New nuclear technologies and the UK energy strategy

Rob Arnold

ThEC 2011, The City College of New York

11th October 2011

Overview

- A bit about DECC
- UK civil nuclear policy
- Long term UK energy context to 2050 and beyond
- Opportunities for thorium technologies within this
- Considerations for developers

What is DECC?

- UK's central governmental department with responsibility for:
  - Energy security and supply
  - Decarbonisation of the UK economy
  - Leading on UK participation in climate negotiations
  - Debate and evidence on climate impact in international fora.

- Formed in October 2008 from the energy section of the business department and climate section of the environment department

DECC's Corporate Goals

- **Save energy and support vulnerable consumers**
  - Reduce energy use and help to protect the fuel poor
- **Deliver secure energy on the way to a low carbon energy future**
  - Ensure that the UK has a diverse, safe, secure and affordable energy system and incentivise low carbon investment and deployment
- **Drive ambitious action on climate change at home and abroad**
  - Work for international action to tackle climate change, and work with other government departments to ensure that we meet UK carbon budgets efficiently and effectively
- **Manage our energy legacy responsibly and cost-effectively**
  - Ensure public safety and value for money in the way we manage our nuclear, coal and other energy liabilities

DECC's long term targets

- Climate Change Act (2008) commits the UK to an 80% reduction on 1990 levels of CO2 emission by 2050
  - Energy supply must be decarbonised
  - Energy demand must be met
  - The electricity grid must be balanced

- Delivered against a series of 5-year carbon budgets
  - Delivery mechanisms exist for up to 2022.
  - Planning for 2023-27 in progress.

- This occurs against a background of:
  - Increasing population (16% increase on 2010 population)
  - Likely increase in electrification in heating and transport.

UK civil nuclear power policy

DEPARTMENT OF ENERGY & CLIMATE CHANGE

Policy principles

- Nuclear energy can contribute a significant amount to the UK energy mix – so long as there is no public subsidy to the industry.
- The UK Government is committed to removing any unnecessary obstacles to investment in new nuclear power.
- We are working to ensure that there is a supply chain and skills base in place to enable new nuclear to happen and ensure that the UK benefits from this activity.

Results in:

- A technology neutral approach (within bounds of regulatory compliance).
  - Policies are not fuel cycle or reactor specific.

- No defined limit on the amount of nuclear build.

Facing the future –
The 2050 Pathways Analysis tool

- 2050 Pathways Analysis Tool has been developed to help consider possible technology trajectories for decarbonisation.
  - Offers high level sensitivity analysis
  - Extrapolates the UK energy system from 2010 to 2050.
  - Assumes build rate and uptake limitations.
  - Accounts for technology lock in and asset stranding.

- Allows user to select between 4 levels of "ambition" for deployment of energy supply and demand-reduction measures.

- Varies between (1) less-than-planned-for to (4) limits of technological or societal potential (disruptive change).

Multiple level 4s considered undesirable / unachievable!

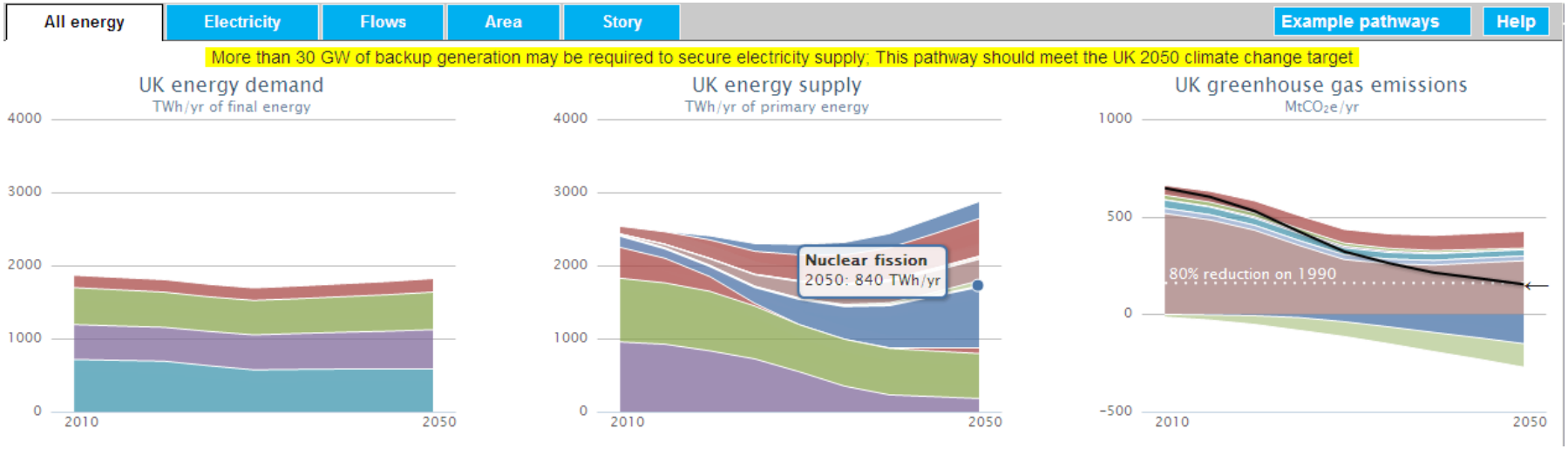
Facing the future –
The 2050 Pathways Analysis tool

Options for nuclear

- Nuclear scenarios considered for no new nuclear, as well as 40 GW, 90 GW and an extreme case of 150 GW nuclear generation by 2050 .

- Limitations of 2050 Pathways tool for nuclear.
  - Specifies only capacity, not technology.
  - Doesn't consider uranium supply (as only 2050)
  - Limited pathways to supply for nuclear heat (allows low grade heat from thermal power stations, but no process heat).
  - No electricity to synthetic fuels pathway.
  - Does not include reprocessing or waste challenges.

2050 Pathways Analysis tool – Example "balanced" scenario



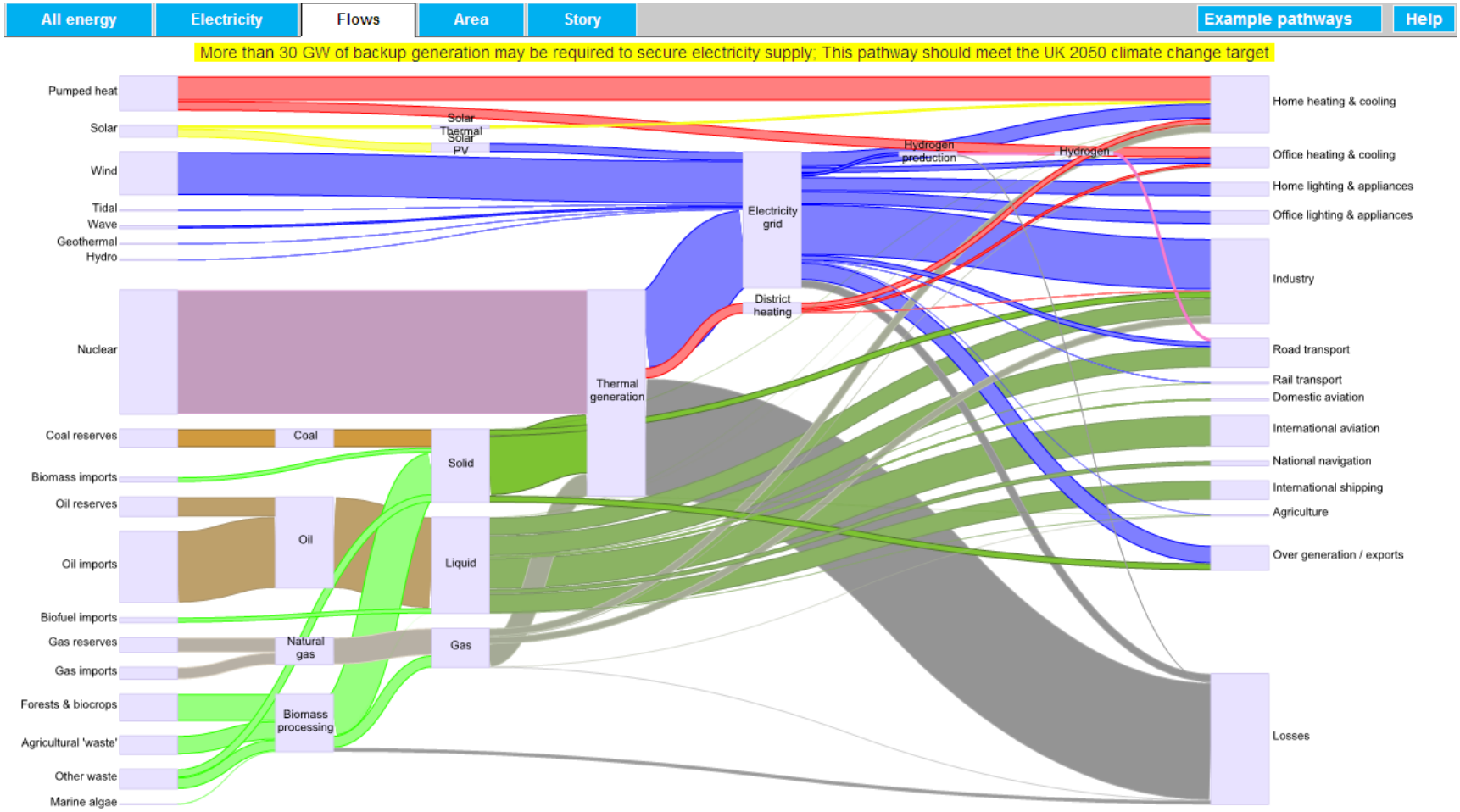
REQUIREMENTS...

- 840 TWh / yr from ~40 GW of nuclear plant.

BUT ALSO...

- 10 % of UK land area dedicated to bioenergy crops - "1 x Wales"
- Dependent on a reasonable degree of biomass imports
- 240 TWh / yr (25-40 power stations) of CCS co-firing

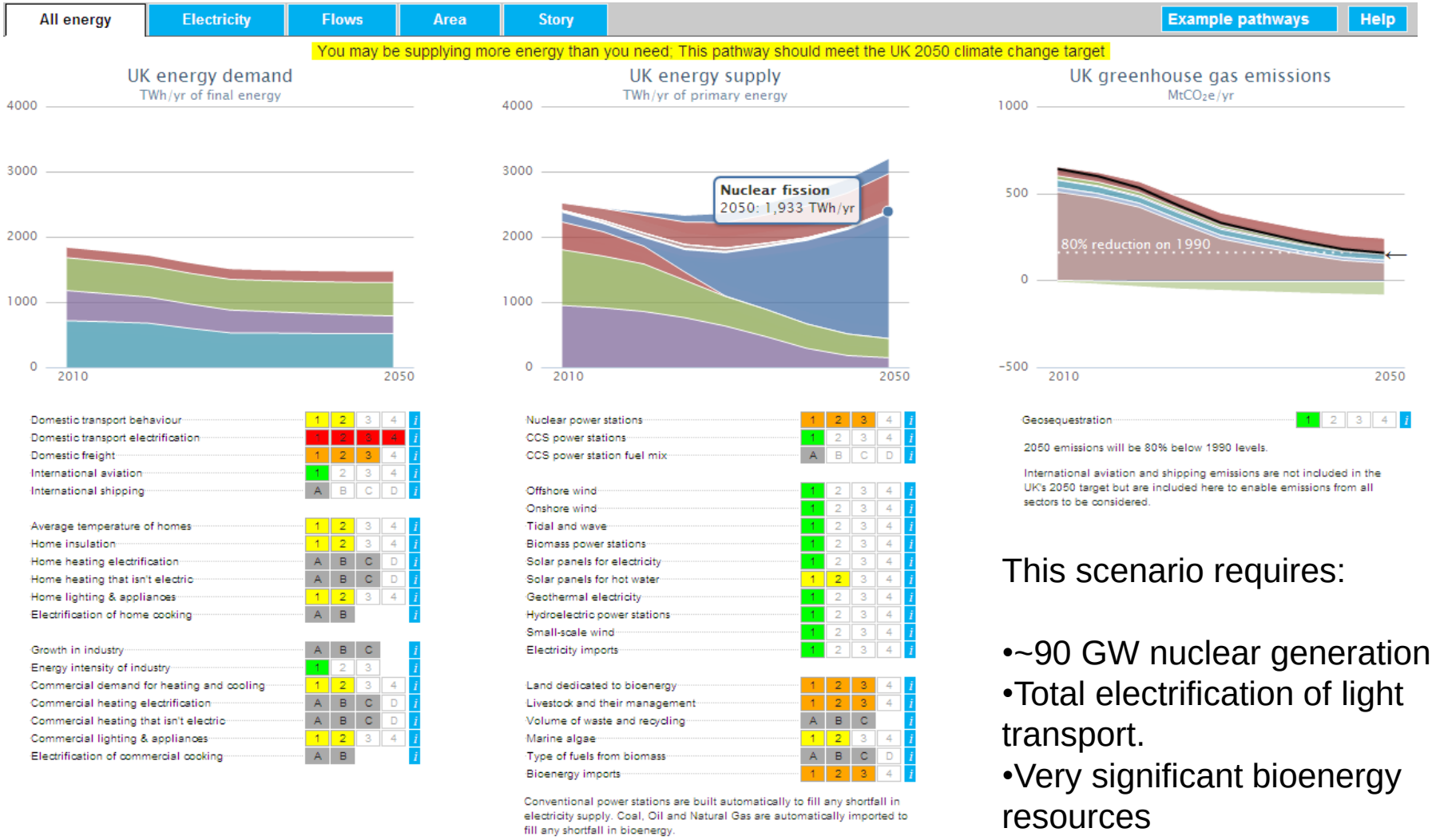
2050 Pathways Analysis tool – Example "balanced" scenario



DEPARTMENT OF ENERGY & CLIMATE CHANGE

What happens if technologies fail?

2050 Pathways Analysis tool – Technology failure example: no CCS



This scenario requires:

- ~90 GW nuclear generation
- Total electrification of light transport.
- Very significant bioenergy resources

2050 Pathways Analysis tool – Wider technology failure + no nuclear

Proposed by FoE:

- Limited bioenergy, no CCS beyond demo or nuclear
- Theoretically possible, BUT requires many level 4s
- Raises questions of build rate feasibility, social acceptability and socio-economic impacts.

Achieving a low carbon transition

DEPARTMENT OF ENERGY & CLIMATE CHANGE

Conclusions

- No single "silver bullet" technology to meet forecast demand
  - Biomass and renewables too low energy density.
  - Nuclear build rate too slow.
- A portfolio of low carbon generation is necessary.
- Nuclear energy is likely to play an important role.

Building new UK nuclear capacity

DEPARTMENT OF ENERGY & CLIMATE CHANGE

Immediate needs

- Last of the current fleet of gas-cooled reactors will close by 2023
- First tranche of new nuclear build already anticipated
  - Up to 16 GW by late 2020s
  - Gen III technology (EPR / AP 1000) being proposed
  - At start-up, a once-through uranium fuel cycle will be used
- Largely dictated by timing and anticipated reprocessing capacity

Building new UK nuclear capacity

DEPARTMENT OF ENERGY & CLIMATE CHANGE

Looking ahead

- In low-build scenarios (e.g. 16 GW, single build), a once-through U cycle might suffice.

- Other drivers become relevant at higher capacity build levels:
  - Waste volumes and longer term capacity for permanent disposal.
  - “Energy services” such as short term grid-balancing (i.e. replace gas, spatial location, probably begin to play a more significant role.
  - “Waste services”, such as actinide burning and the minimisation of intermediate & low level waste become more attractive.
  - Diverse Pu management issues.

Building new UK nuclear capacity

DEPARTMENT OF ENERGY & CLIMATE CHANGE

Looking ahead

- Long term needs appear to align well with proposed operating characteristics of a number of advanced designs, with thorium cycle potentially offering enhancements delivering these.

- >16 GW build would suggest demand for new services from reactor and fuel cycle technology from circa 2030 onwards, but still expected to be influenced by development of:
  - Development of other dispatchable generation technologies.
  - Other storage and interconnection capacity.

- We need accurate appraisal of technical capabilities of technologies:
  - DECC's "watching brief" on thorium is a process of active dialogue..

DEPARTMENT OF ENERGY & CLIMATE CHANGE

How to introduce new technologies?

Building new UK nuclear capacity

DEPARTMENT OF ENERGY & CLIMATE CHANGE

Licensing new reactor designs / facilities

- UK Government does not invest in new reactor designs or fuels directly.
  - Academic research contribute to knowledge and skills base.
  - Developers are expected to progress and propose new designs.
  - Role of government is to minimise barriers to submitting designs for approvals and licensing.

- Licensing requirements are outcome driven, rather than prescriptive.
  - Designed to accommodate technological innovation.

- Two routes:
  - Generic Design approval – better if multiple sites are likely, but more burdensome.
  - Site licensing – best for individual installations.

Building new UK nuclear capacity

Licensing new reactor designs / facilities

- Early engagement is essential!
  - Limited number of regulators at any one time.
  - Regulation is specialised occupation – global market for skills.
  - Training and familiarisation with proposed technologies needed is essential.
  - Recommend contacting UK authorities via DECC 3-5 years ahead of proposed date for licensing.

DEPARTMENT OF ENERGY & CLIMATE CHANGE

Thank you for your attention

DECC Website: http://www.decc.gov.uk

2050 Pathways tool: http://www.decc.gov.uk/2050