



University of  
**Strathclyde**  
Engineering

# Setting the pace: Scotland's targets for sustainable energy

Dr. Graham Ault & Prof. Jim McDonald

University of Strathclyde

# Overview

- Current energy situation in Scotland
- Policies and targets
- Scotland's contribution:
  - Resources
  - Innovation
- Key actions required and planned

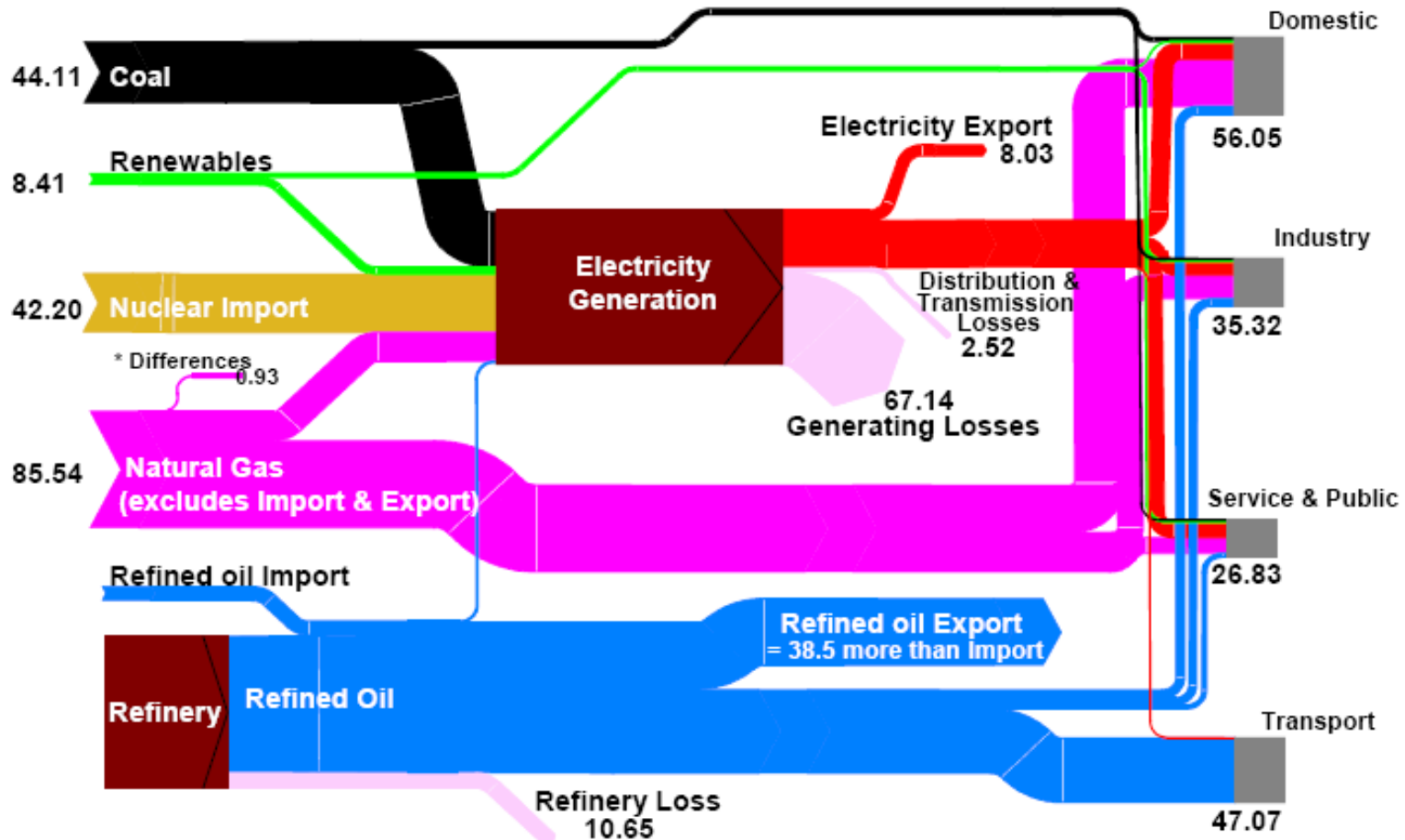


# Key Challenges for Energy in Scotland

- Should Scotland follow the same policy as the UK on energy?
- Can Scotland utilise natural energy resources and at the same time reduce greenhouse gas emissions?
- Can significant improvements in energy efficiency be made?
- Can Scotland stimulate the development and demonstration of alternative technologies given its R&D base and the innovative activities already taking place in the country?
- What decisions are needed to replace lost capacity in a manner that ensures security and continuity of supply?



# Scottish energy flows

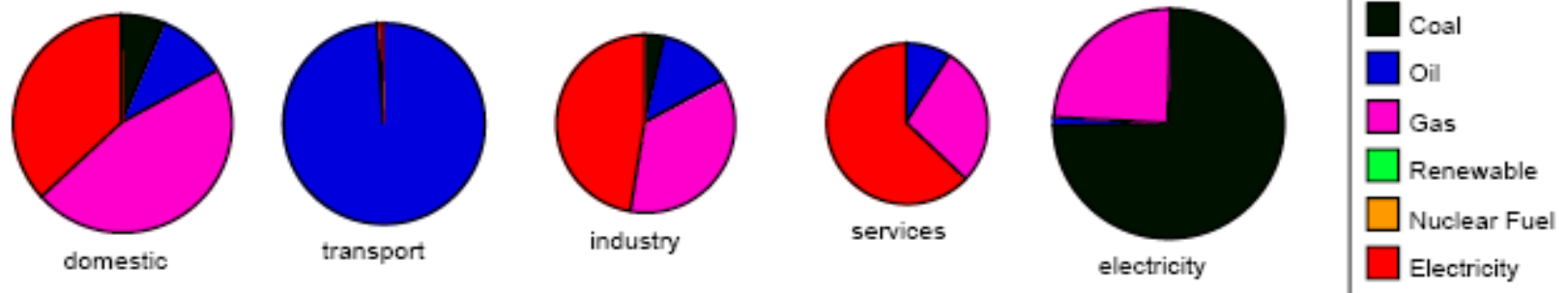


# Scottish energy supply and demand



- Natural gas, oil (especially for transport) and electricity are the predominant forms of energy delivered to end-users.
- Coal and nuclear fuel also make significant contributions via electricity generation.

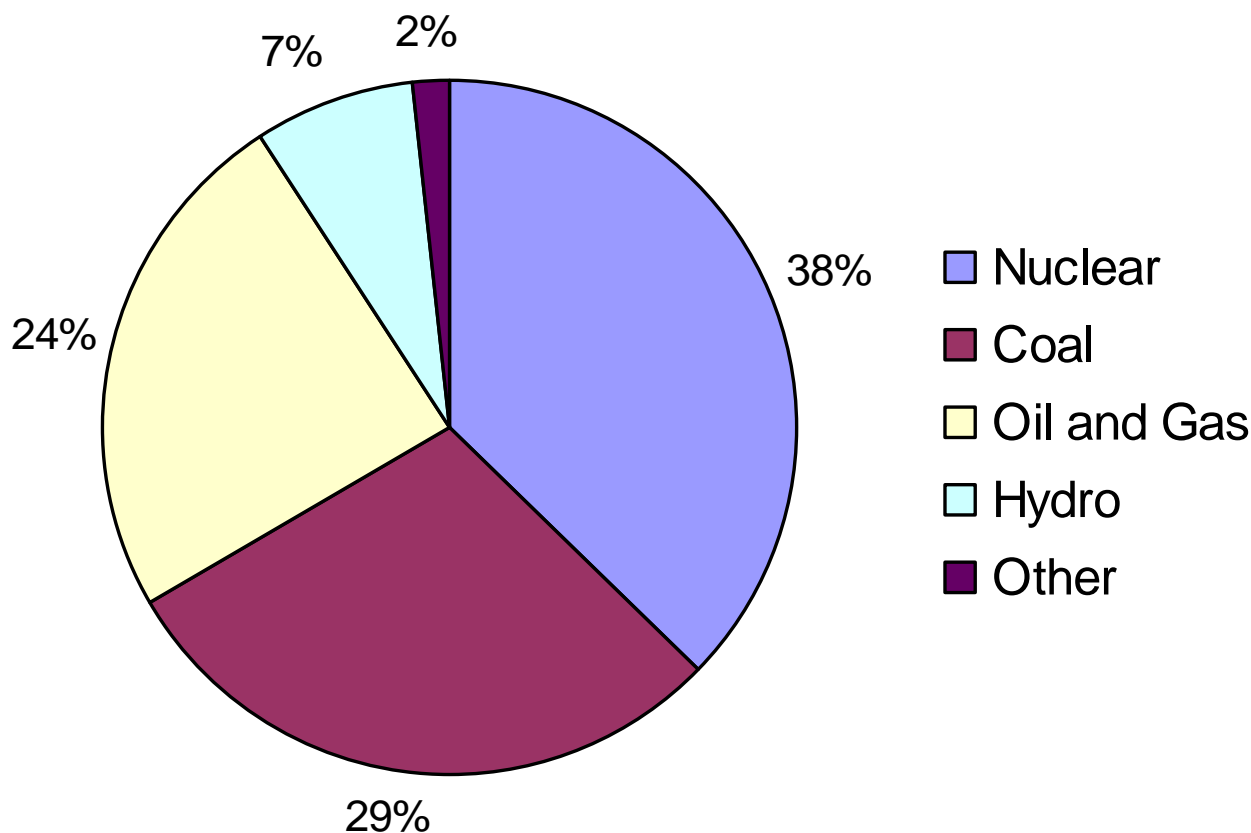
# Emissions from Scotland's energy sector



- UK generating 'basket' figure of 0.432 kg CO<sub>2</sub>/kWh for emissions from electricity generation.
- Over period from 1990-2003, Scotland has reduced emissions of methane (-35%), NO<sub>x</sub> (-16%) and CO<sub>2</sub> (-8%).
- Scotland's HFC, SF<sub>6</sub>, CH<sub>4</sub>, NO<sub>x</sub> and PFC emissions are higher than the UK average.

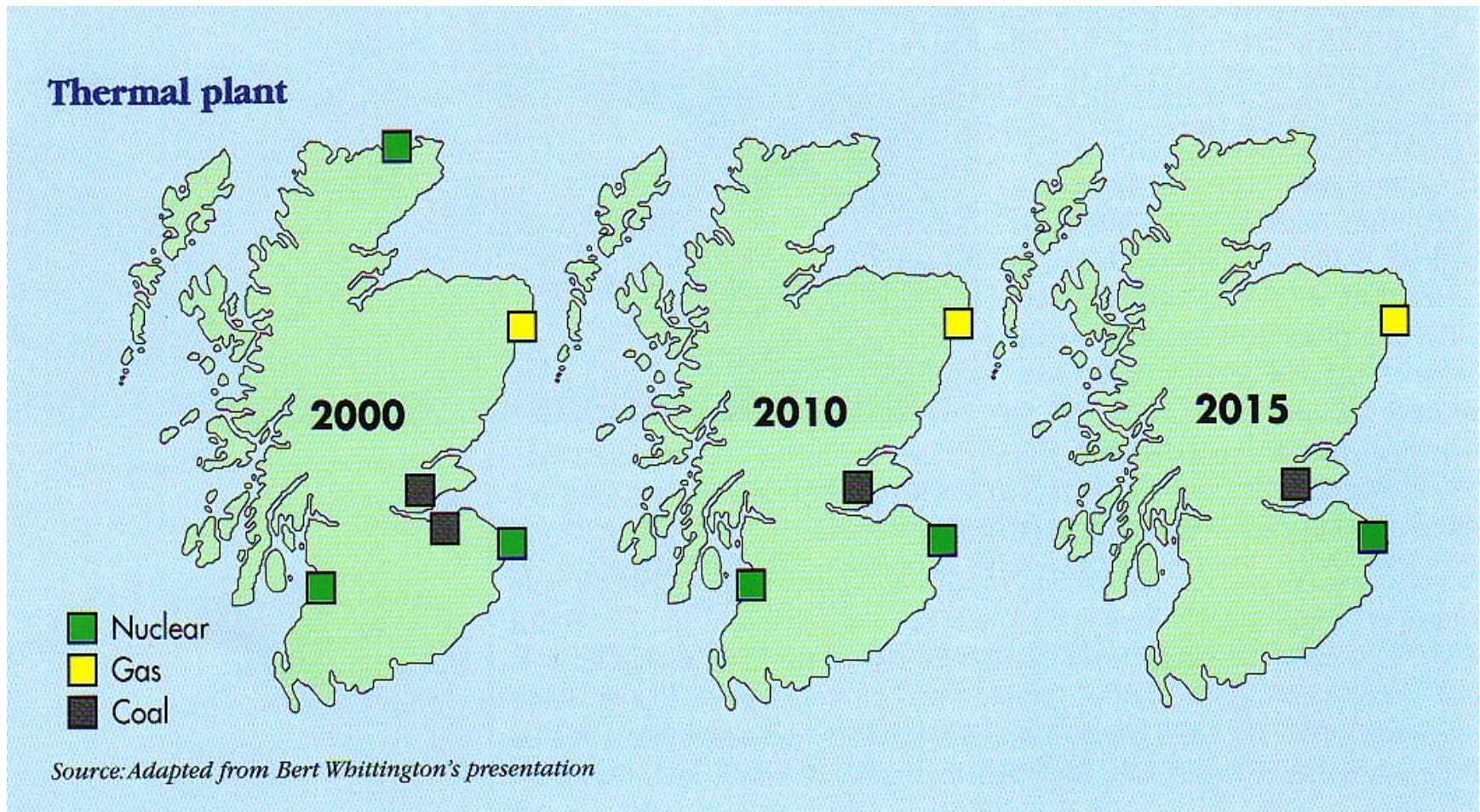


# Electricity Generation in Scotland



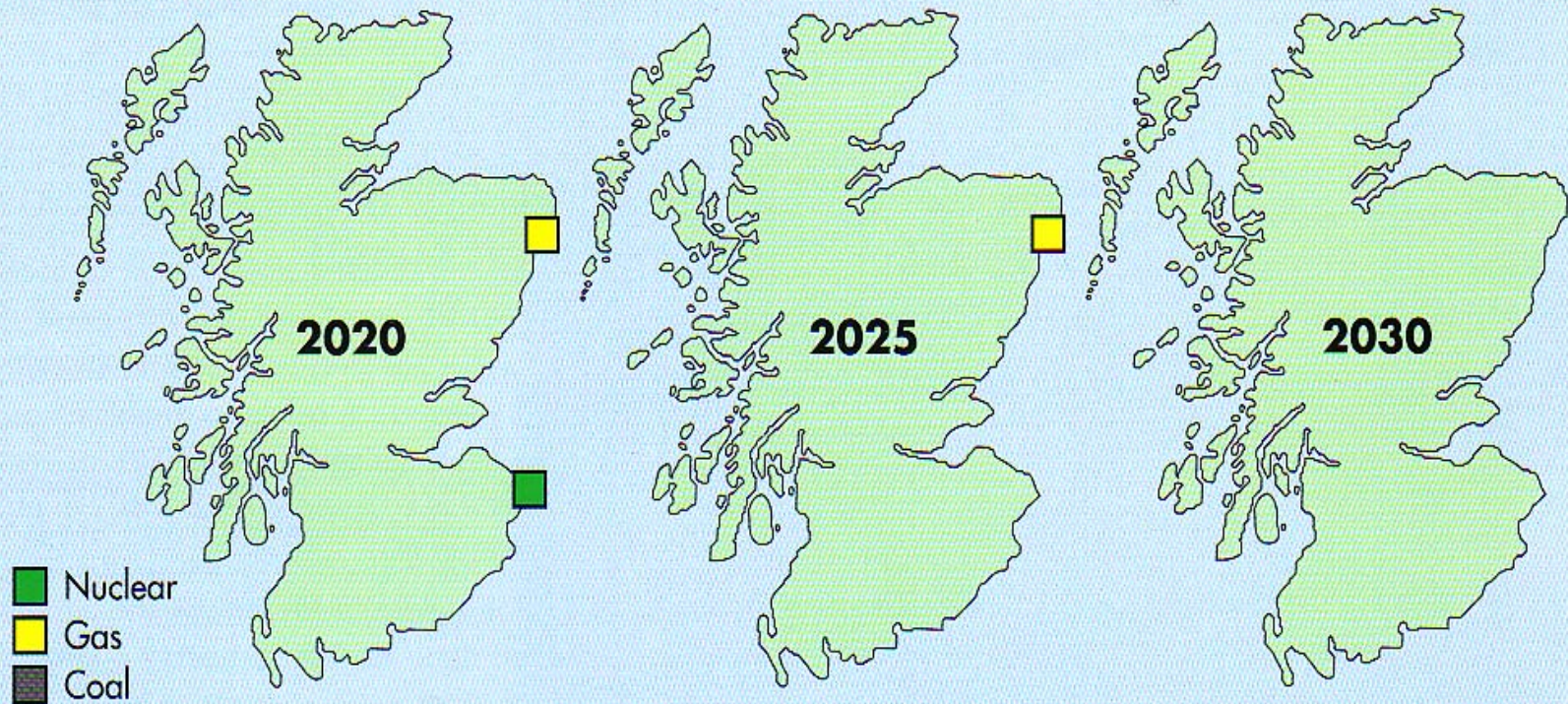
- Total annual generating capacity around 86.7 TWh
- Total annual electricity generation around 49 TWh

# Replacing lost capacity



# Replacing lost capacity

## Thermal plant



Source: Adapted from Bert Whittington's presentation



# Energy Policies and Targets in Scotland

# Scottish and UK Renewable Energy Targets

## Scottish Executive

18% by 2010

40% by 2020

## UK Government

10% by 2010

20% by 2020



Achievable?



# Policy Framework in Scotland

- Energy Policy is a reserved matter
- Planning is devolved
- Renewable Energy is devolved
  
- Scotland employs the same type of policy instruments as E&W:
  - ROCs
  - Emissions Quotas (CCL and EU ETS)
  - Planning
  - Energy Efficiency



# What does Scotland have to offer?

## Resources



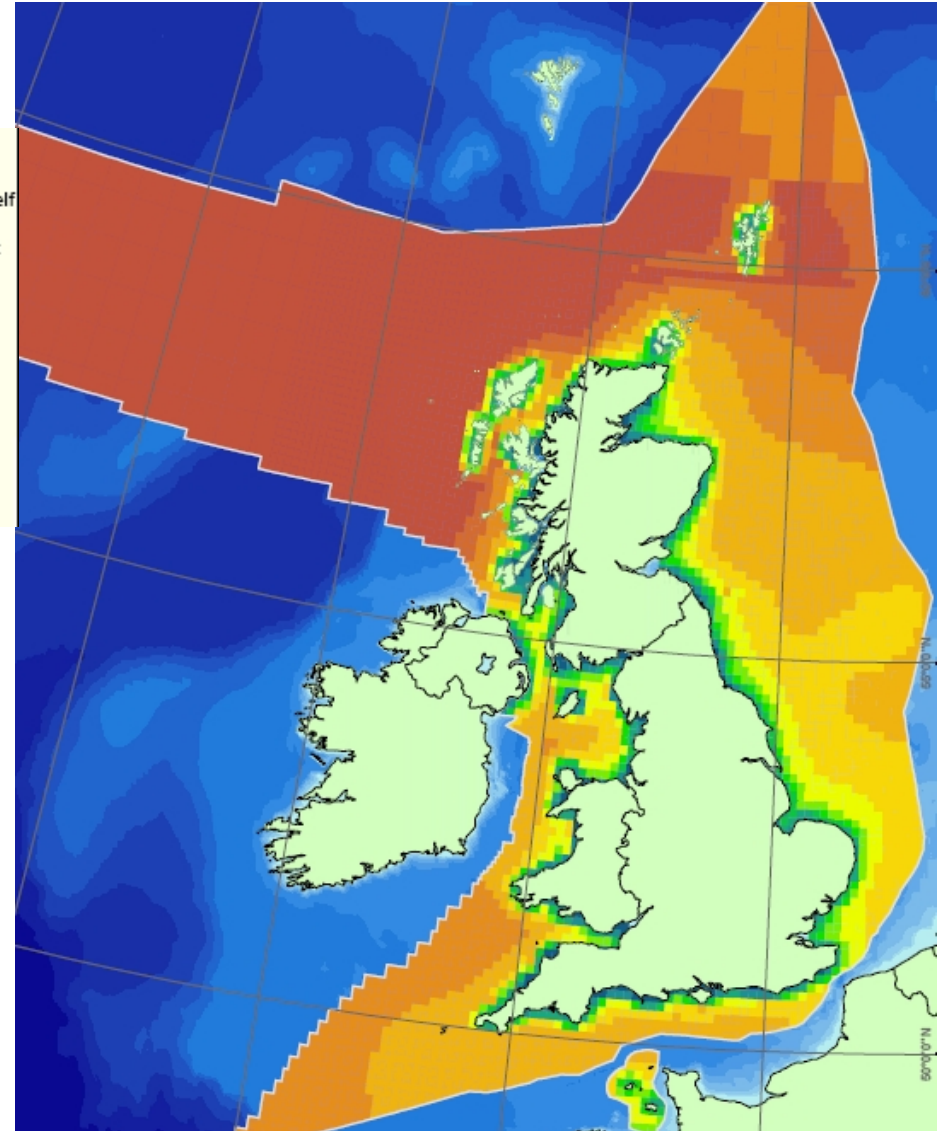
# Wind Energy in Scotland



Existing Wind Farms in  
Scotland = 712MW

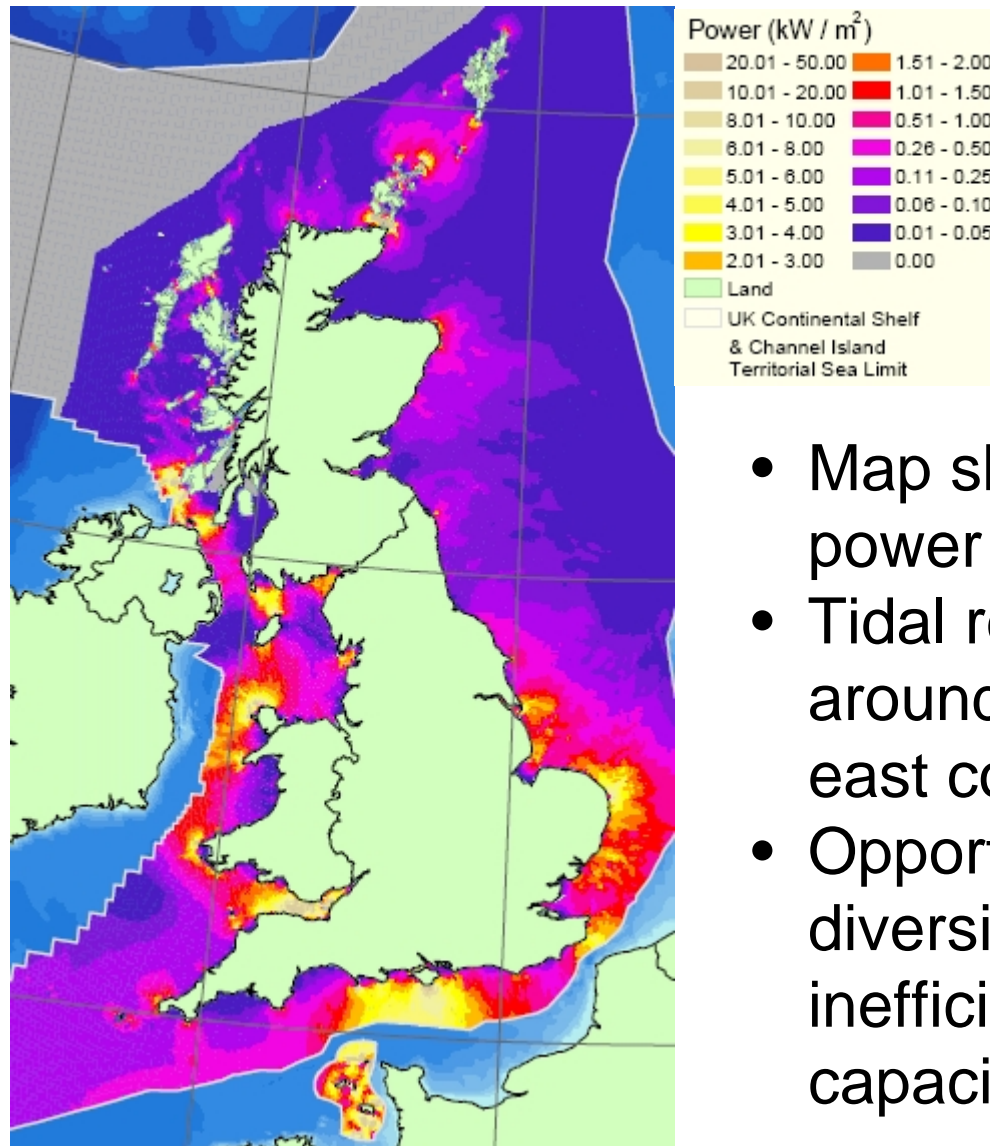
- **1,428MW Onshore consented (including 322MW onshore development for Whitelee)**
- **180MW Offshore consented**
- **5,356MW Onshore planned**
- **10MW Offshore planned**

# UK Offshore Wind Resource



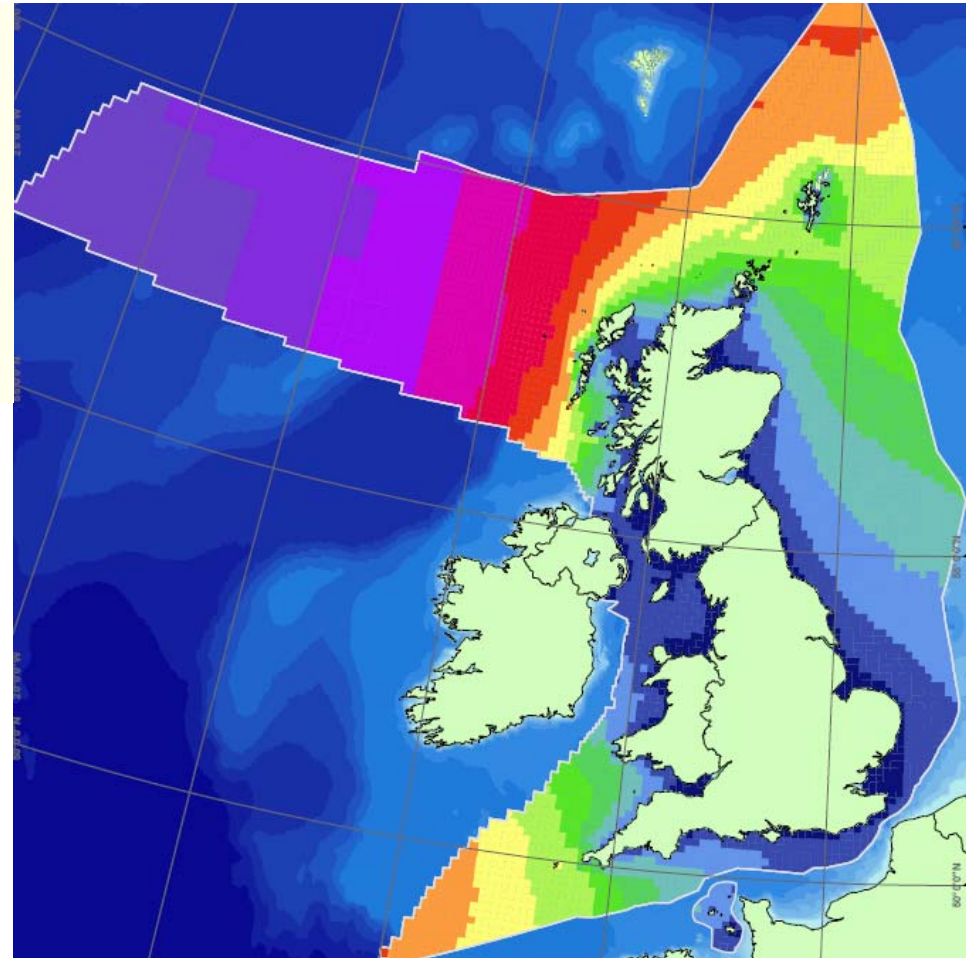
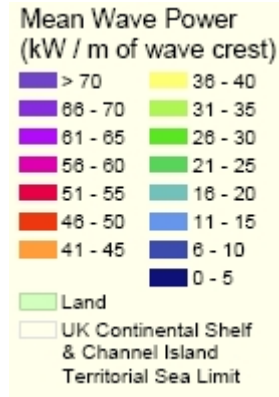
- Map shows annual mean wind power density
- Significant energy density is available closer inshore on west coast of Scotland

# UK Tidal Energy Resource



- Map shows mean spring tidal power density.
- Tidal resources distributed around west, south and south east coasts.
- Opportunities to exploit temporal diversity of tidal flow - but inefficiencies arise as tidal capacity increases.

# UK Wave Energy Resource



- Map shows annual mean wave power
- Greatest opportunities are off north and west coasts of Scotland
- Wave and offshore wind output likely to be correlated

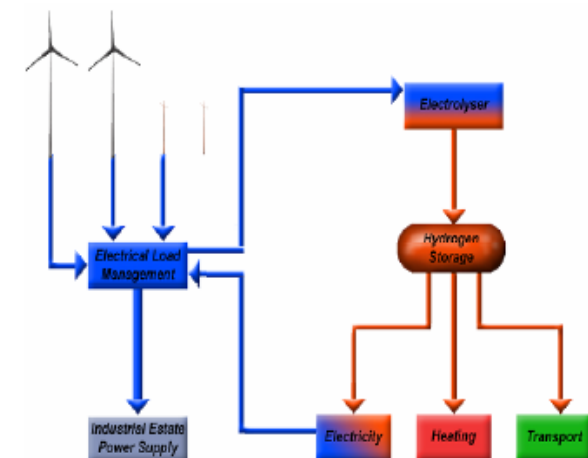


# What does Scotland have to offer?

## Innovation

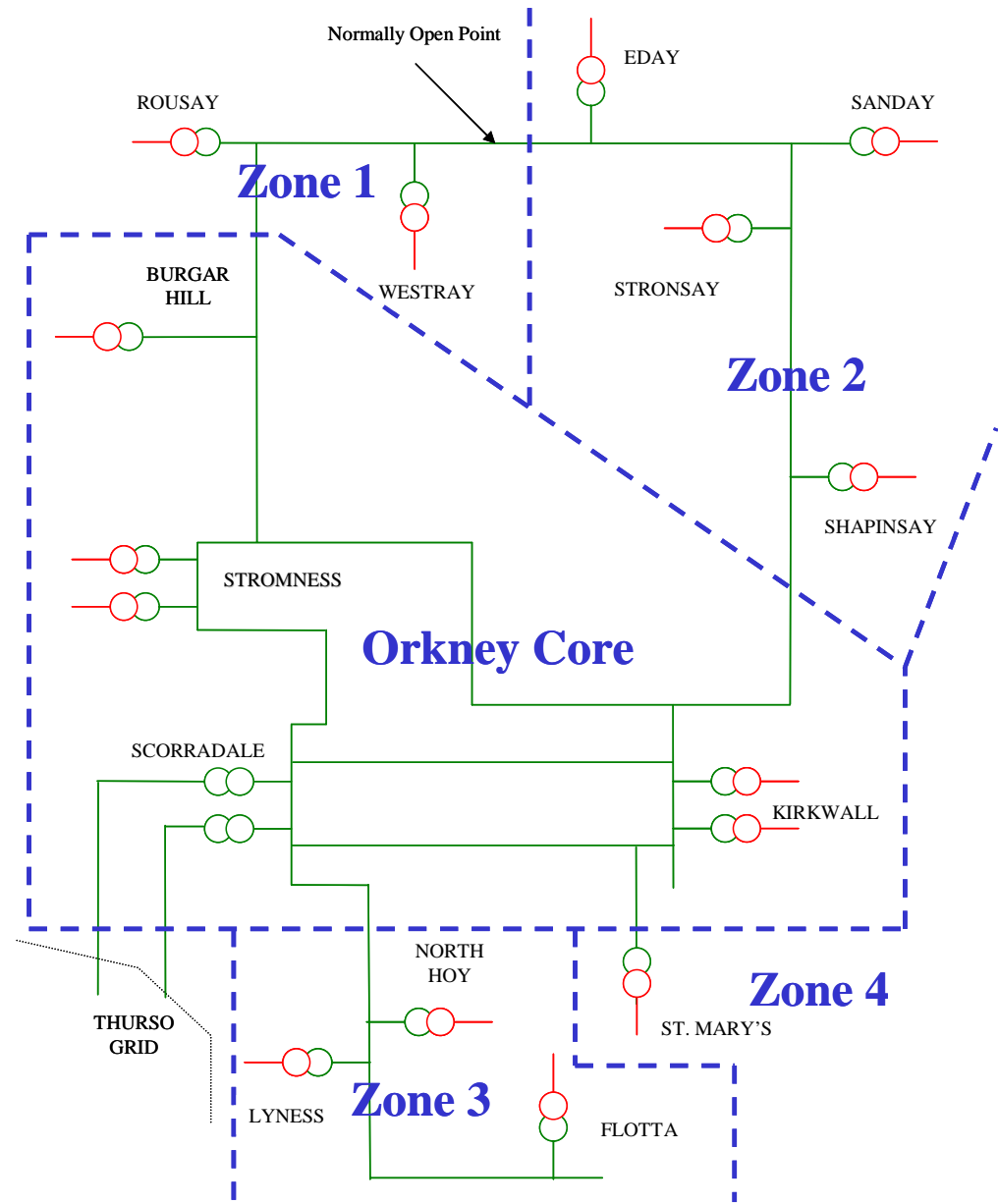
# Promoting Unst Renewable Energy (PURE)

- Community owned energy scheme incorporating:
  - Wind turbines
  - Electrical and heat load management
  - Hydrogen production and storage
  - Hydrogen powered transport
  - Fuel cell electrical power generation
- Also attracts eco/energy tourism
- Return of first mainland university graduates to Unst in a generation



# Orkney Registered Power Zone

- Constrained internal circuits and submarine cable link to mainland
- Real time dispatch of generating units
- Enhanced connection capability of power network







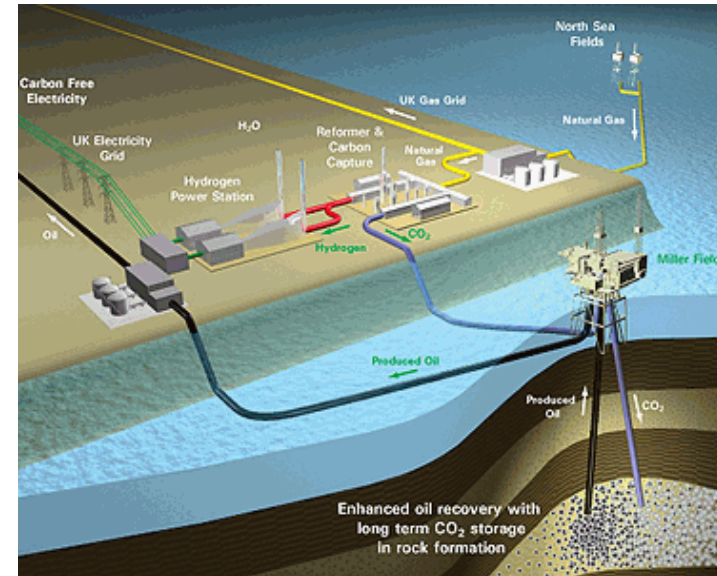
# Marine Devices

- Several device types at different stages of RD&D emerging from Scottish HEIs and SMEs
- Clear potential but still a long way to go:
  - Full prototype demonstration for many concepts
  - Market competitiveness still unproven



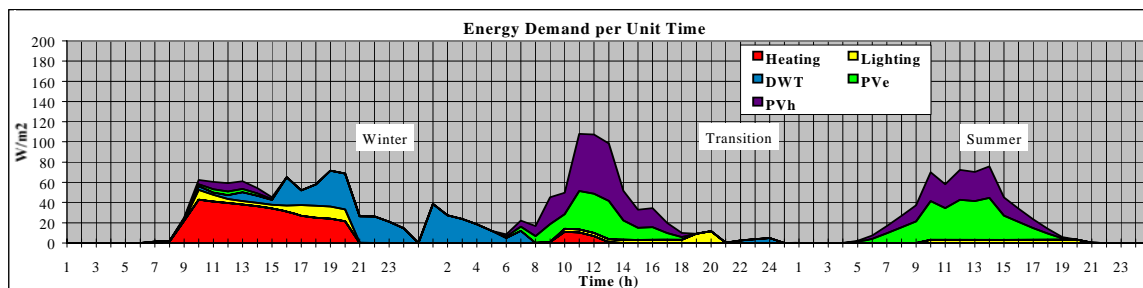
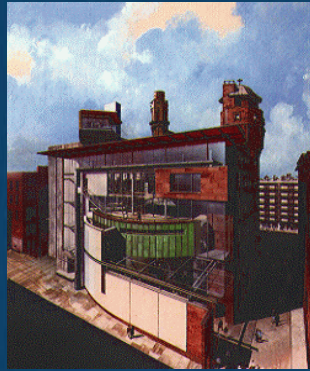
# Peterhead Hydrogen Power

- Hydrogen production from natural gas
- Carbon Capture and Storage
- Enhanced Oil Recovery
- 90% reduced carbon emitting electricity production





# The Lighthouse Building in Glasgow



**total demand:**  
**68 kWh/m<sup>2</sup>.yr**

**total RE supply:**  
**98 kWh/m<sup>2</sup>.yr**



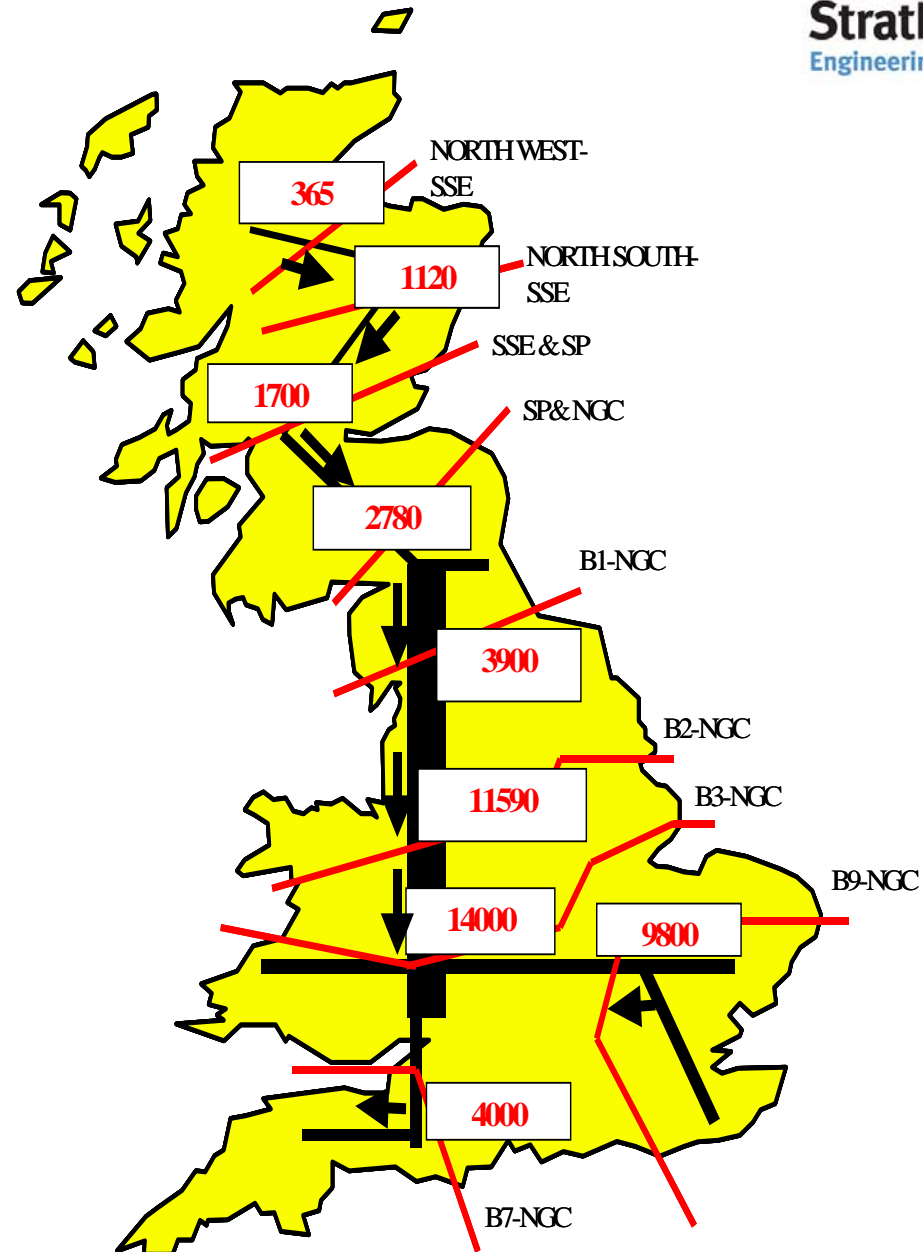
# Barriers to progress



# Electricity Network Issues

- Existing infrastructure designed to support centralised generation and facilitate unidirectional power flows.
- Renewable generation challenges this philosophy and requires new technologies and modes of network operation.
- Much renewable resource in sparsely populated areas with limited available network capacity.
- Uncertainty with regard to future network infrastructure can act as a barrier to the increased penetration of renewable and distributed generation.

- North to South constraints on transmission system
- Problem not exclusively Scottish
- Large infrastructure developments required to facilitate different primary energy sources





### Electricity Supply System

Transmission 400 kV — 275 kV  
Substations 400 kV ● 275 kV ●

#### Power Stations

Pumped storage △

Nuclear ●

Hydro ▲

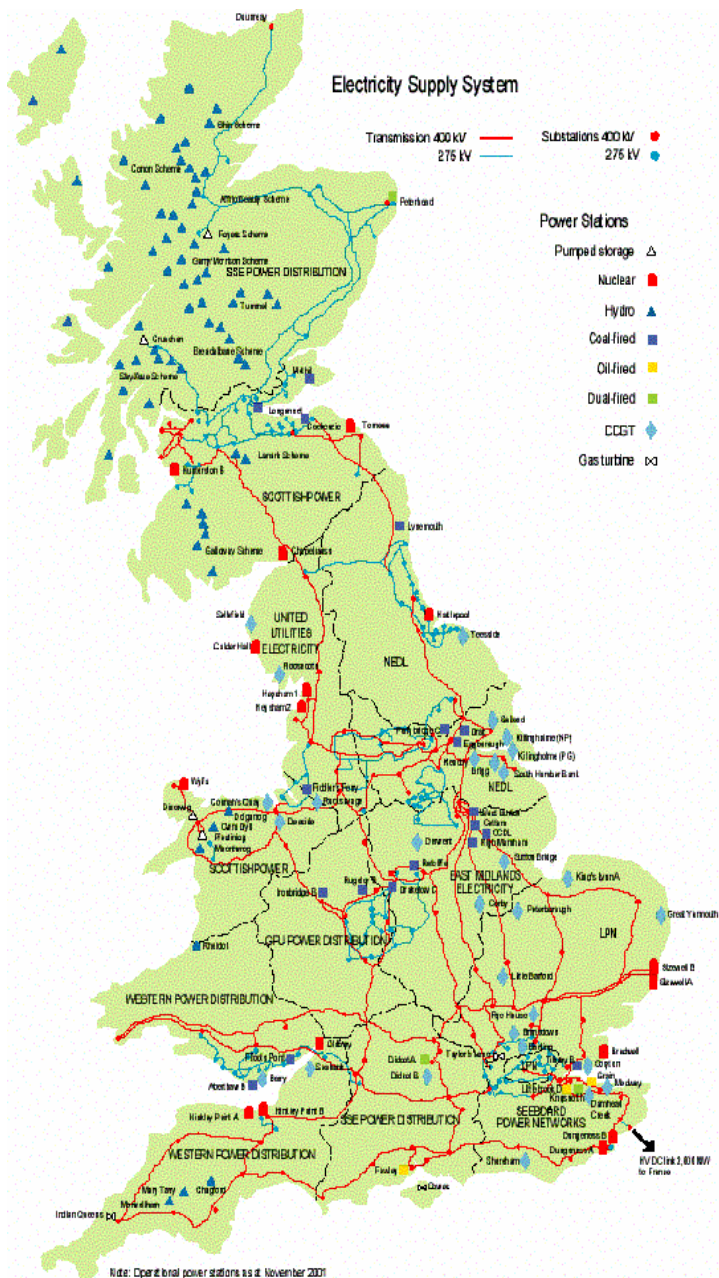
Coal fired ■

Oil fired ■

Dual fired ■

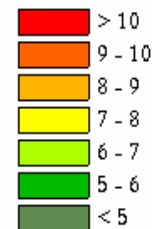
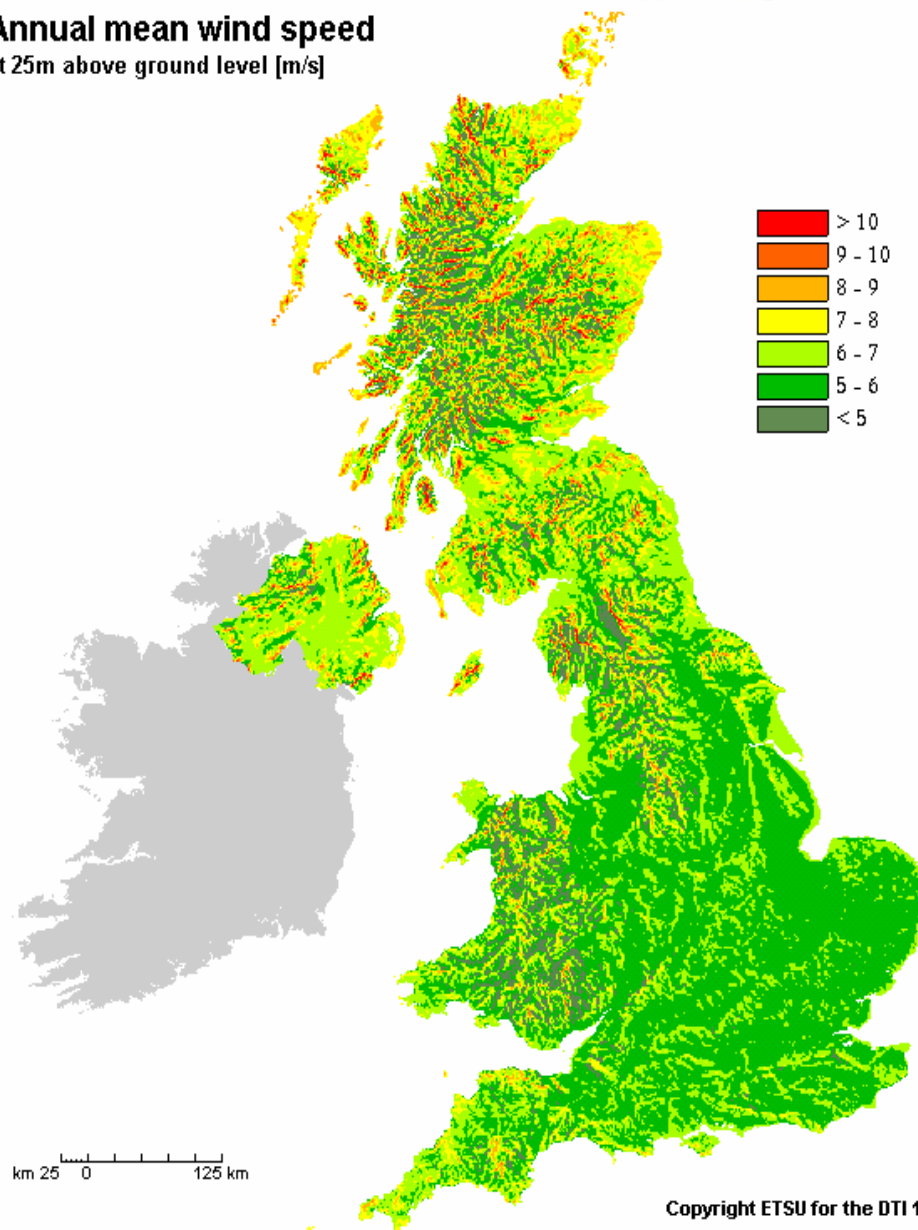
CCGT ◆

Gas turbine □



Note: Operational power stations as at November 2001

### Annual mean wind speed at 25m above ground level [m/s]





# Consumer issues

- 52% of Scots have more than five appliances on standby
- 16% believe turning appliances off uses more energy
- 29% of Scots are turned off by an energy saving lifestyle

*A more coordinated and effective programme for energy efficiency needs to be developed, based on education, awareness and implementation.*



# Action required

# Action

- Coordinate Scotland's energy policy, strategy and research
- More efficient use of energy
- Cleaner sources of energy should be used
- Use of wastes for energy
- Research, development and demonstration of new technologies will be needed
- Implement more effective means of improving the operation of the market
- Infrastructure development

# Conclusions

- Scotland's enviable energy situation outlined
- Richness and diversity in conventional and renewable energy resource
- Diversity in energy research, development and demonstration activities
- Future concerns raised (primary sources and infrastructure)
- Active and growing RD&D programmes
- Action required:
  - Many actions require coordinated approaches across legislatures and authorities