An overview of the development, operation and future challenges of the electrical grid

Dr Jenny Cooper

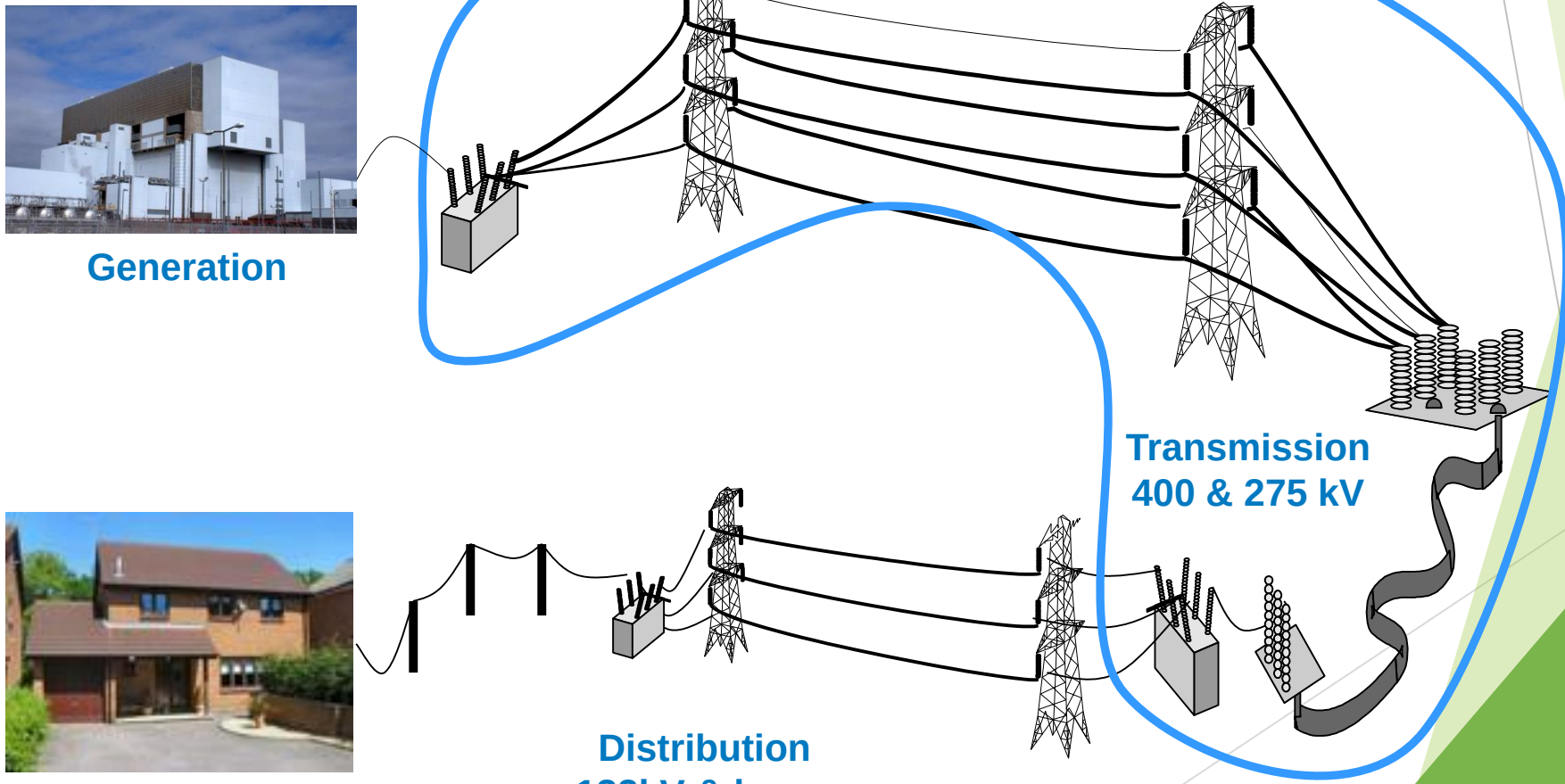
Outline (not necessarily in this order but with some interchangeability)

- Who am I?
- The Energy Industry – an overview and the challenges
- Innovation landscape funding
- Skills
- Thoughts

Who am I?

- Grew up in Warwickshire, educated at a girls school
- Graduate physicist from Durham University
- Doctorate in Electrical Engineering from the University of Manchester
- Worked for over 27 years in the energy industry
- Volunteer in charities, hospital and education
- Wife and Mum

The electricity industry – an overview



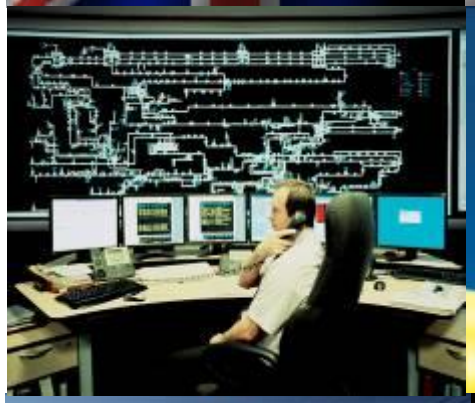
National Grid's Business

50:50

UK

US

Transmission

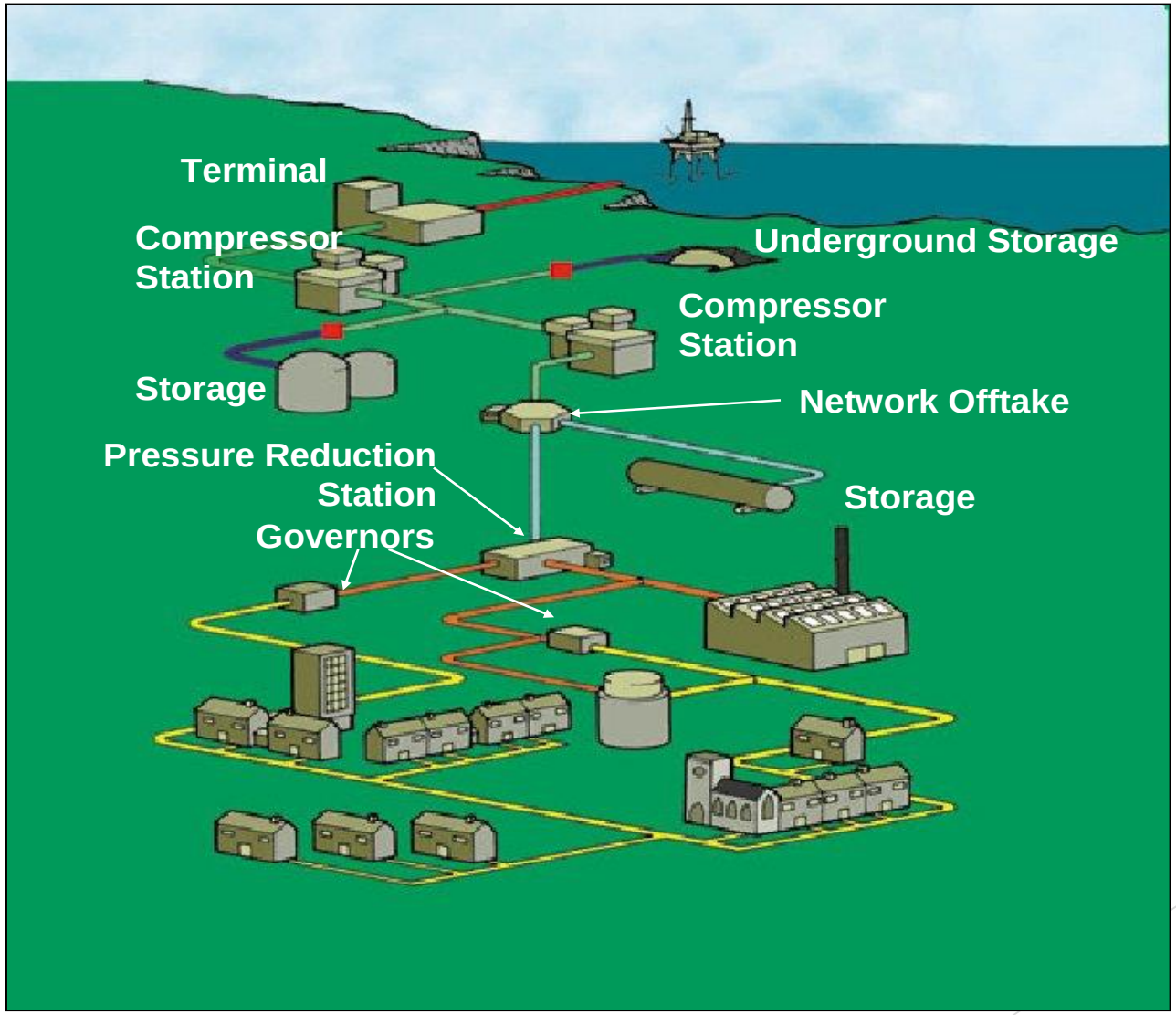


Distribution

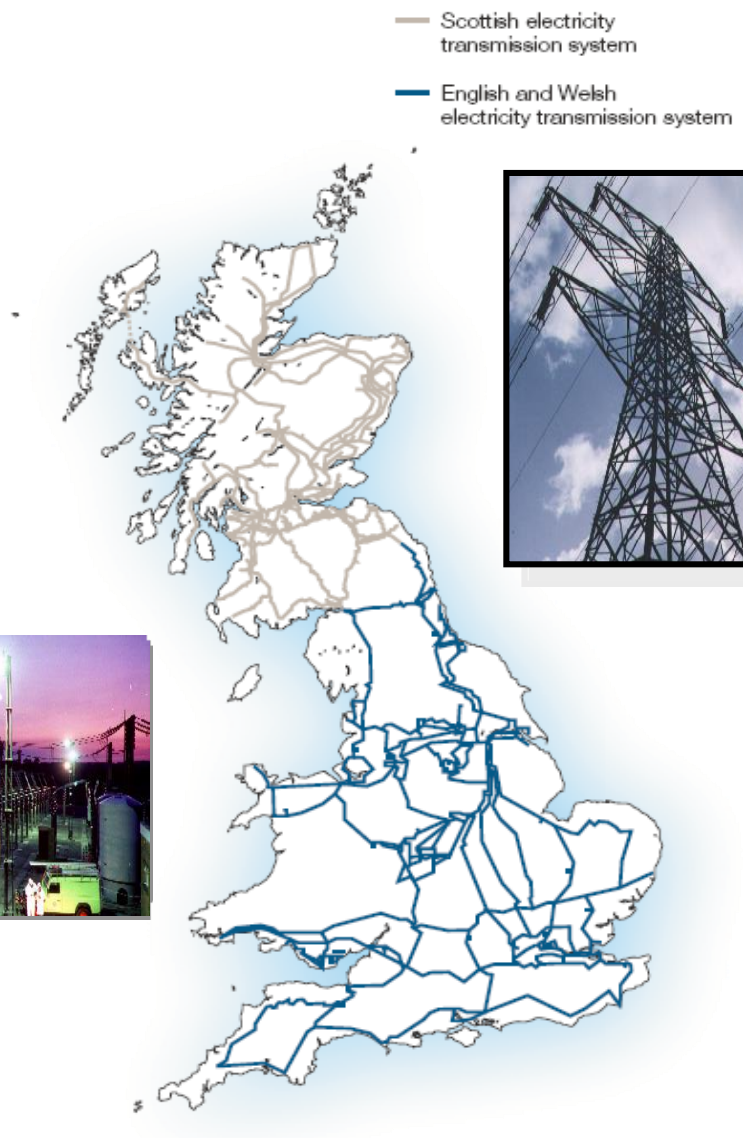
Electricity

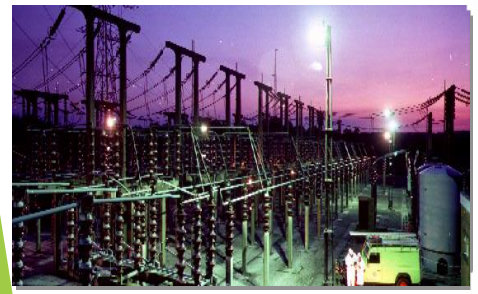
Gas

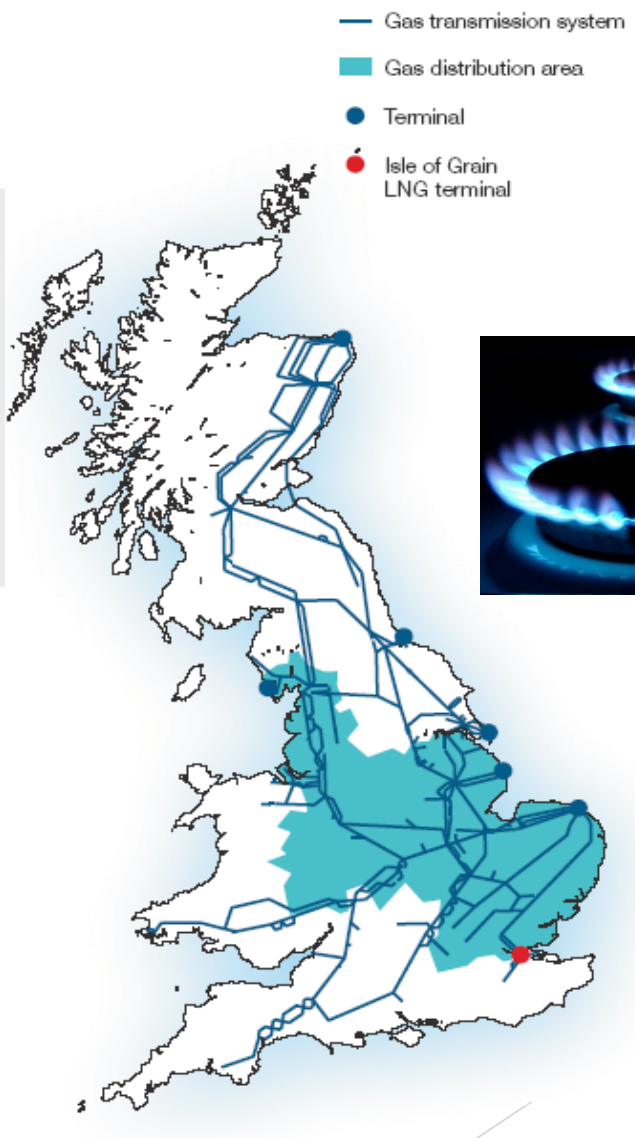
Gas: From Beach To Meter



National Grid - UK







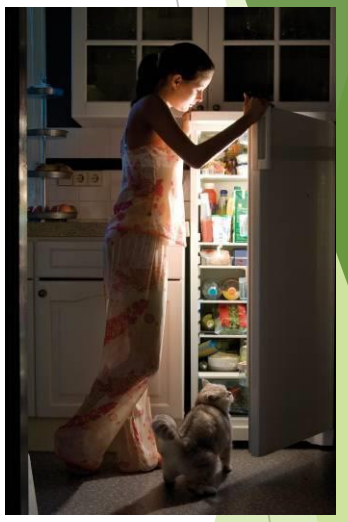
Regulation

- The energy industry is regulated by:

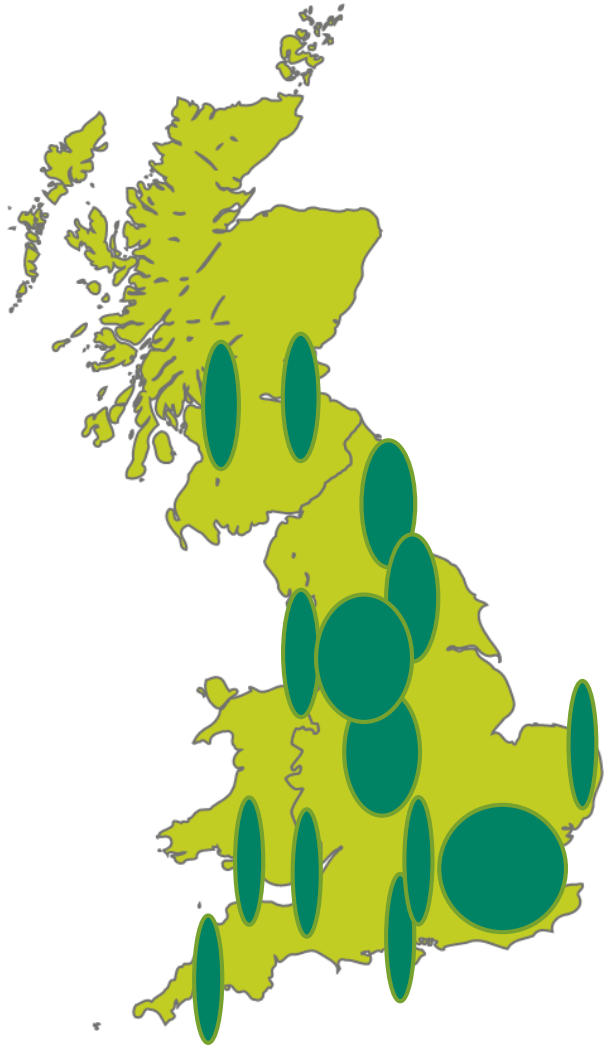
ofgem Making a positive difference for energy consumers

- Revenues are set by Ofgem for Price Control Periods
- Companies must prove they are spending customers money wisely
- They are incentivised to:
  - Work sustainably
  - Provide good customer service
  - Invest efficiently to ensure safe & reliable service
  - Include stakeholders in our decision making process
  - Use innovation to develop solutions to challenges

What is Demand?



Where are the biggest demands?



MW Average Demand *2010*

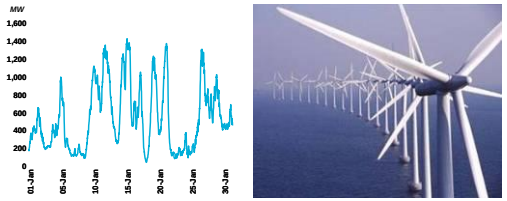
Greater London	12000
Manchester	3300
Birmingham	1200
Leeds	1000
Glasgow	850
Edinburgh	730
Sheffield	680
Liverpool	570
Bristol	530
Cardiff	470
Newcastle	380
Southampton	300
Plymouth	300
Oxford	250
Norwich	170

Source: DECC

…It Becomes Obvious

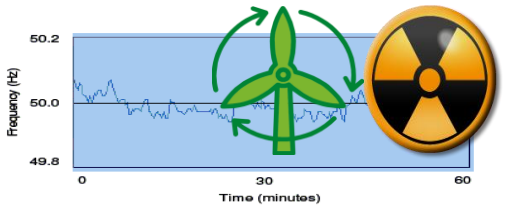
Balancing Generation with Demand

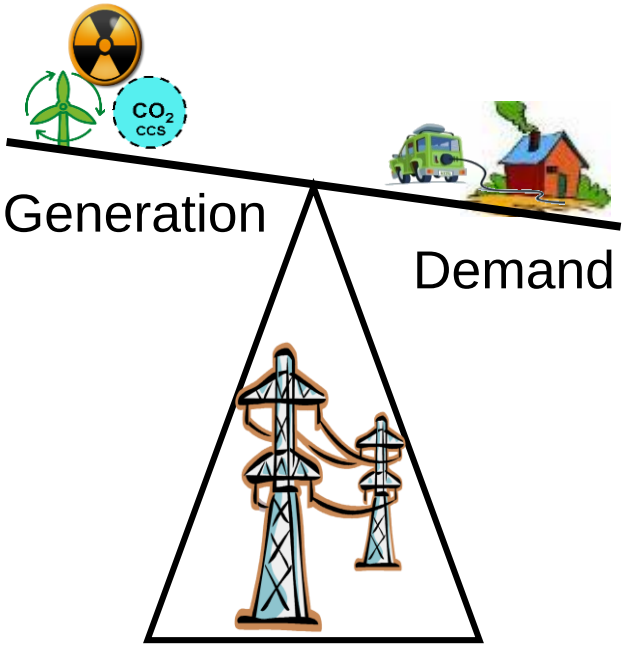
Variable generation



Large generation

Inflexible generation





Passive Demand

Industrial

Domestic

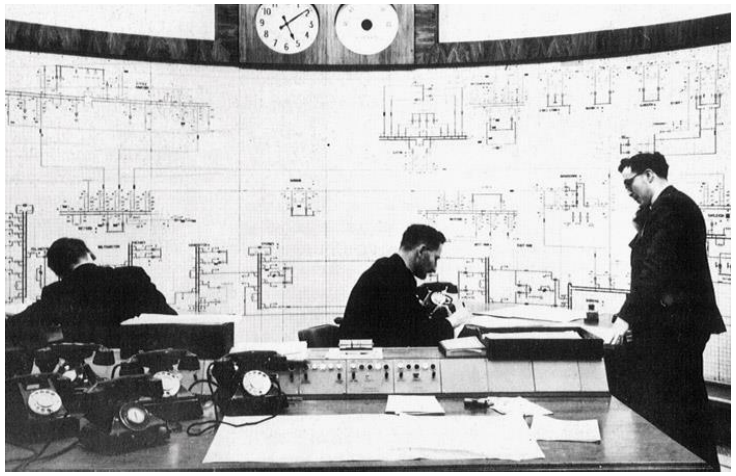
Active demand

Industrial

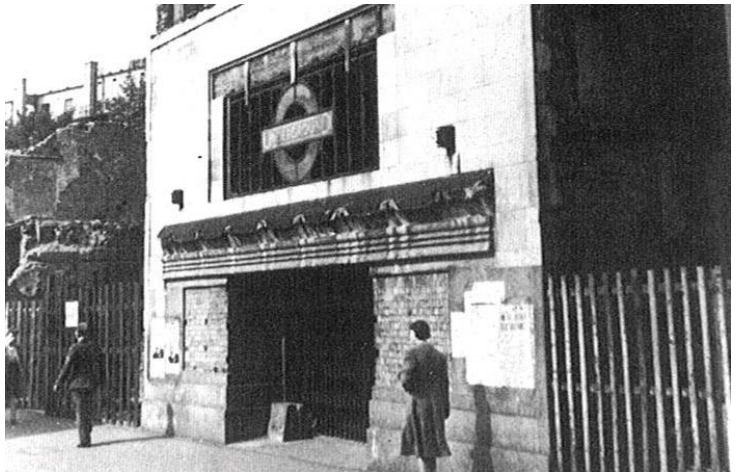
Domestic

Distributed generation

National Electricity Control

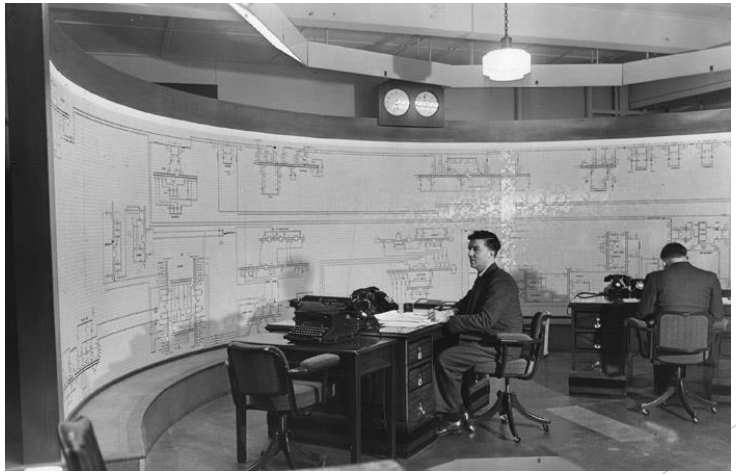


1938 – Start of National Control



1939 – Move Underground for WWII

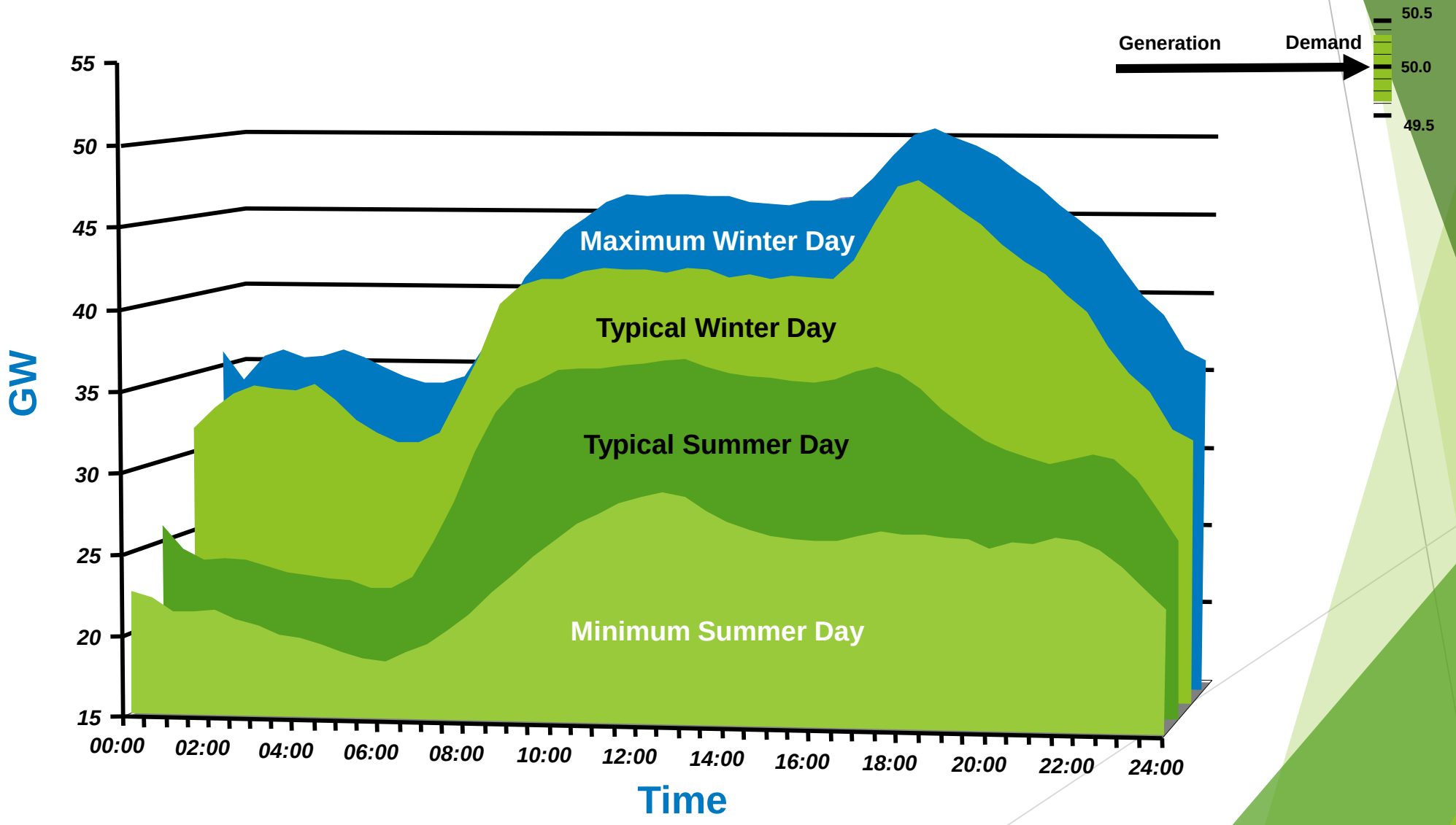
1950 – Move to Paternoster Square



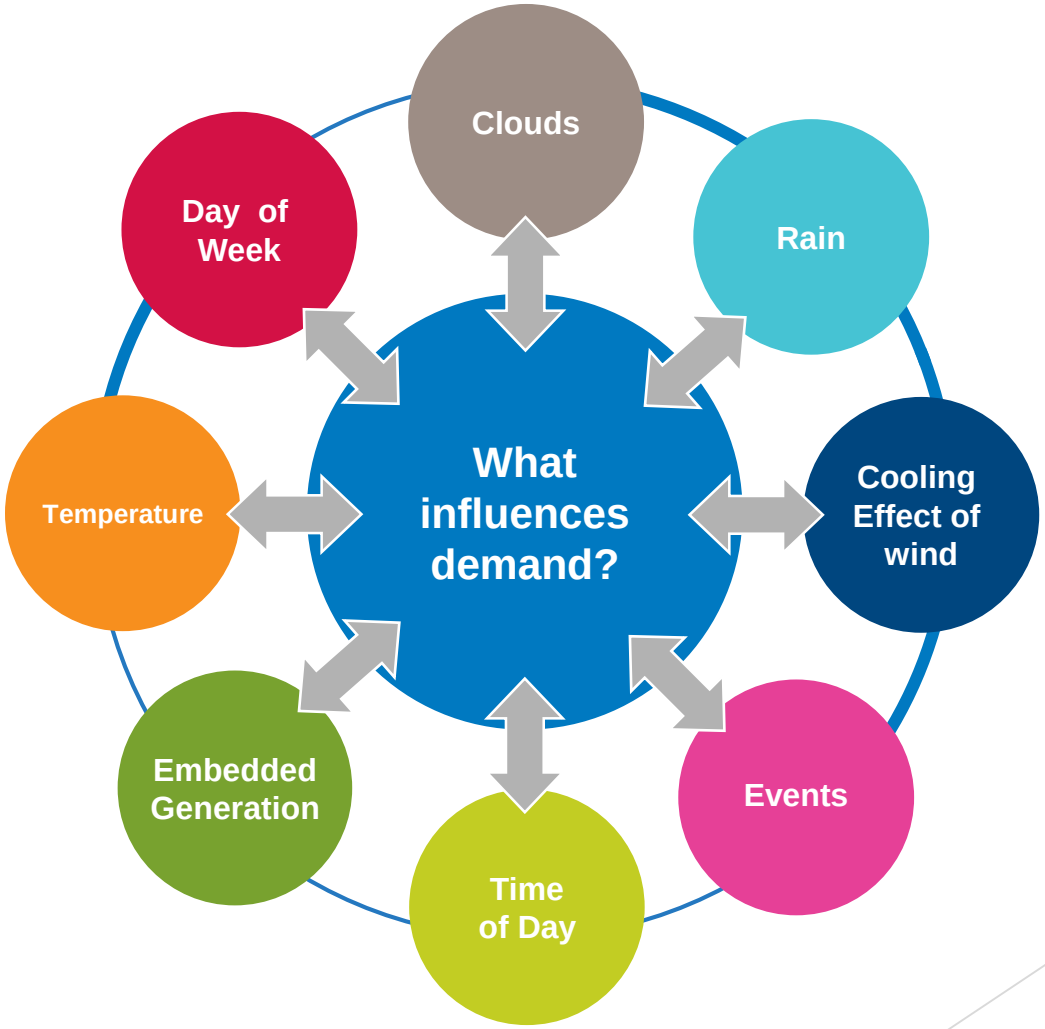
1950 – Inside Paternoster Square

Minute-by-minute control

Energy Balancing Seasonal Effects



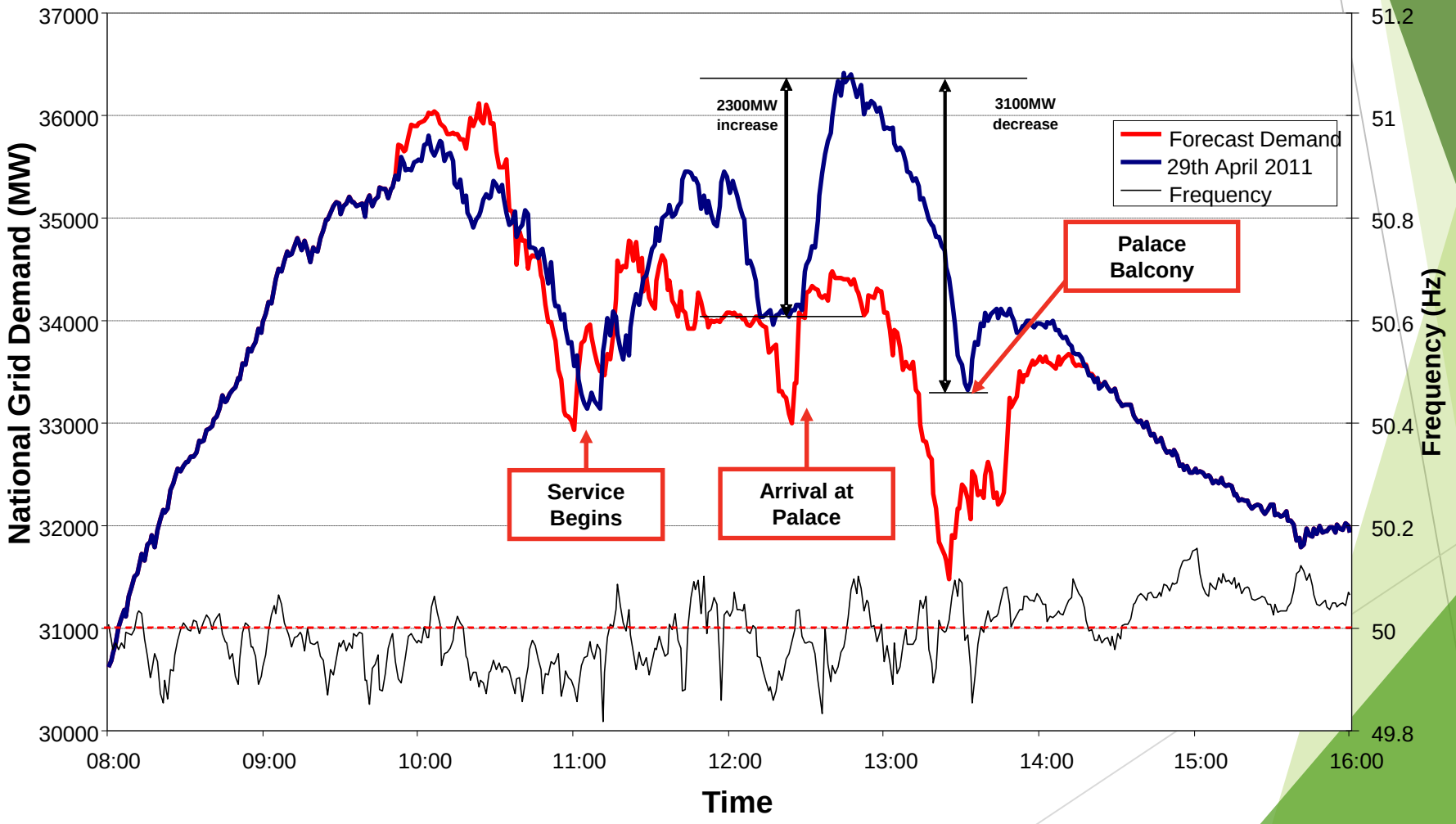
What Influences Demand?



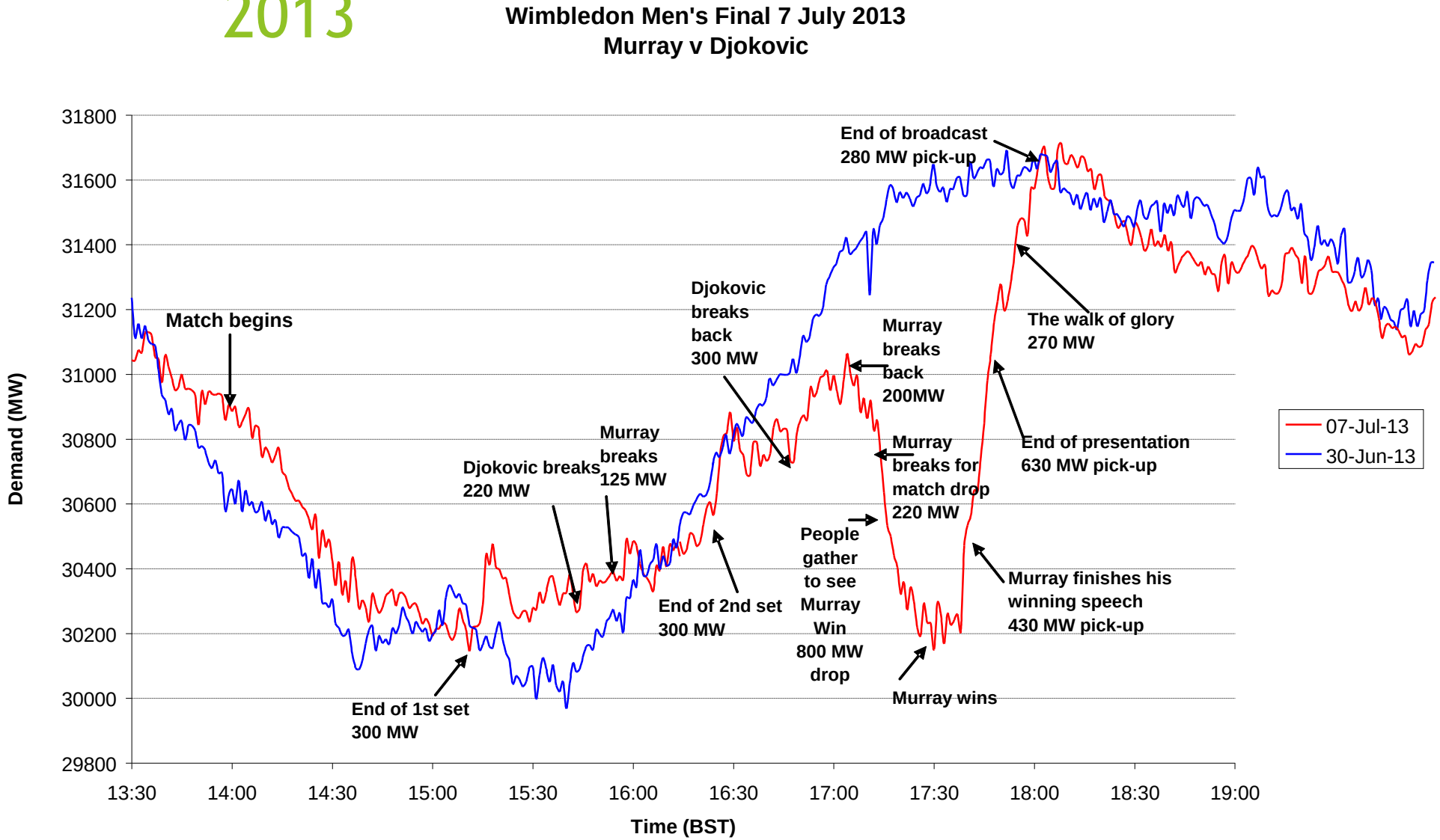
Frequency

52.0	Generators tripping
50.5	Upper statutory limit
50.0	Normal operating frequency
49.5	Lower statutory limit
48.8	Demand disconnection starts
47.8	Demand disconnection complete

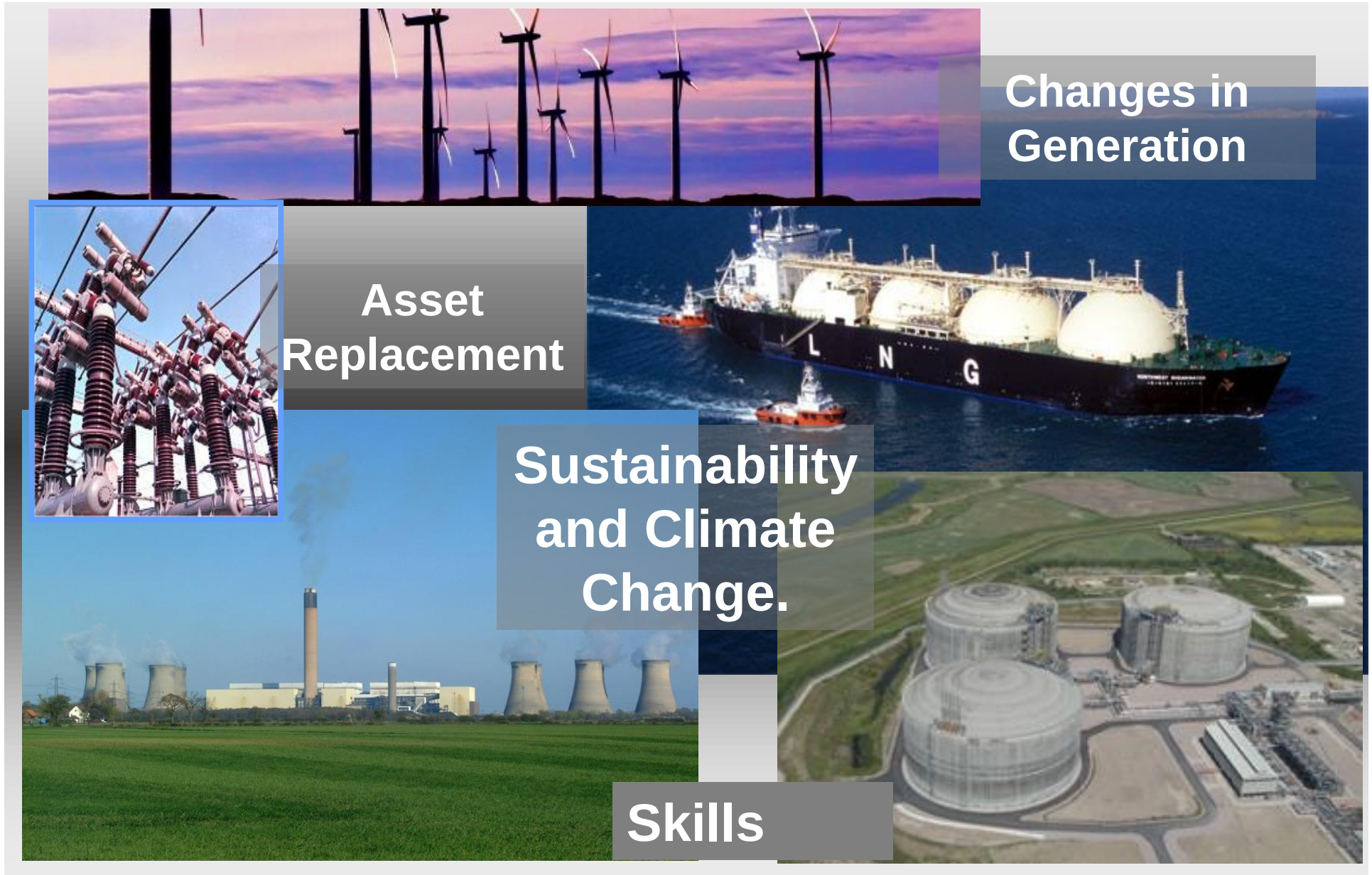
Royal wedding 29th April 2011



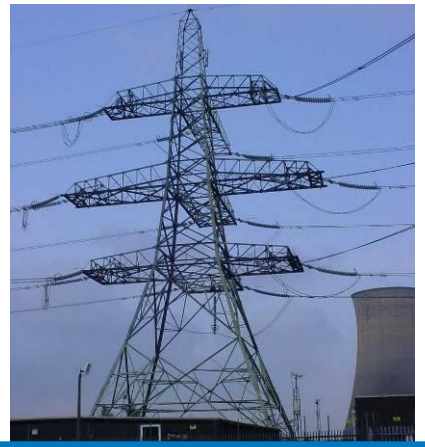
Wimbledon Men's Final 2013



What's Happening in Energy?

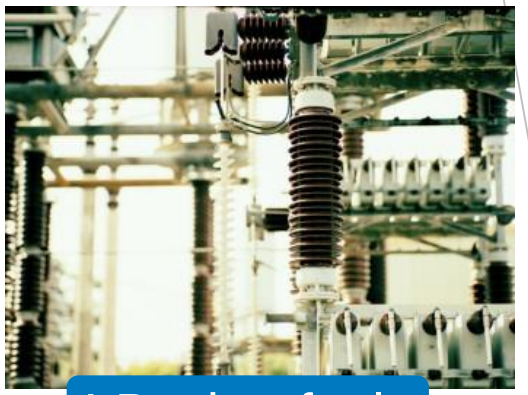


Faults on the System and Annual Stats



2 Double circuit faults
6 Simultaneous faults
105 Single circuit faults

5 Cable faults



4 Busbar faults

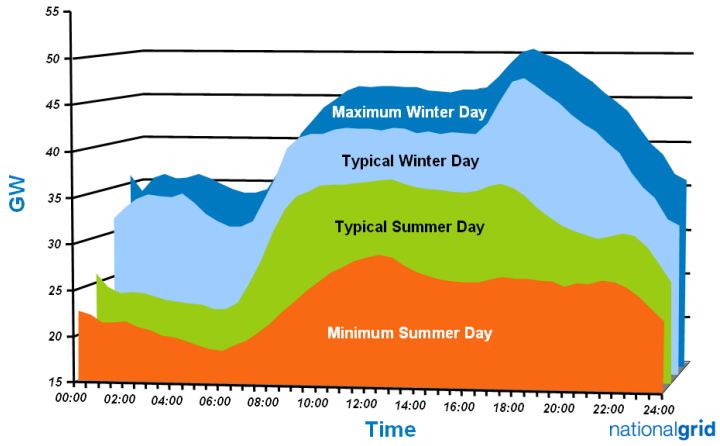
10 Transformer

21 Circuit Breaker faults

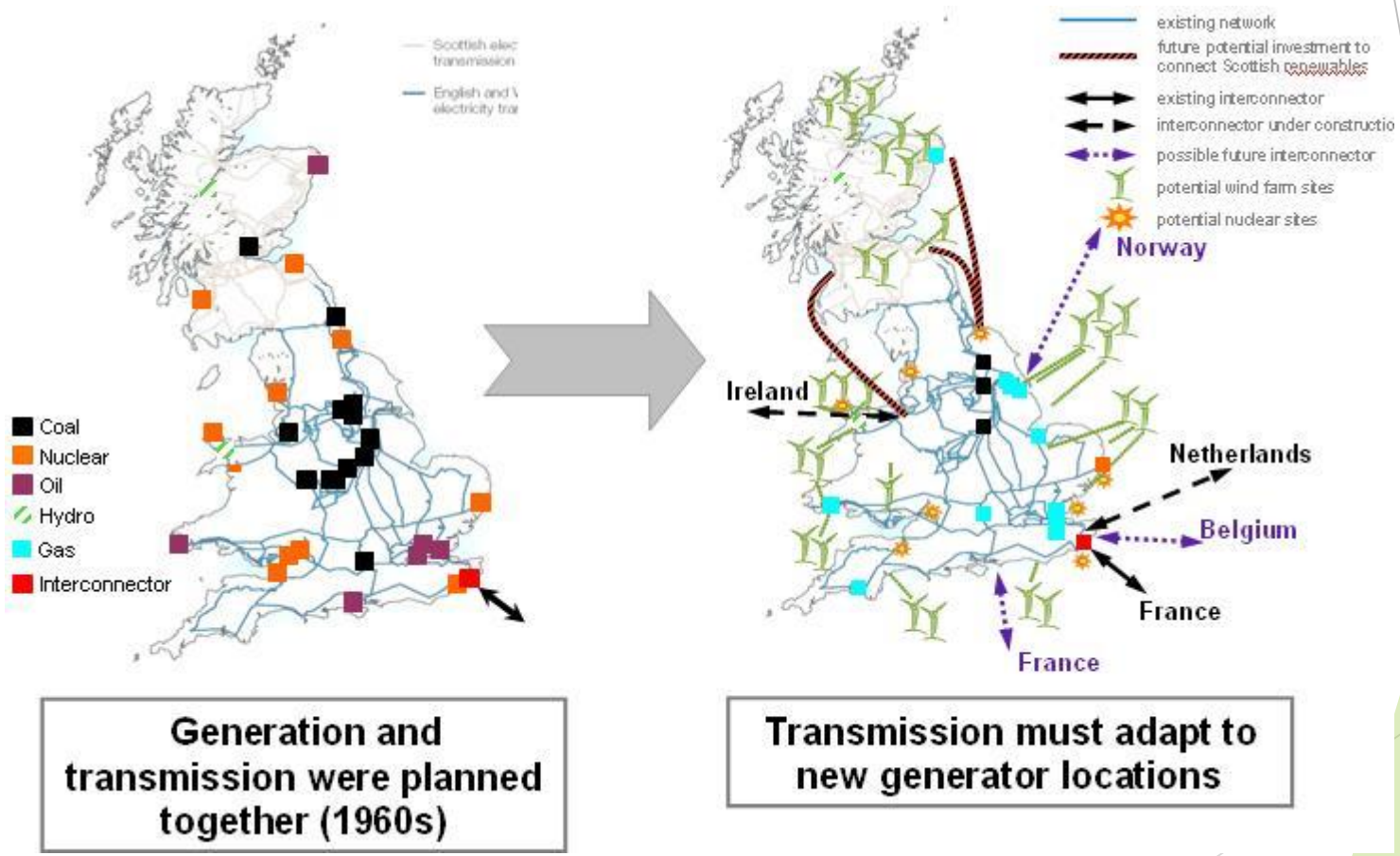
2000 Protection or Communication failures

When it goes wrong : Willesden QB Failure

The Times They Are A-Changin’



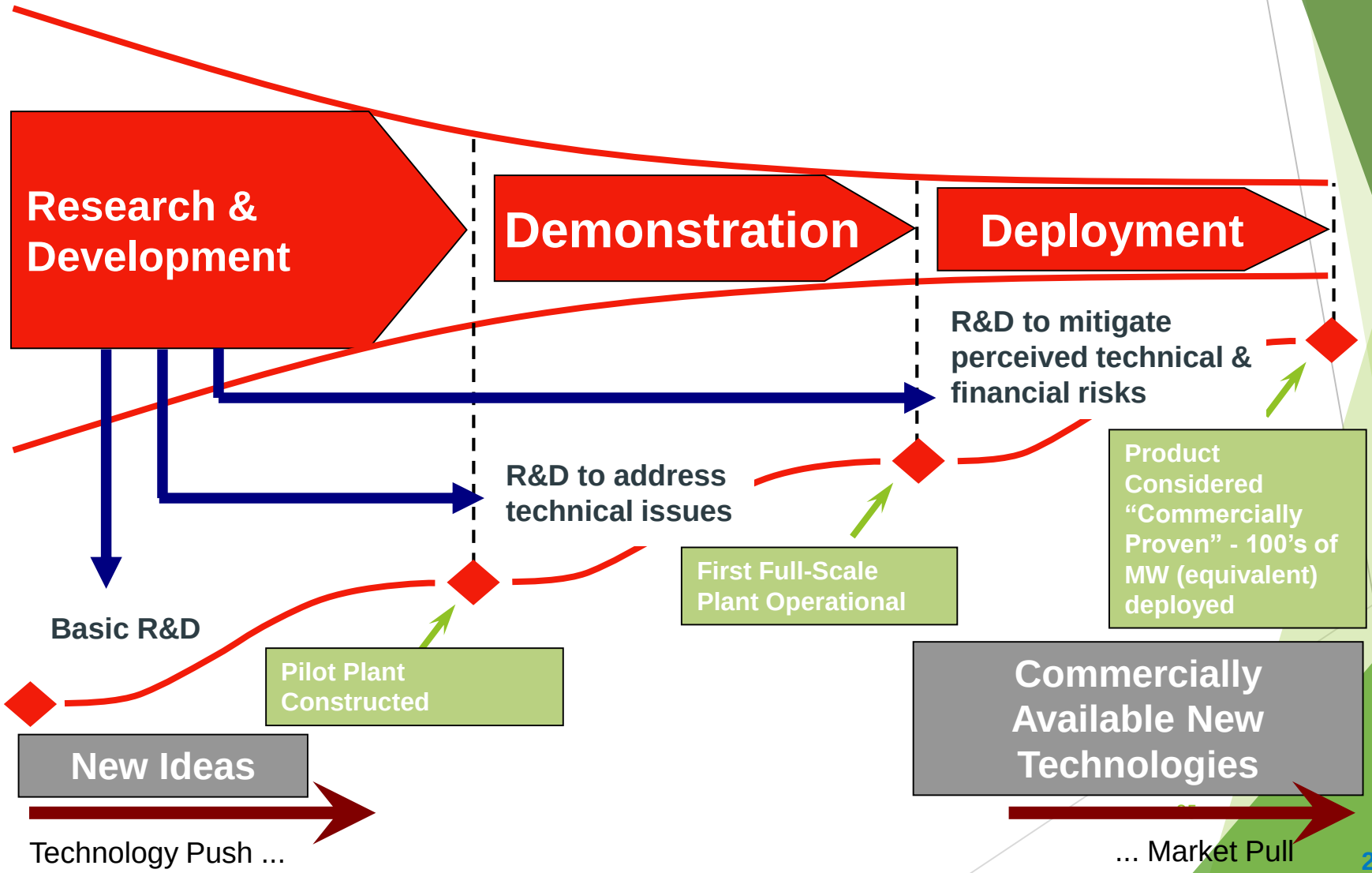
Future Transmission Network



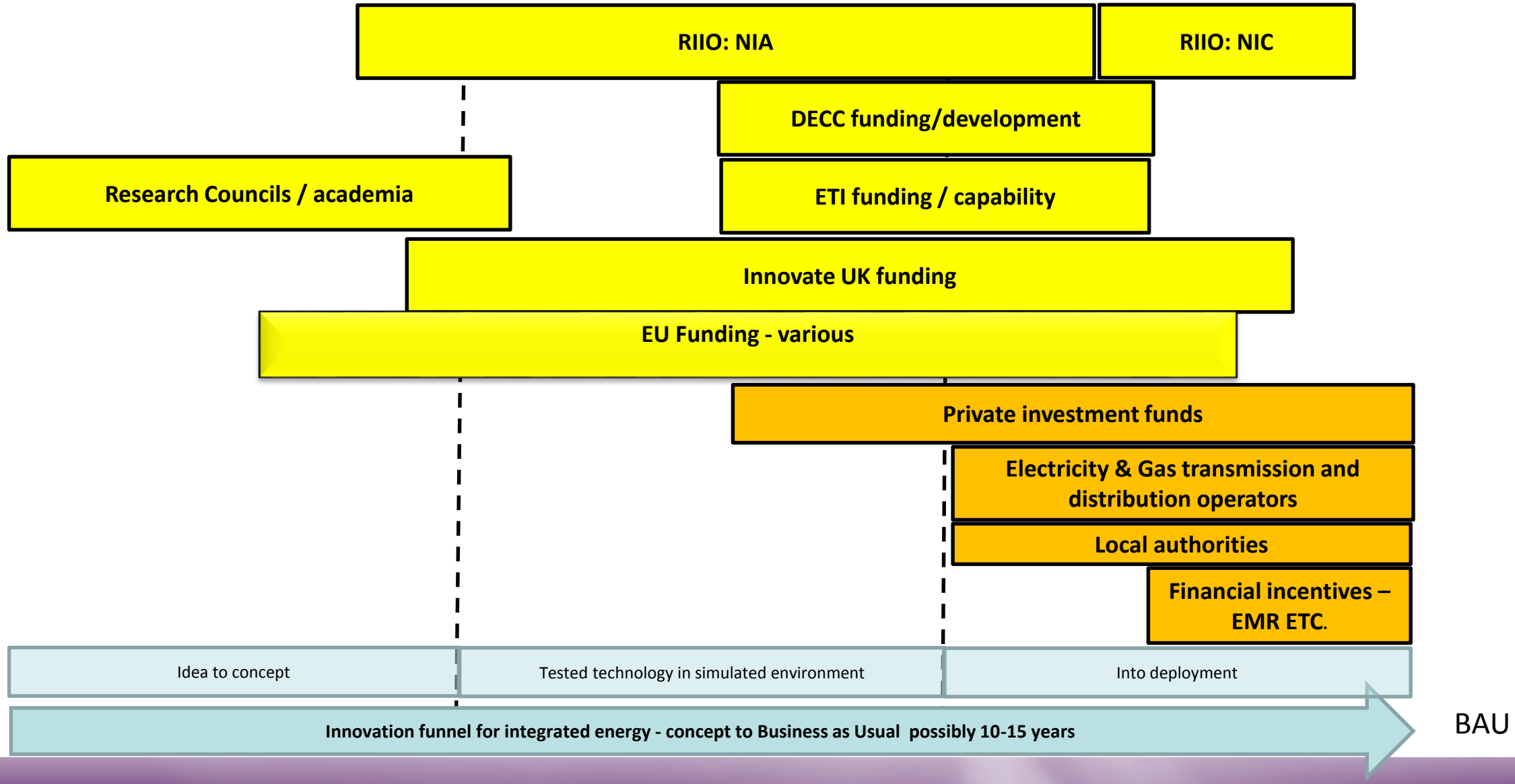
Generation and transmission were planned together (1960s)

Transmission must adapt to new generator locations

Innovation Lifecycle



UK innovation support landscape



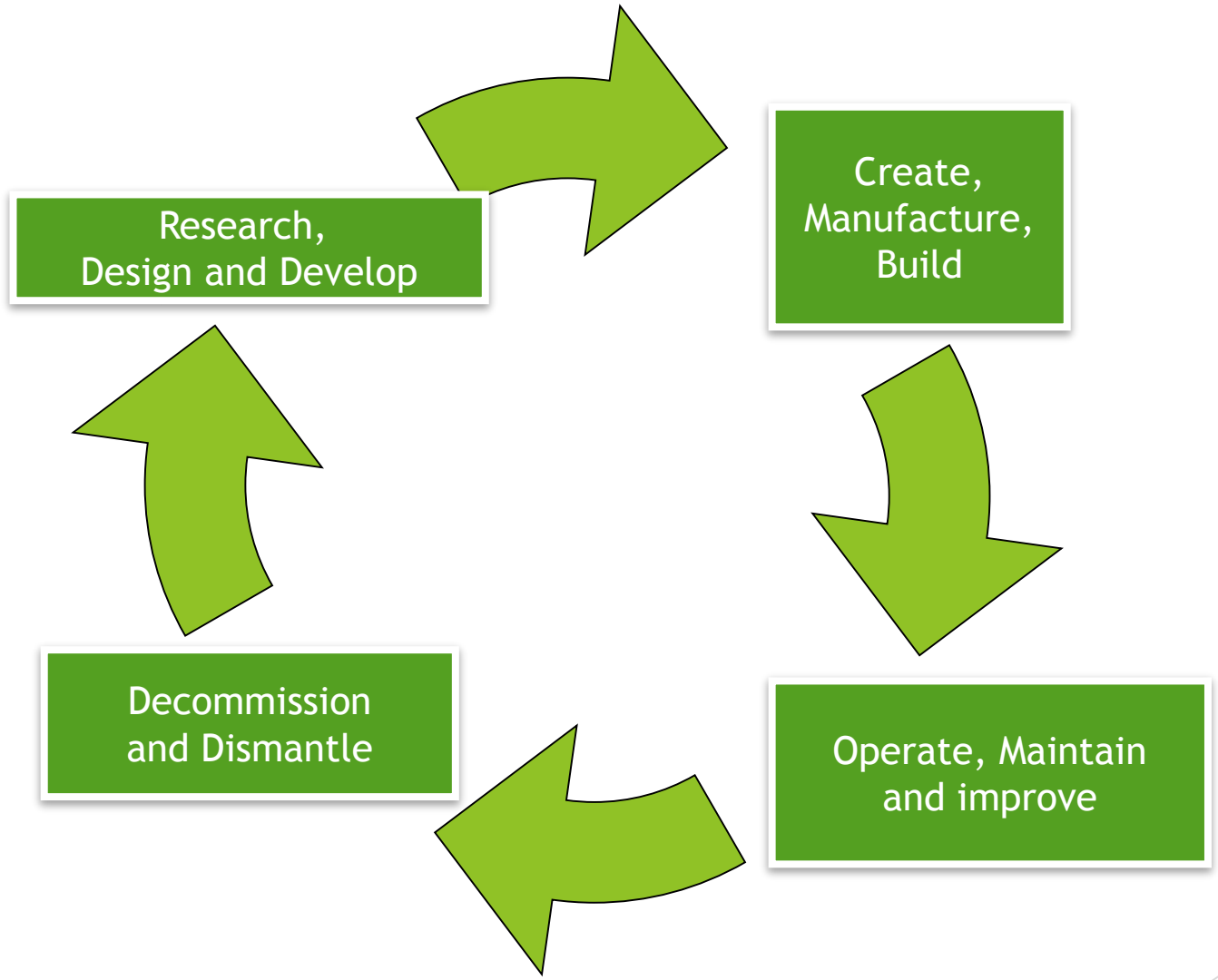
Climate Change/extreme weather



It’s a £200 billion Engineering Challenge - that needs people with skills.



Why engineering?



Thank you for listening

- Questions?