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Connecting Islands

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EirGrid Group Annual Customer Conference

Agenda

- National Grid - An International Electricity and Gas Company
- Contracted RES Export Projects
- Joint EirGrid and National Grid Study Work
- Challenges and Opportunities
- Benefits of Future Integration

An international electricity and gas company

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- … based in the UK and north-eastern US
  - We play a vital role in delivering gas and electricity to millions of people safely, reliably and efficiently
- One of the world's largest investor-owned utilities
- Approximately 19 million industrial, commercial and domestic customers
- Almost 28,000 employees
  - 63% work in the US; 37% work in the UK

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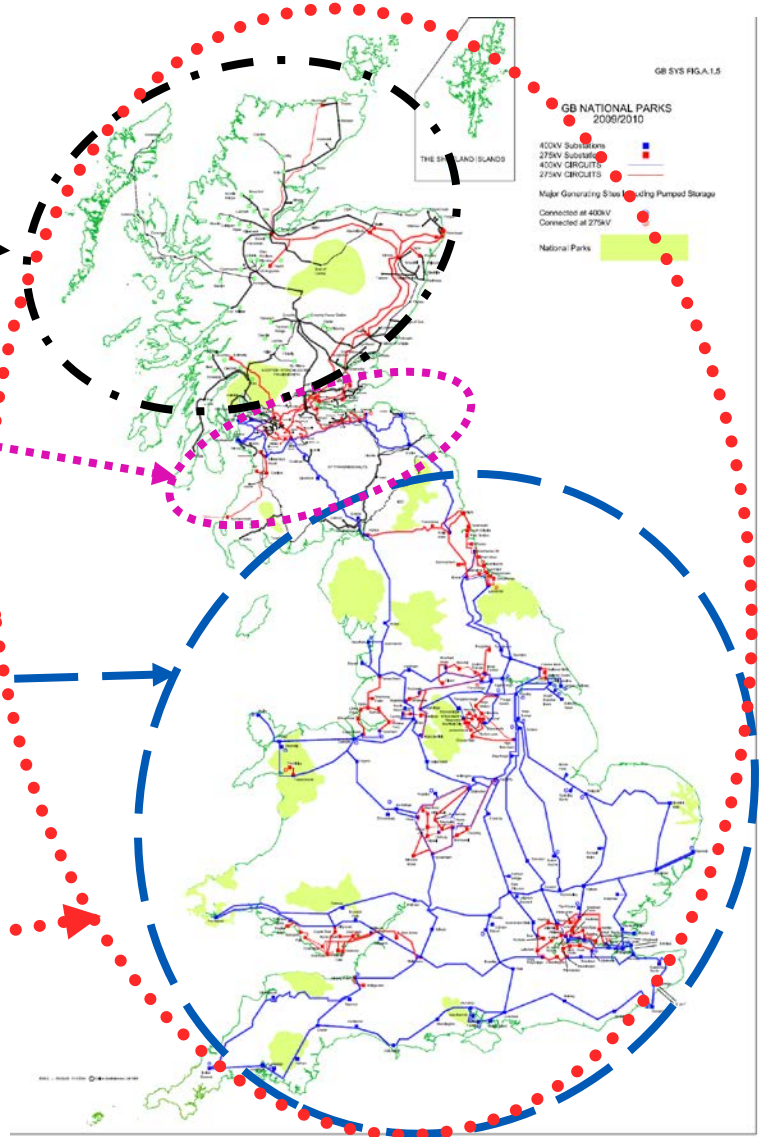
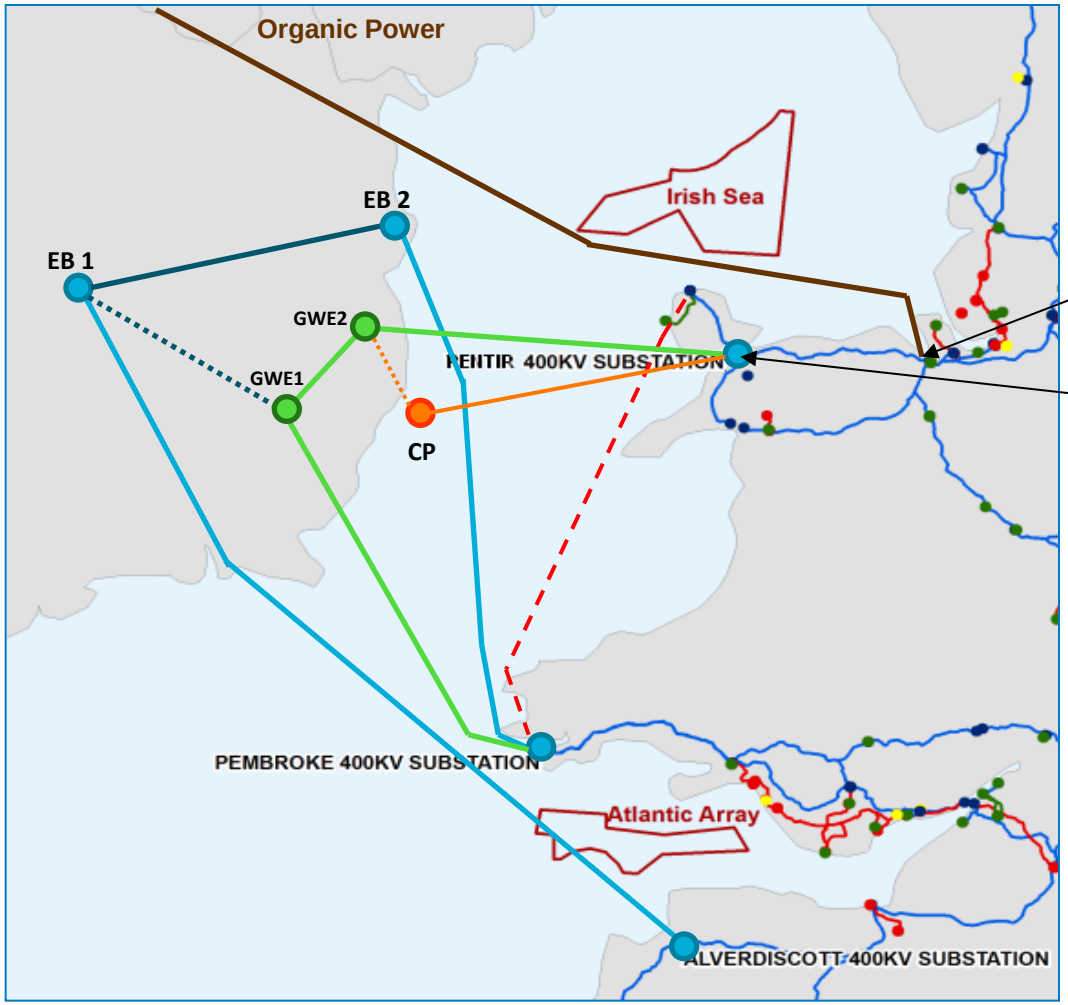
System Operator and Transmission Owners

- **TOs in Scotland**:
  - Scottish Hydro Electricity Transmission
  - Scottish Power Transmission
- **TO in England and Wales**
  - National Grid
- **System Operator GB**
  - National Grid



Contracted RES Export Projects Integrated Design (not fully optimised)



Irish Wind Export
Deeside
1,500 MW Organic Power
Pentir
1,000 MW Greenwire (2018) 1,000 MW Codling Park (2018)
Pembroke
2,500 MW Energy Bridge (2017-2020) 2,000 MW Greenwire (2017)
Alverdiscott
2,500 MW Energy Bridge (2018)
Total – 10,500 MW

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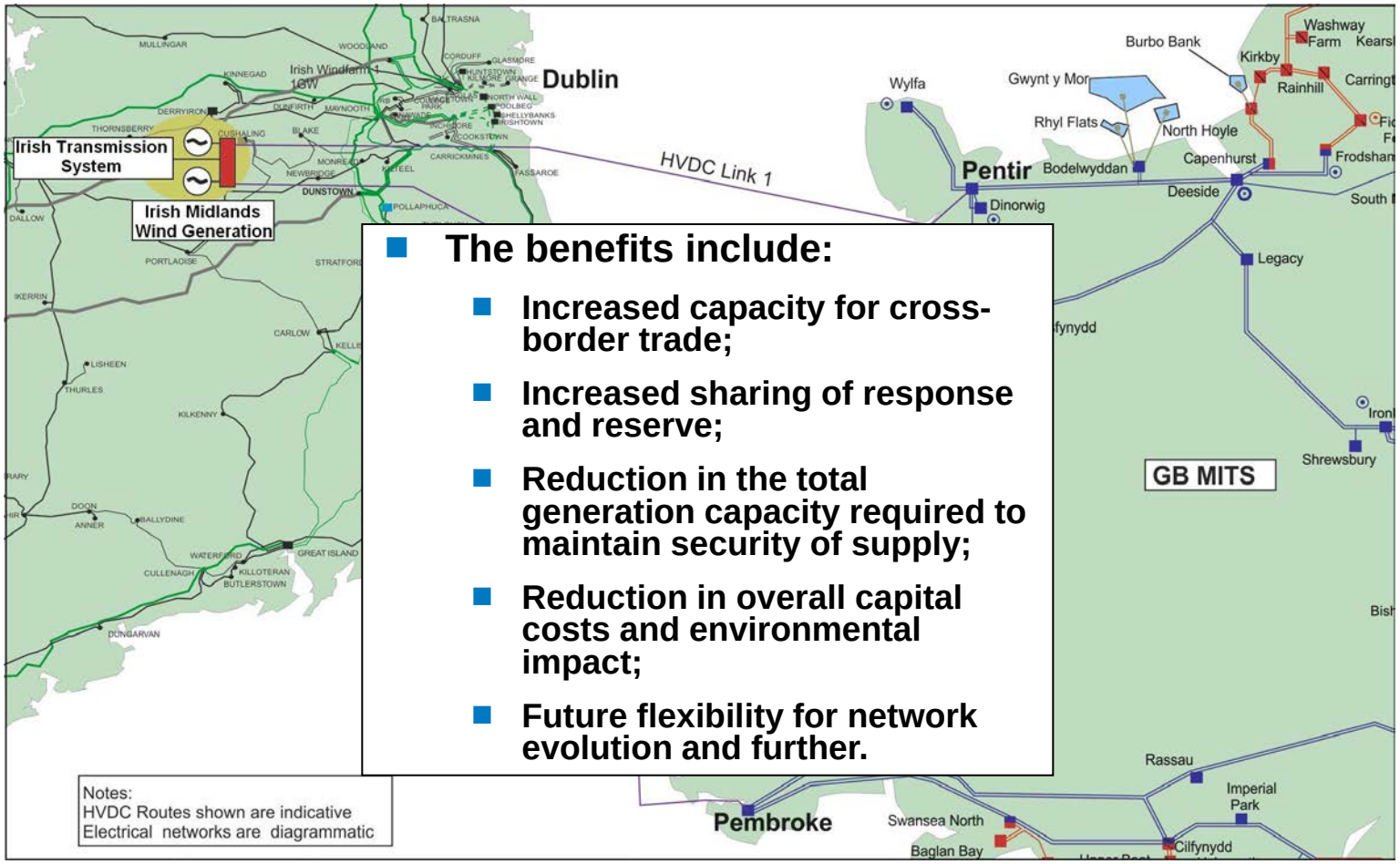
1st Joint Report - Based on an Integrated design

- The study focussed on the incremental costs and benefits arising from adding one or more new connections of 0.5 to 0.7 GW from an integrated design to the Irish transmission system compared to a scenario with no such connection.



- **The benefits include:**
  - **Increased capacity for cross-border trade;**
  - **Increased sharing of response and reserve;**
  - **Reduction in the total generation capacity required to maintain security of supply;**
  - **Reduction in overall capital costs and environmental impact;**
  - **Future flexibility for network evolution and further.**

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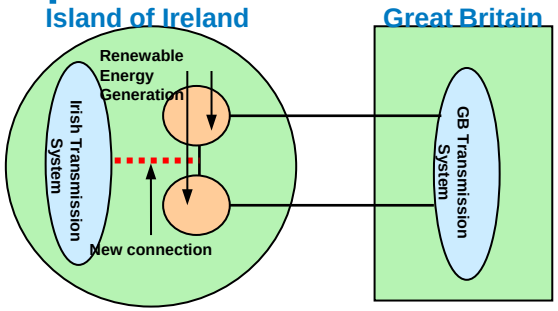
Connection Options to EirGrid

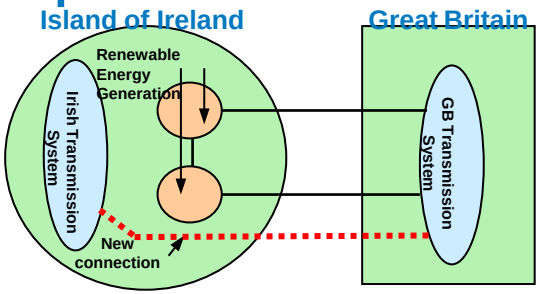
- In each schematic the new connection to the Irish transmission system is represented by **(- - -)**. It also includes a representation of a generic integrated design to connect Irish wind export generation to the Great Britain transmission system (using 2 links).

Option 1 (HVDC multi-terminal)



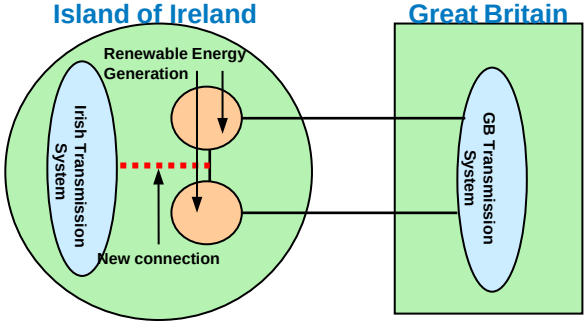
Capital Cost ~ **£71m/€88m**

Option 2 (dedicated HVDC link)



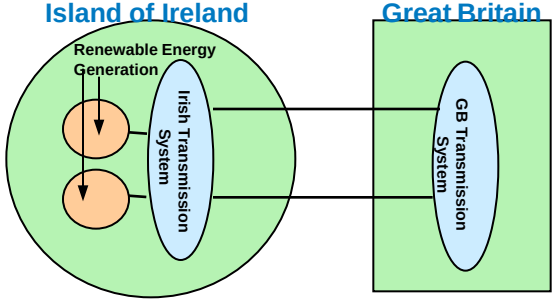
Capital Cost ~ **£463m/€570m**

Option 3 (HVDC back-to-back)



Capital Cost ~ **£150m/€185m**

Option 4 (connection to Irish TO)

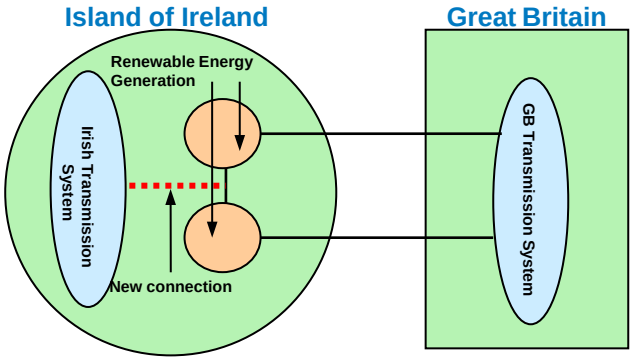


Technically Very Challenging

1st Joint Report Findings

- Integrated network design approach with connection to the Irish transmission system was identified to be the optimal solution.
- This integrated approach provides benefits for consumers on both islands as well as generation developers:
  - Greater integration of British and Irish electricity markets;
  - Lower electricity costs;
  - Improved system security;
  - More reliable access to markets for developers;
  - Deferred network investment.
- A connection sized at 0.5 GW can be accommodated without driving a need for new build network reinforcements on either the Irish or Great Britain network.

Option 1 (HVDC multi-terminal)



Capital Cost ~ **£71m/€88m**

Estimated Annual Benefits and Payback:

Total annual benefits:	**£61m / €75m**	**Beneficiary:**
Trading	35%	GB and IRL
Response	20%	IRL only
Generation Capacity	40%	IRL only
Boundary Transfer	5%	GB only

Payback period in the region of 15 months.

Challenges and Opportunities

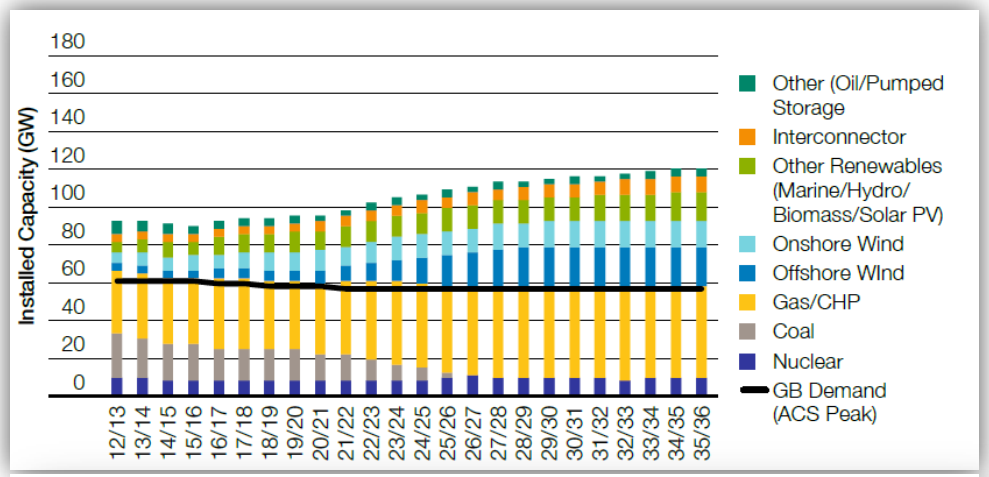
Increase in Penetration of Intermittent Generation

At different locations in the Grid

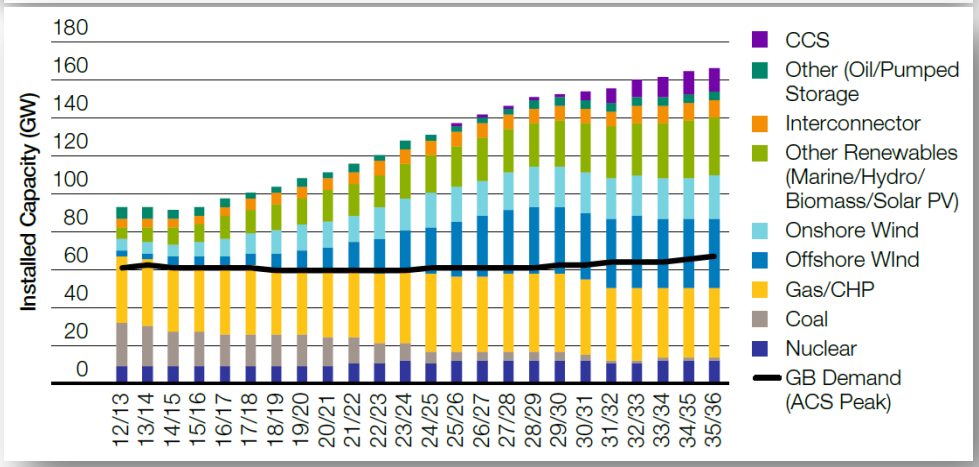
Does not match Existing Network Capability

Technology Landscape has changed

The UK Future Energy Scenarios document describes the scenarios used in our annual planning processes



Slow Progression



Gone Green

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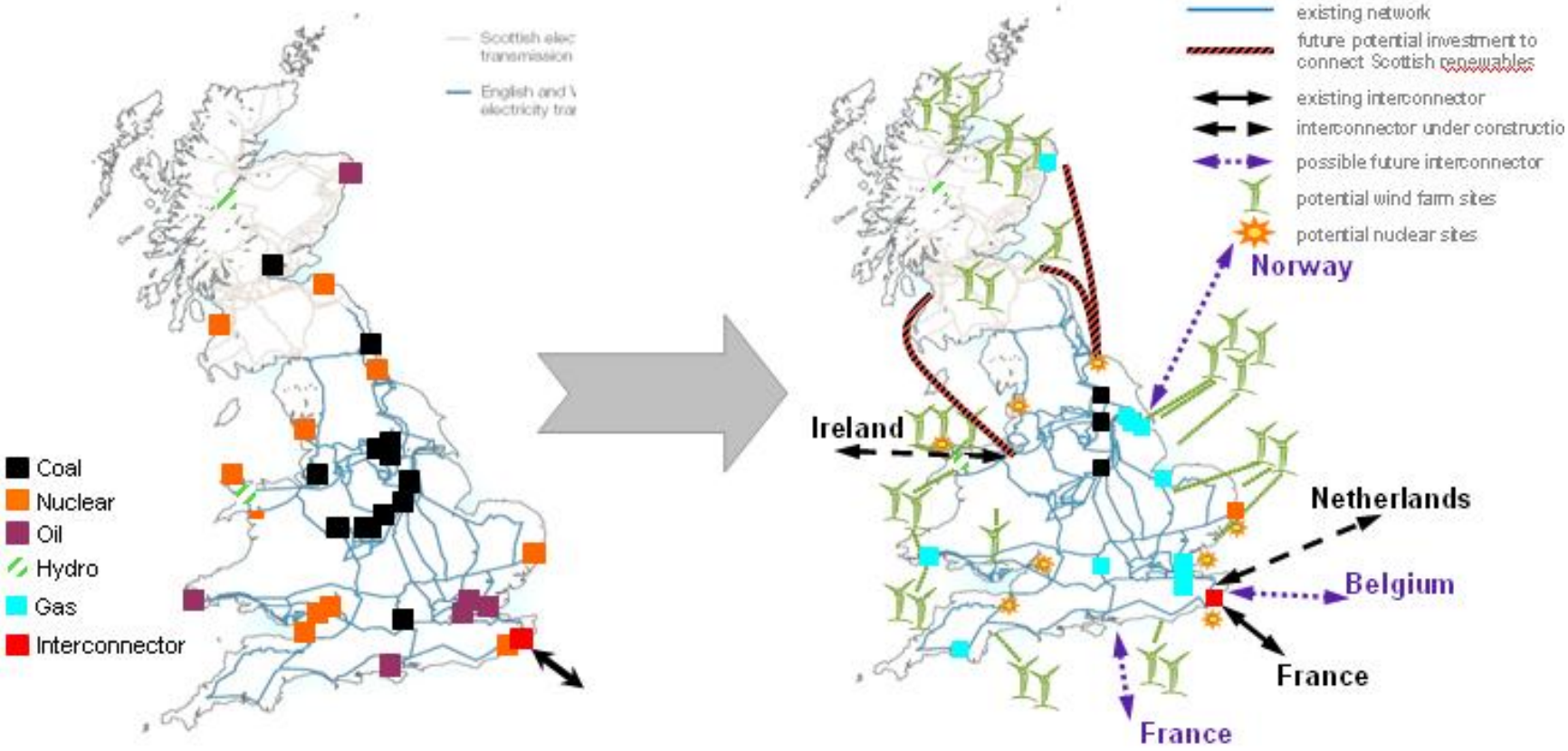
Changing Generation Pattern / Location



Generation and transmission were planned together (1960s)

Transmission must adapt to new generator locations

System Inertia

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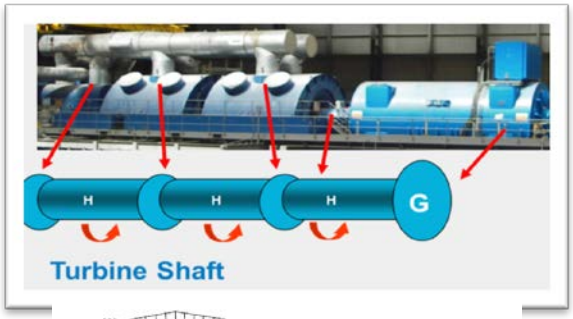
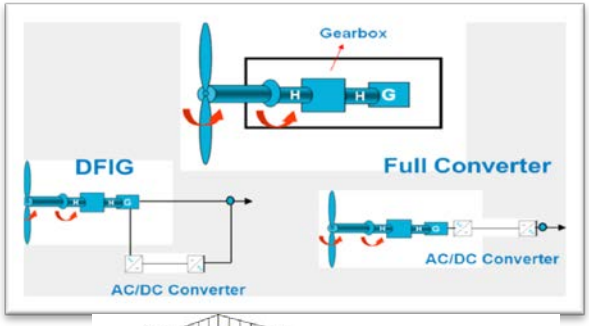
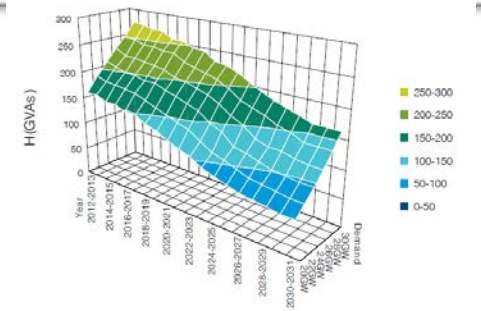
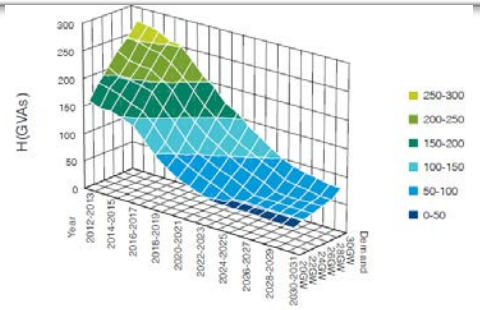
Energy Stored in the mass of Generators running in the system + any rotating mass in the demand side (motor loads)

Thermal Power Stations provide high level of inertia – Wind Turbines provide less (some wind turbine technologies provide no inertia)







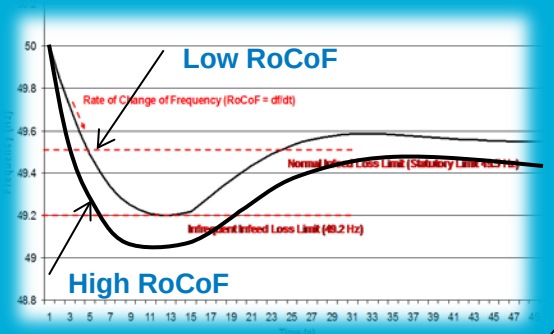


Slow Progression

Gone Green

Why Important?

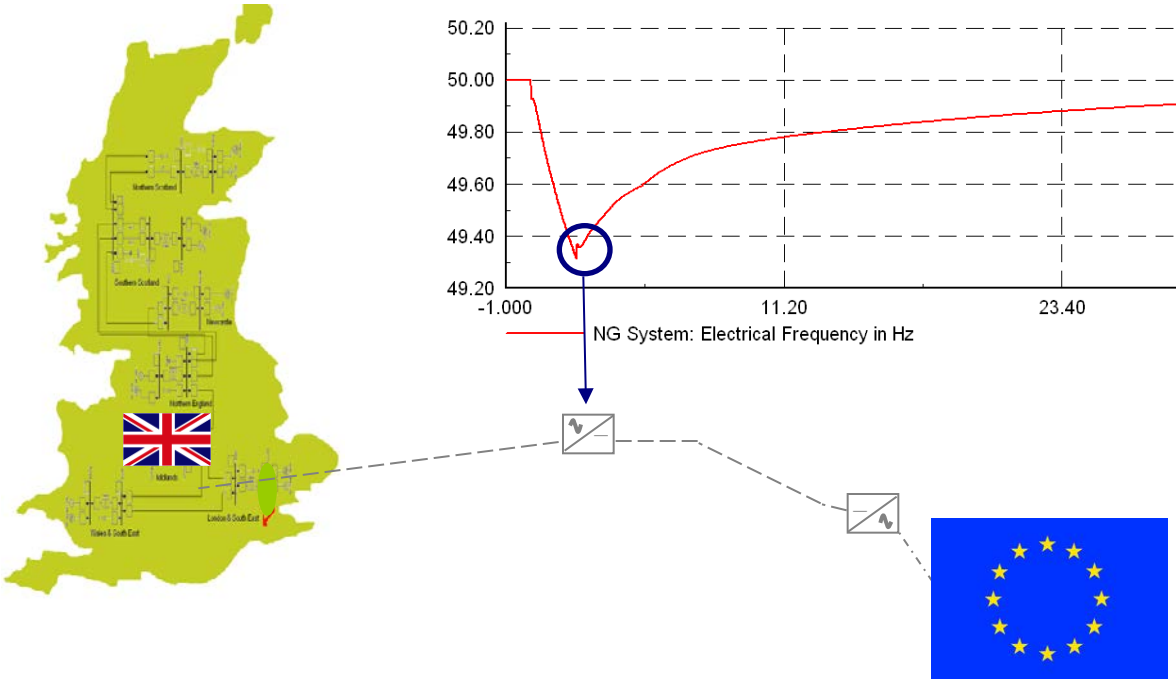
System Frequency is dependent on how much inertia is on the system – a Low inertia system will experience higher rate of change of frequency



In the future with increasing the level of non-synchronous generation (i.e. solar PV, windfarms) the system inertia will reduce

Sharing Response/Reserve

- Sharing Frequency Response/Reserve on Interconnectors
  - Synchronous system in Europe has much higher inertia compared to GB and Ireland.
  - Rapid Frequency Response (within 1-2s) though HVDC links can be used to manage frequency in GB.



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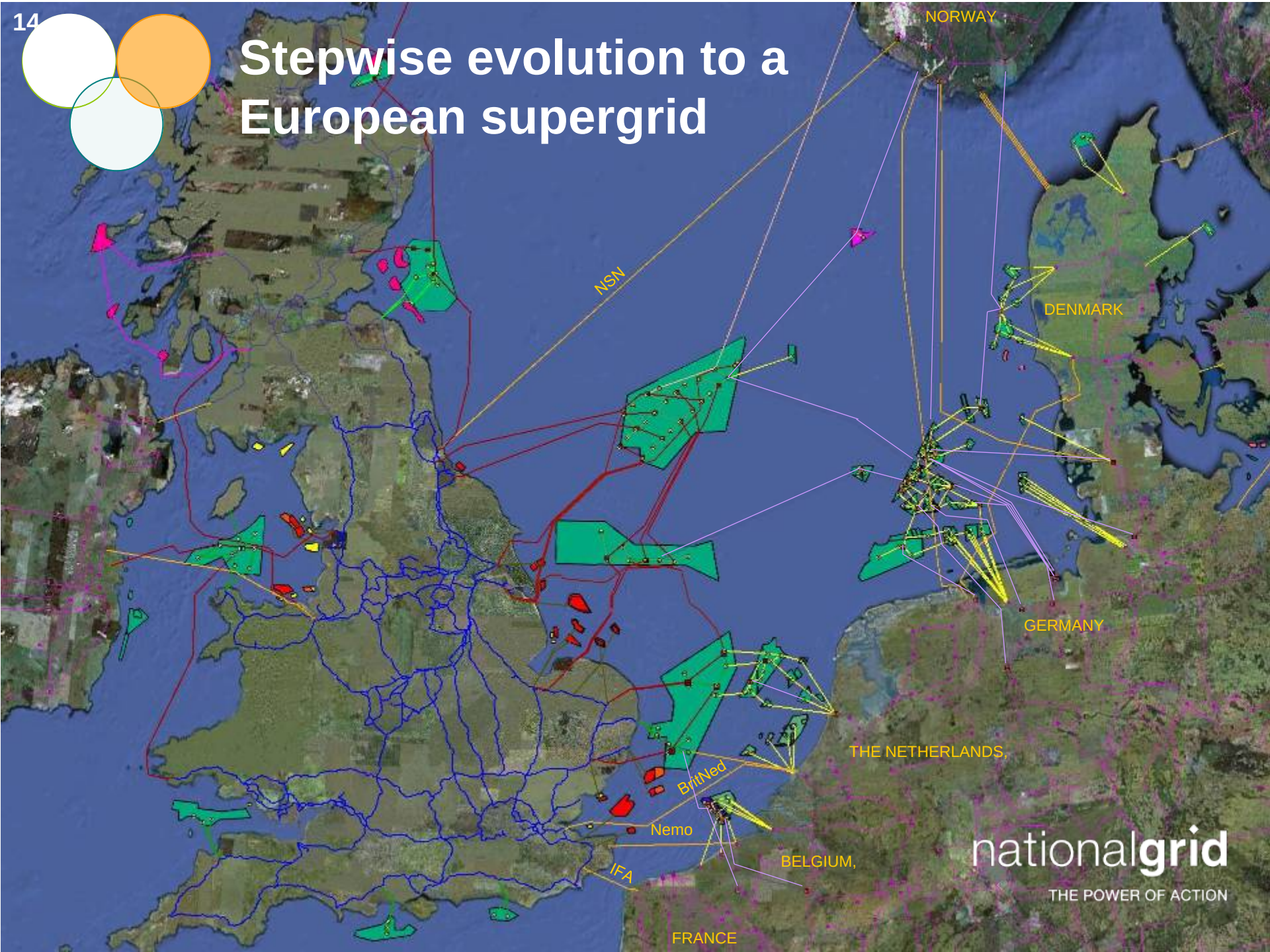
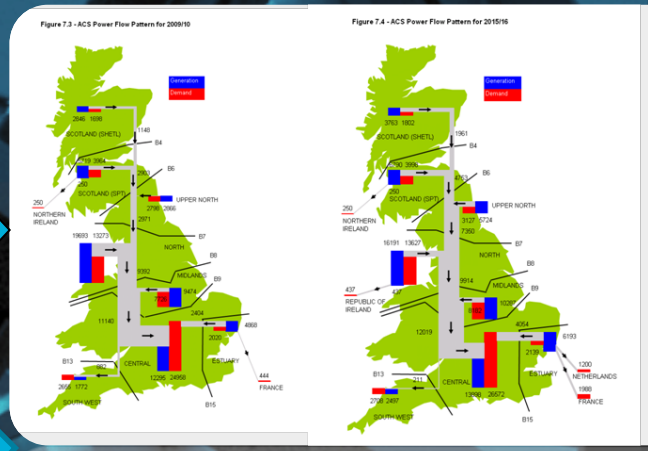
Benefits of Future Integration

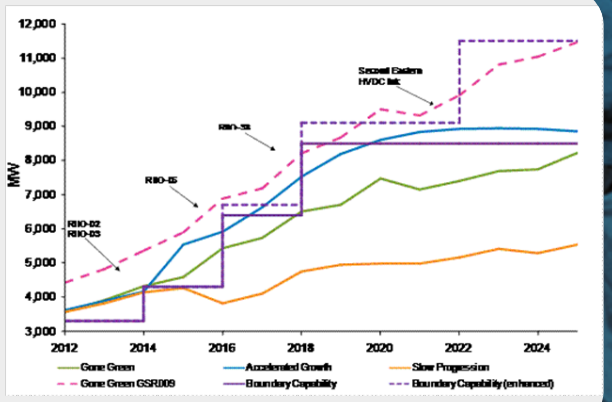
- Ensuring most economic and efficient way of utilizing resources available to meet carbon reduction targets
- Improving power system resilience by providing ancillary services (i.e. blackstart, frequency response, reserve)
- Driving Technology to meet future system needs (i.e. development of larger VSC-HVDC links)

Stepwise evolution to a European supergrid



Electricity Ten Year Statement

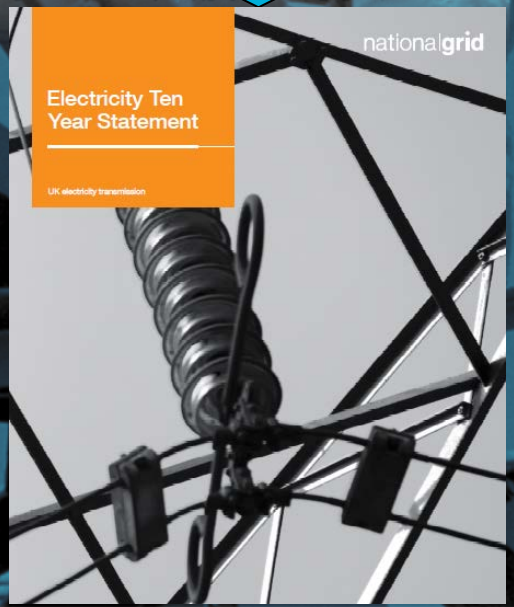




Impact of Future Generation/Demand Changes on the GB Power System

Describes Future Network Developments

Highlights System Operation Challenges and Solutions Available to Address the Challenges



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Questions and Discussion