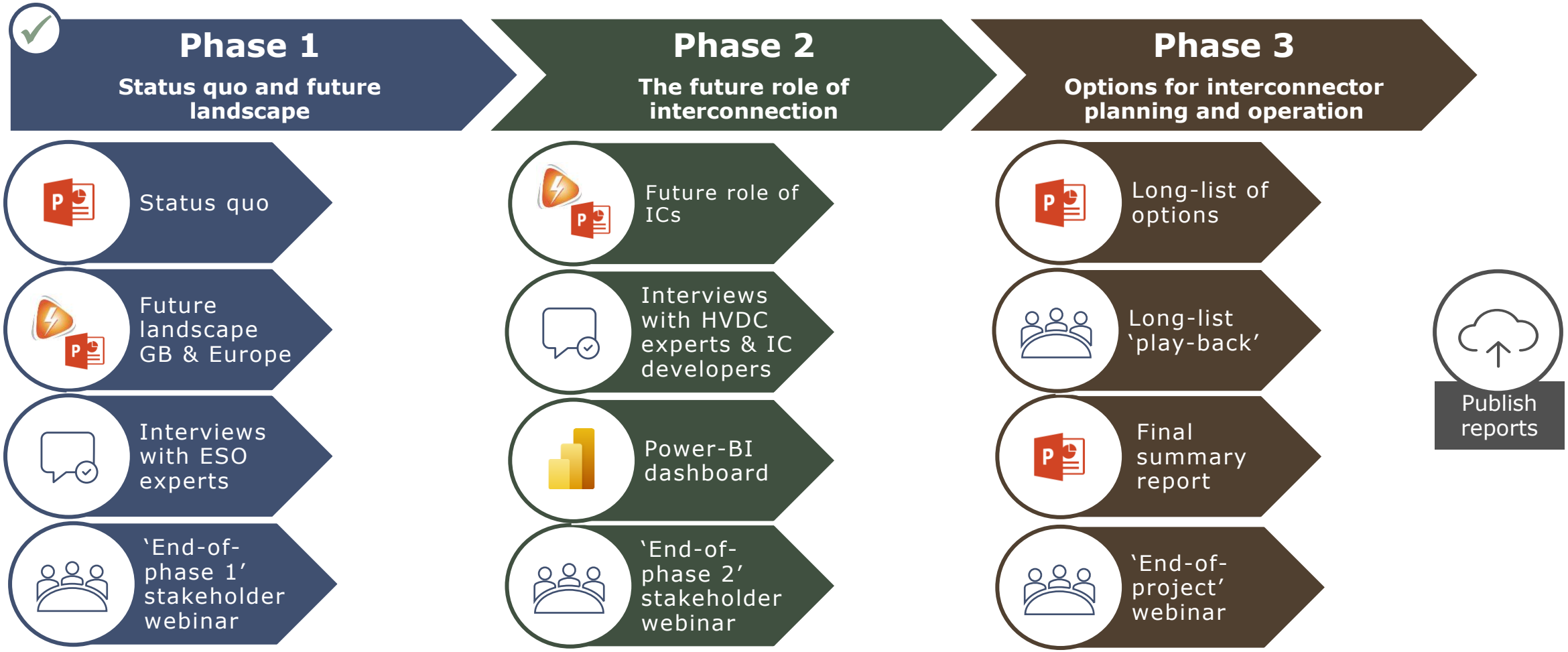

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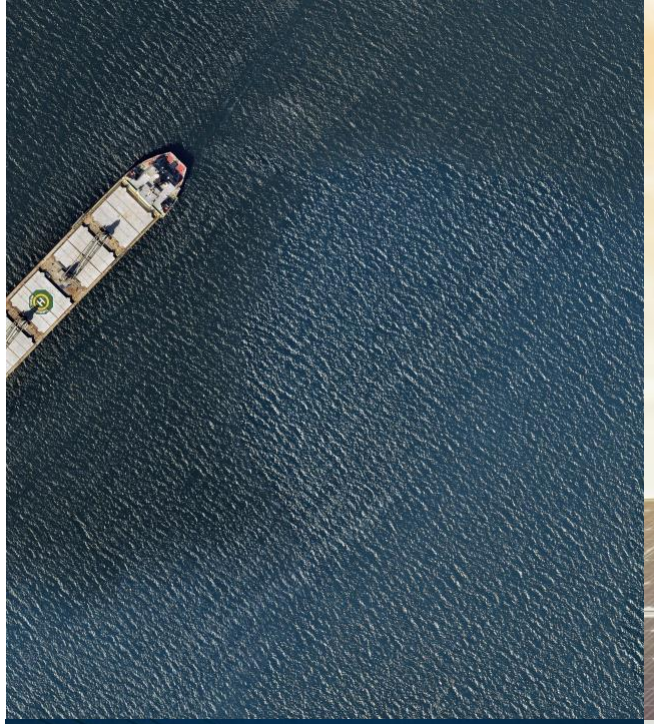

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