Materials in the Transmission Challenge

Jenny Cooper

nationalgrid

The power of action.

Who is National Grid?

National Grid is one of the world's largest utilities, focused on delivering energy safely, reliably, efficiently and responsibly

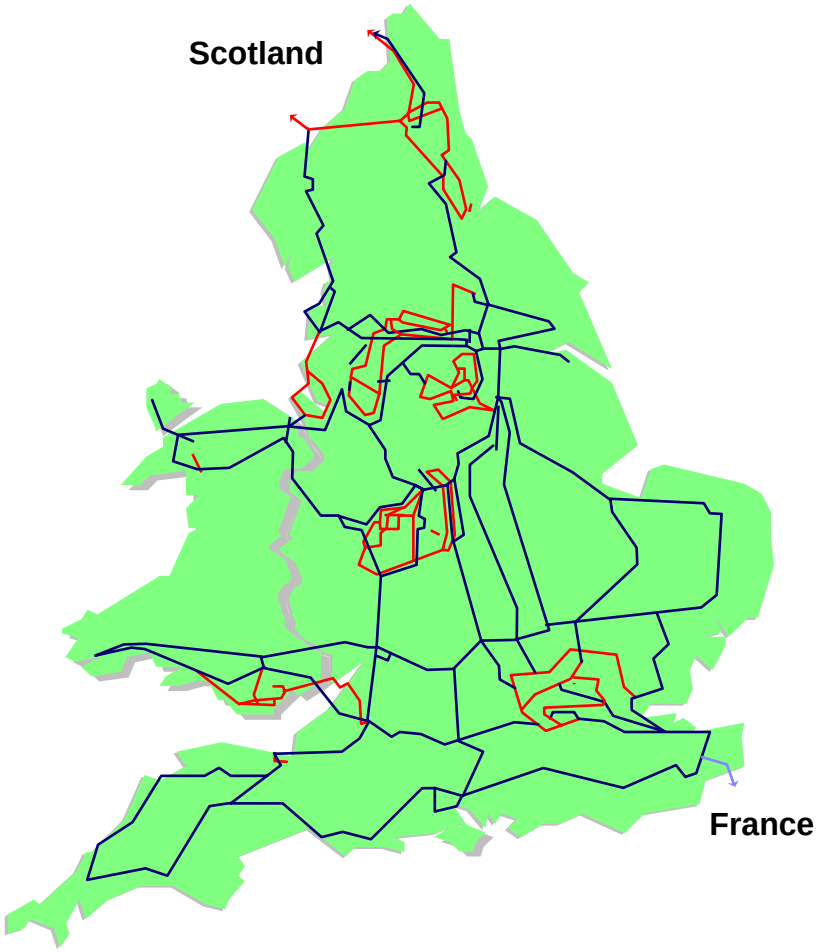
We own and operate gas and electricity transmission and gas distribution networks in the UK and US and electricity distribution networks in the US.

Our core skills lie primarily in the management of large and complex energy delivery networks.

National Grid's goal is to be the world's premier utility through focus on

- **Performance**
- **Integration**
- **Reliability**
- **Safety**

National Grid UK Electricity Transmission



Key Statistics

- Operating voltages 132, 275 & 400kV
- 341 substations
- 190 Grid Supply Points
- 128 generating unit connections
- Installed capacity: 67 GW
- Maximum demand: 53.29 GW
- Energy transmitted: 308.7 TWh
- 14,102 circuit km of OHL
- 985 km of cables
- 21,890 Transmission towers
- 2,751 circuit breakers
- 727 transformers

nationalgrid
The power of action.

National Grid UK Gas National Transmission System (NTS)

Key Statistics

Operating pressures 70-94 bar

Miles of NTS pipeline - 6800km

Compressor Stations - 25

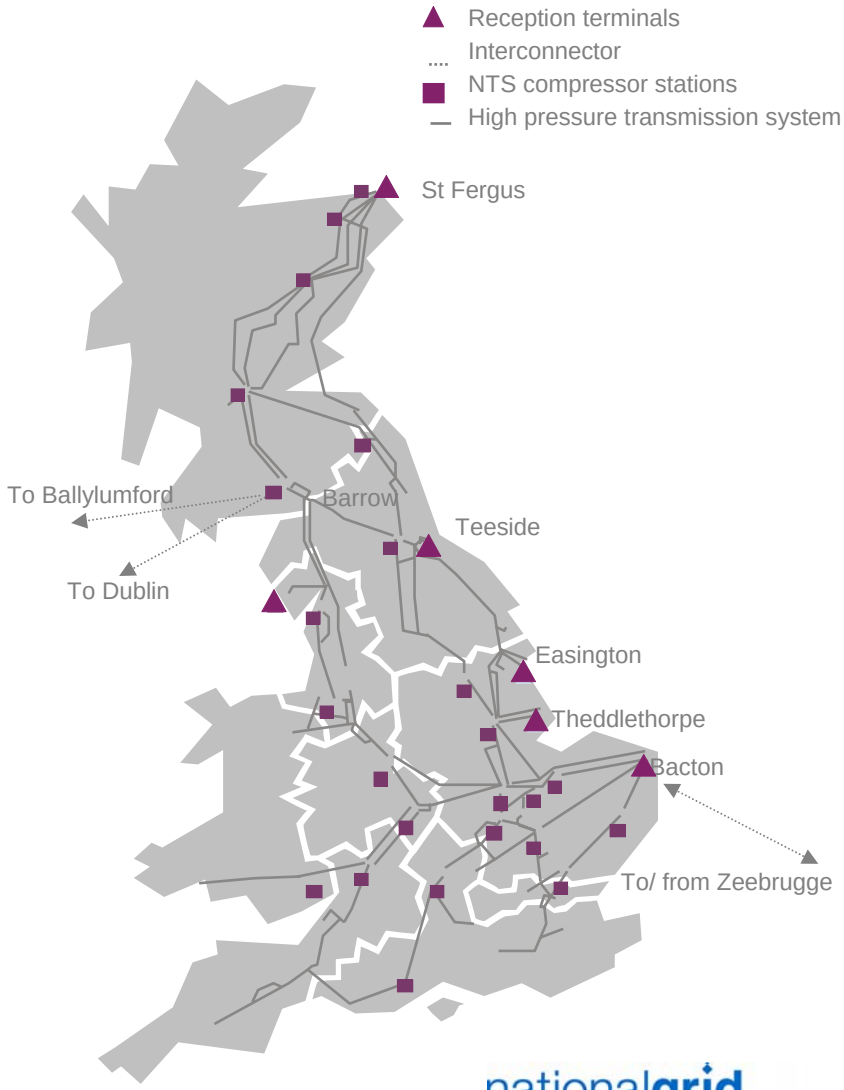
Beach Gas Reception Terminals - 6

Off-takes to Distribution networks - 106

LNG Storage Sites (Unregulated) - 5

End Consumers - 21.2 Million

Peak Demand (04/05) - 418 million cubic meters

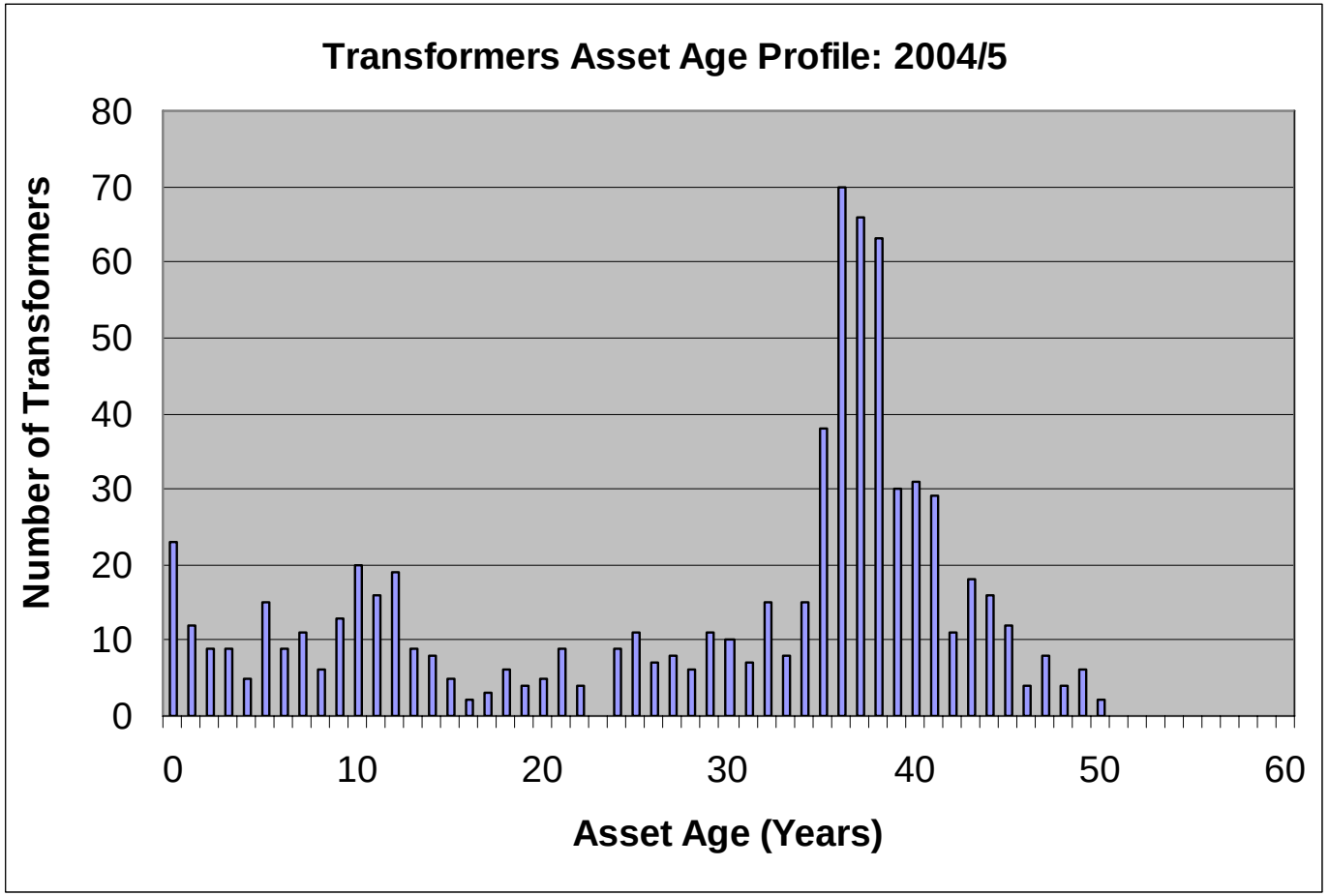


nationalgrid
The power of action.

Challenges for the Electricity and Gas Transmission Networks – Material related

- Asset replacement of the energy networks
- Changing sources of energy supply
- UK Emissions targets
- Implementation of new technology
- Energy policy, planning and regulatory framework

Transformers Asset Age Profiles



nationalgrid
The power of action.

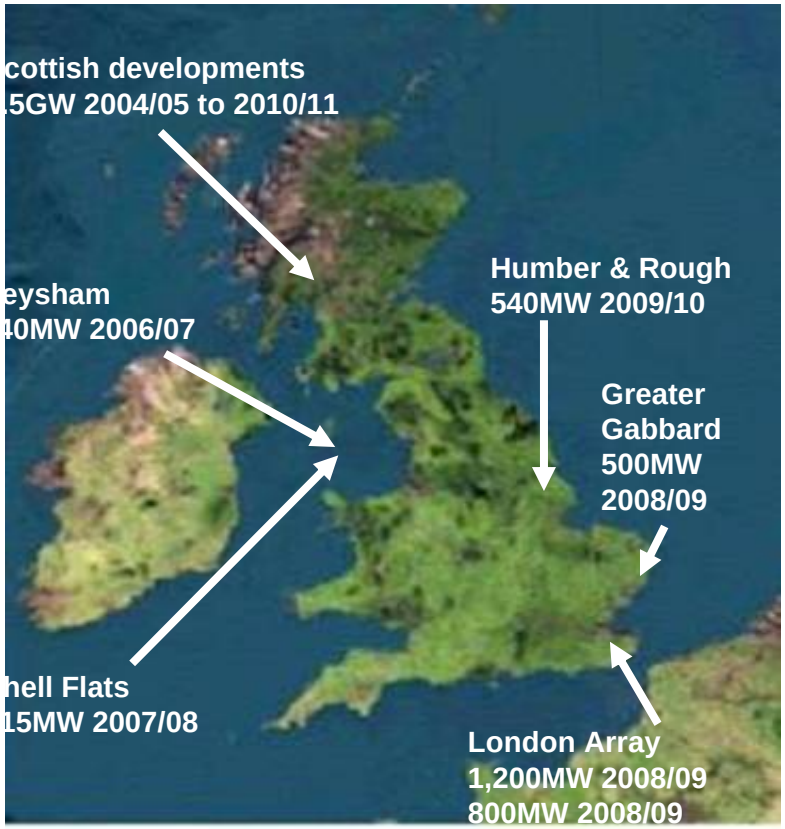
With many outages highly restricted it is critical to understand the condition of plant before ……

Asset Management Maturity Model

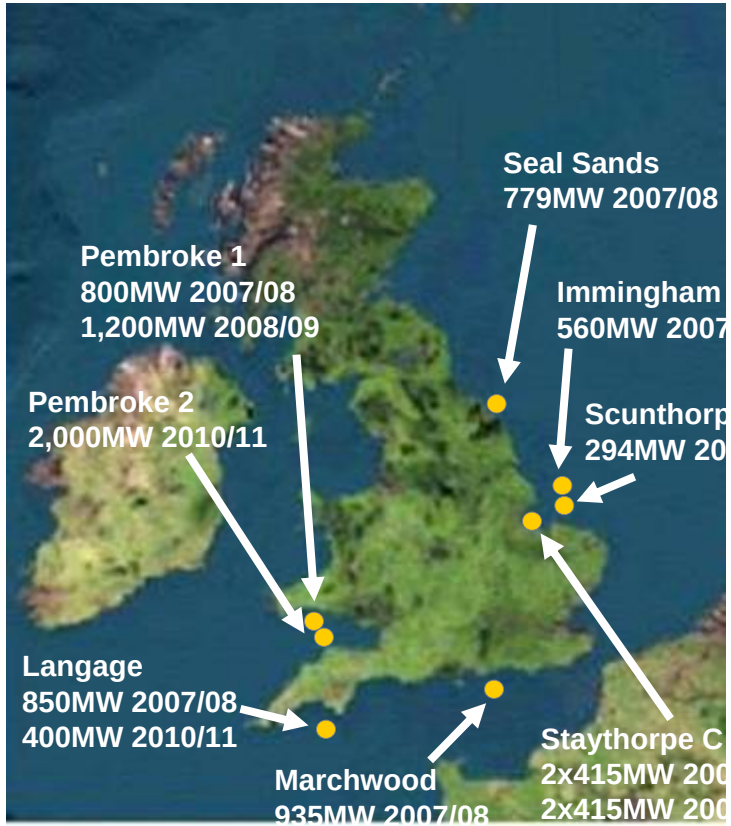
‘Reactive based’ (e.g. repair/replace on fail	‘Interval based’ (e.g. maintain at a set interval, replace at asset life)	‘Condition based’ (e.g. maintain/replace based on condition)	‘Risk & Criticality based’ (e.g. maintain/replace assets with the highest risk and greatest importance)

Increasing maturity of asset management based on fundamental materials research to predict lifetime of current and future materials

Changing sources of electricity



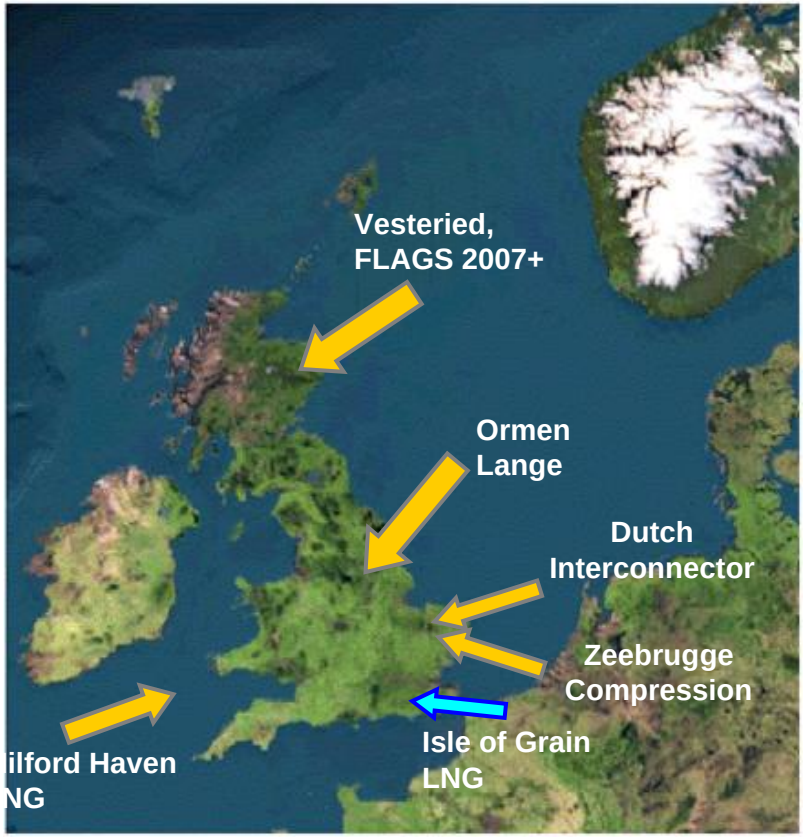
Potential wind developments

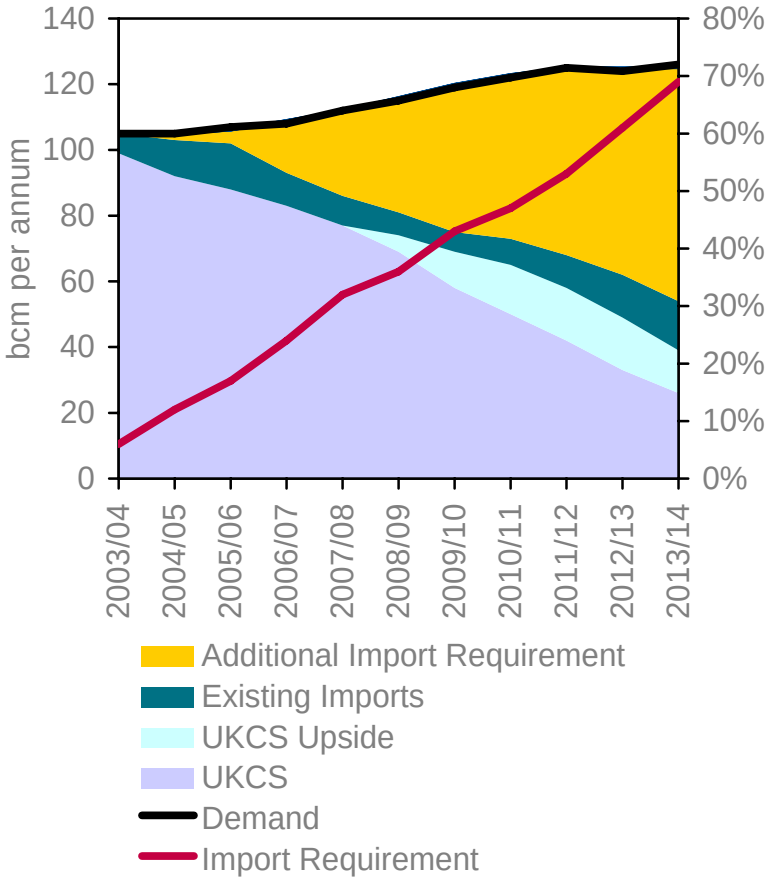


Potential gas-fired plant

nationalgrid
The power of action.

Changing sources of gas





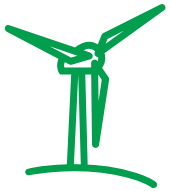
nationalgrid
The power of action.

The Challenge of UK Renewable and emissions targets

National Grid has developed Green 'hypotheses' which assume;

- 100% domestic compliance
- EU 15% target for renewables in GB met in 2020
- emissions reduce along a trajectory towards CO_2 target by 2050

Developing these hypotheses helps us understand the drivers, needs and trade-offs.



Low Carbon Electricity

A collaborative effort amongst the big stakeholders to connect wind by 2020

Low Carbon Energy

Significant behavioural change amongst all parties which leads to green action.

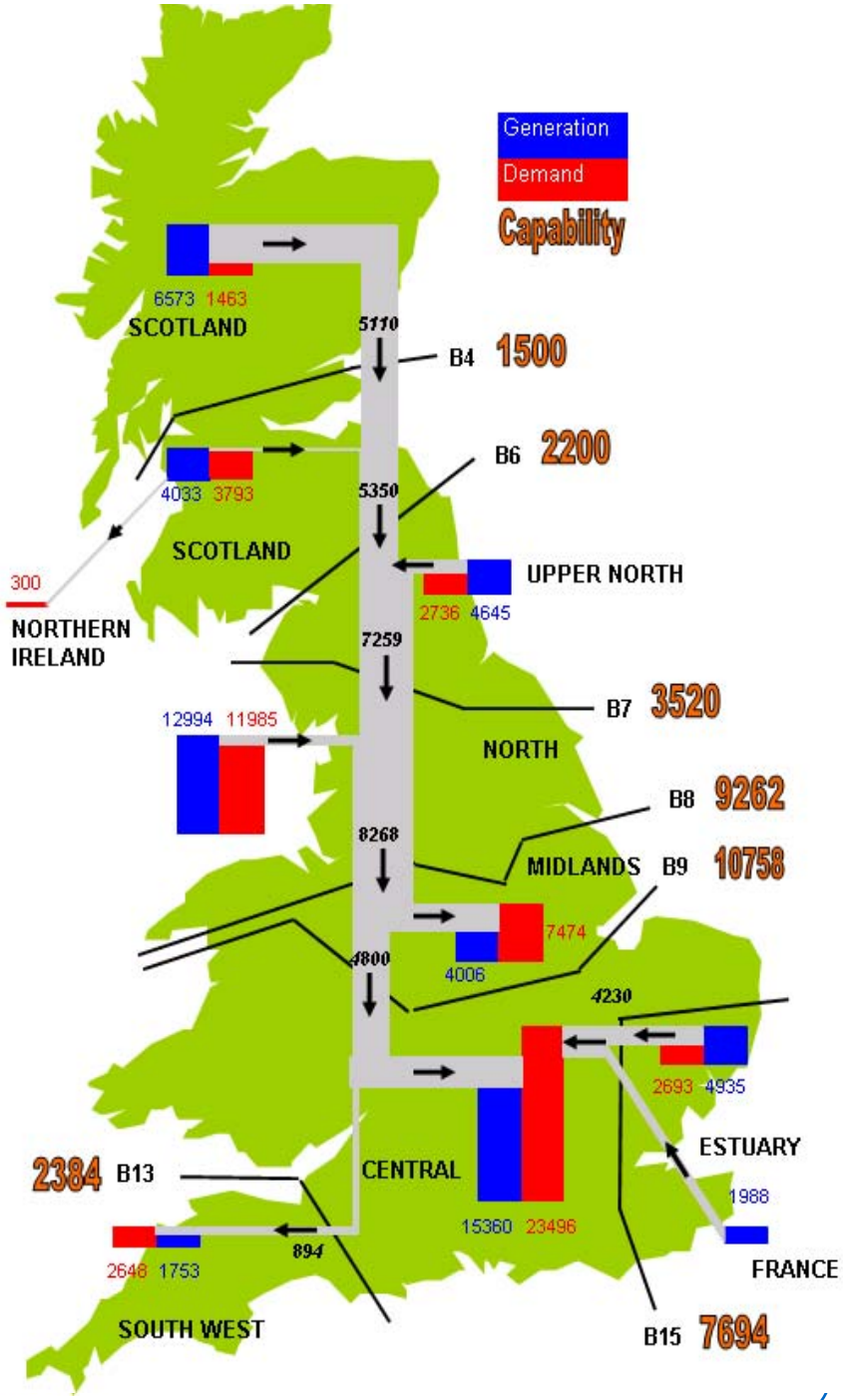
nationalgrid
The power of action.

2008 to 2020 Flows

Very heavy flows from North Scotland, through Scotland and Upper North England

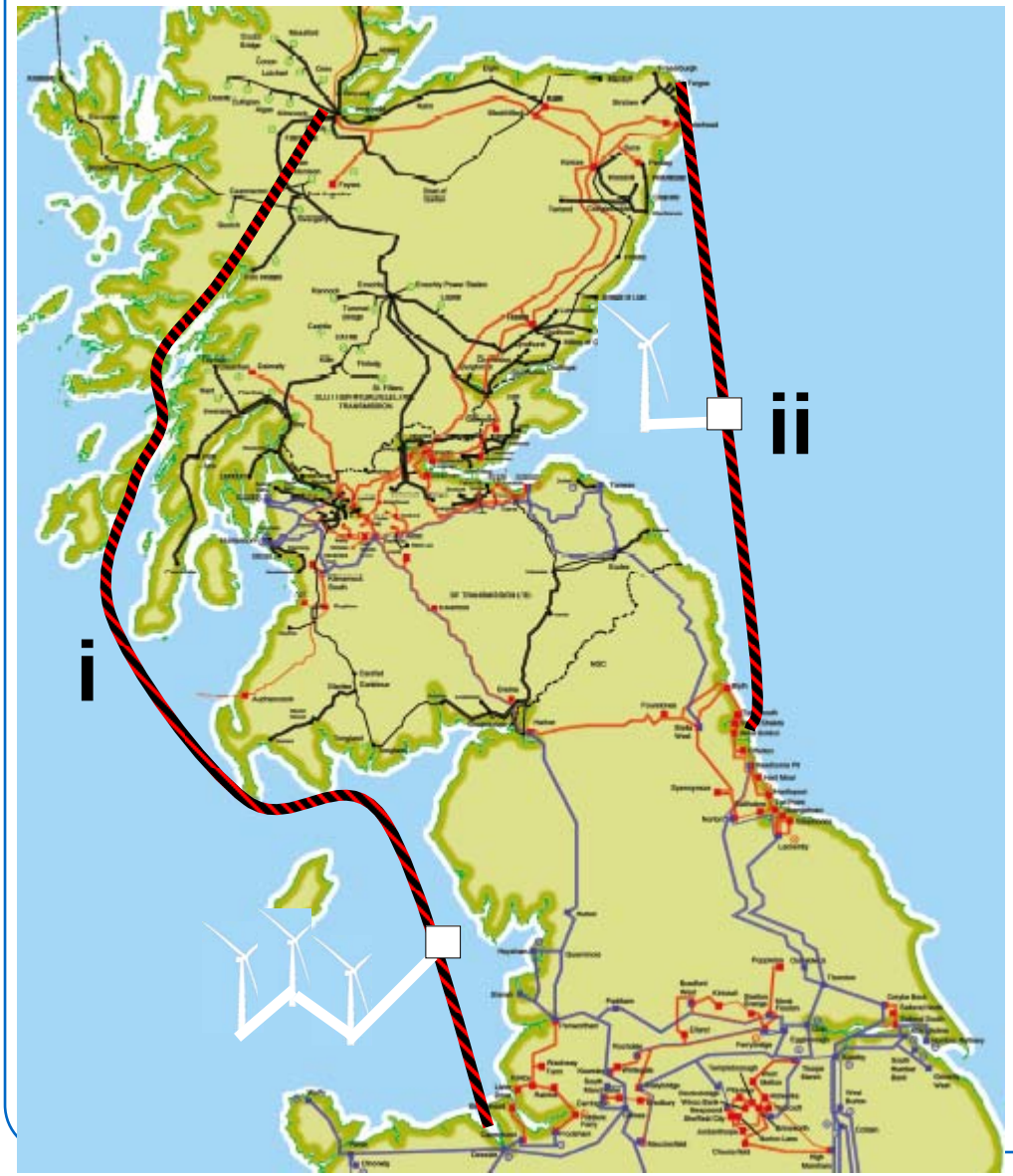
High volume of offshore wind farms off East Coast

Potential for Central Wales renewable generation



Getting Renewables from Scotland

Possible solutions, Offshore HVDC – providing additional capacity



Accommodates 10 GW of renewables from Scotland

Option of connecting 4 GW of offshore wind

Materials transmission challenges in HVDC cables and associated technology including control devices

Beauly – Deny line is a pre-requisite

nationalgrid
The power of action.

Getting Renewables from Scotland

Alternative option – Incremental Onshore Reinforcements – getting more out of existing capacity

Accommodates 10 GW of renewables from Scotland

Option of connecting 2 GW of offshore wind

Use of FACTS (Flexible AC Transmission systems) devices to improve stability limits.

Increase operating voltage – impact on current materials?

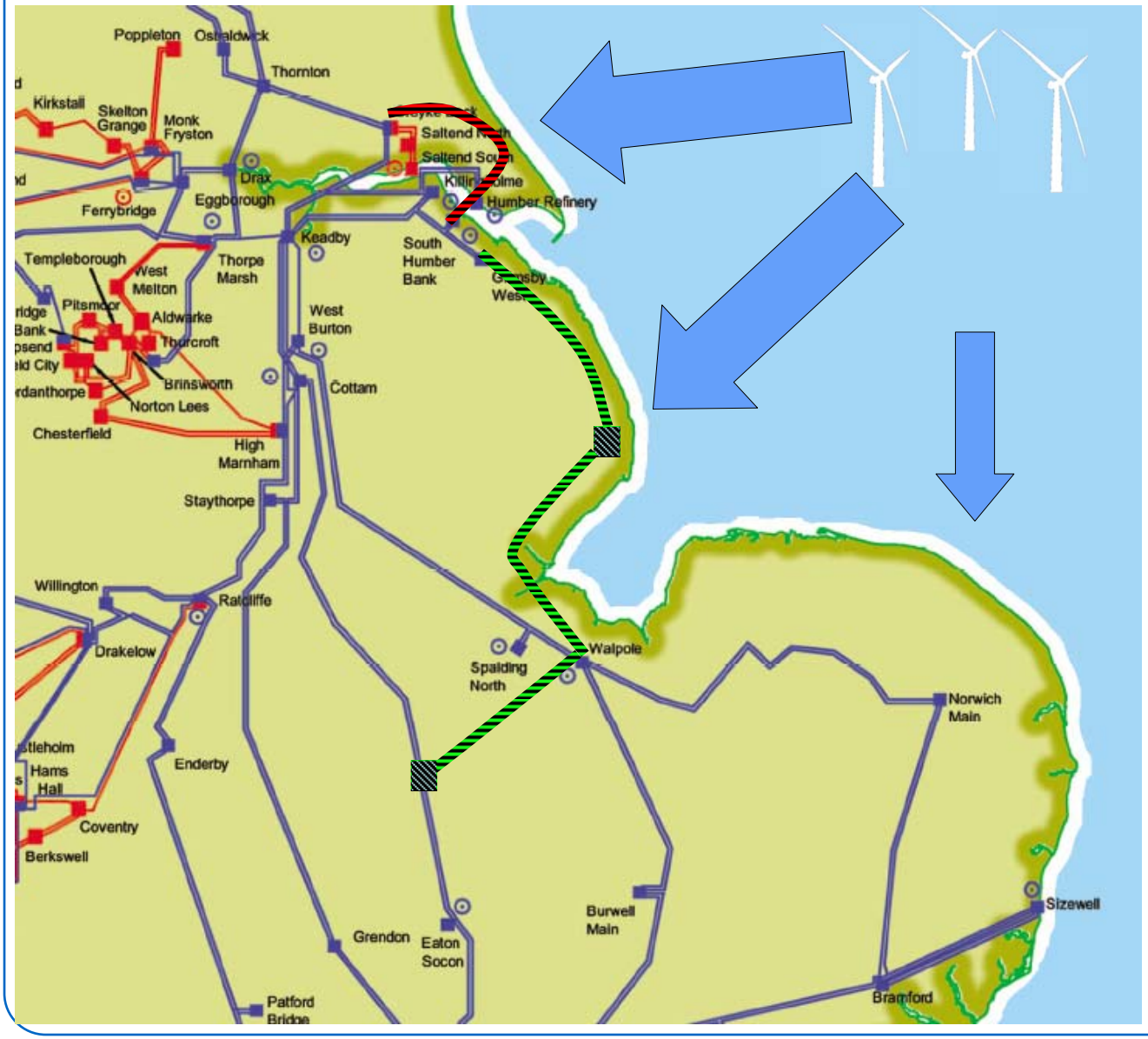
Convert HVAC to HVDC – impact and development of materials

Improved control systems to improve stability limits – HTS, semiconductors.

Beauly – Deny line is a pre-requisite

Connecting East Coast offshore wind

Possible solution to series of east coast radial connections



Facilitating large volumes of wind off of the East coast in a congested part of the network

Required Investment to accommodate offshore generation

New lines AC/DC

- **New conductors**

Rating of Switchgear

- **Fault level 80KA +**
- **Continuous rating 5000A+**
- **Through new materials or working current materials harder and reliably?**

nationalgrid
The power of action.

Conclusions for electricity transmission

- **WE will have to drive the Transmission system harder then ever before.**
- **If we are to meet renewable targets we need to start developing transmission system now.**

SO

- WE **ALL have some exciting challenges ahead that need the support of materials research and technology.**
- HOW **do WE ALL ensure that materials technology is available to required timescales?**

Alternative energy fuel transmission

- **Pipe material developments – targeted both to improve current performance and to extend usage to alternative usage**
- **Low cost cryogenic materials – for liquefied natural gas to increase flexibility of transmission network**
- **Corrosion resistant material – allowing mixed usage or hydrogen**
- **Coatings – improved flow**
- **Sensor developments – improved condition monitoring of ageing assets**
- **Smart materials – detecting condition and potentially self healing**

Where is the combined market for new materials solutions driving short to long term?

- **Construction – current materials and materials from other industry sectors**
- **Resilience to climate change issues – flooding, higher temperatures, wind**
- **Condition monitoring and assessment – sensors and knowledge**
- **Low loss materials – overhead line conductors, coatings for pipes, will HTS ever be reliable enough for transmission?**
- **Alternative energy networks – will hydrogen or carbon dioxide networks emerge, will the materials technology need to evolve or adapt new pipelines?**
- **Alternative transformer and circuit breaking options – non-mineral oils or different transformer designs, an alternative technology or gas to sulphur hexafluoride**
- **More flexible plant – control devices based on HTS or semiconductor technology, multipurpose pipes, composites**
- **Smart materials – self healing materials based on nanotechnology research**

Thank you

Jenny Cooper

nationalgrid

The power of action.