

UCL ENERGY INSTITUTE

The future of nuclear power in the UK

Paul Dodds (p.dodds@ucl.ac.uk)



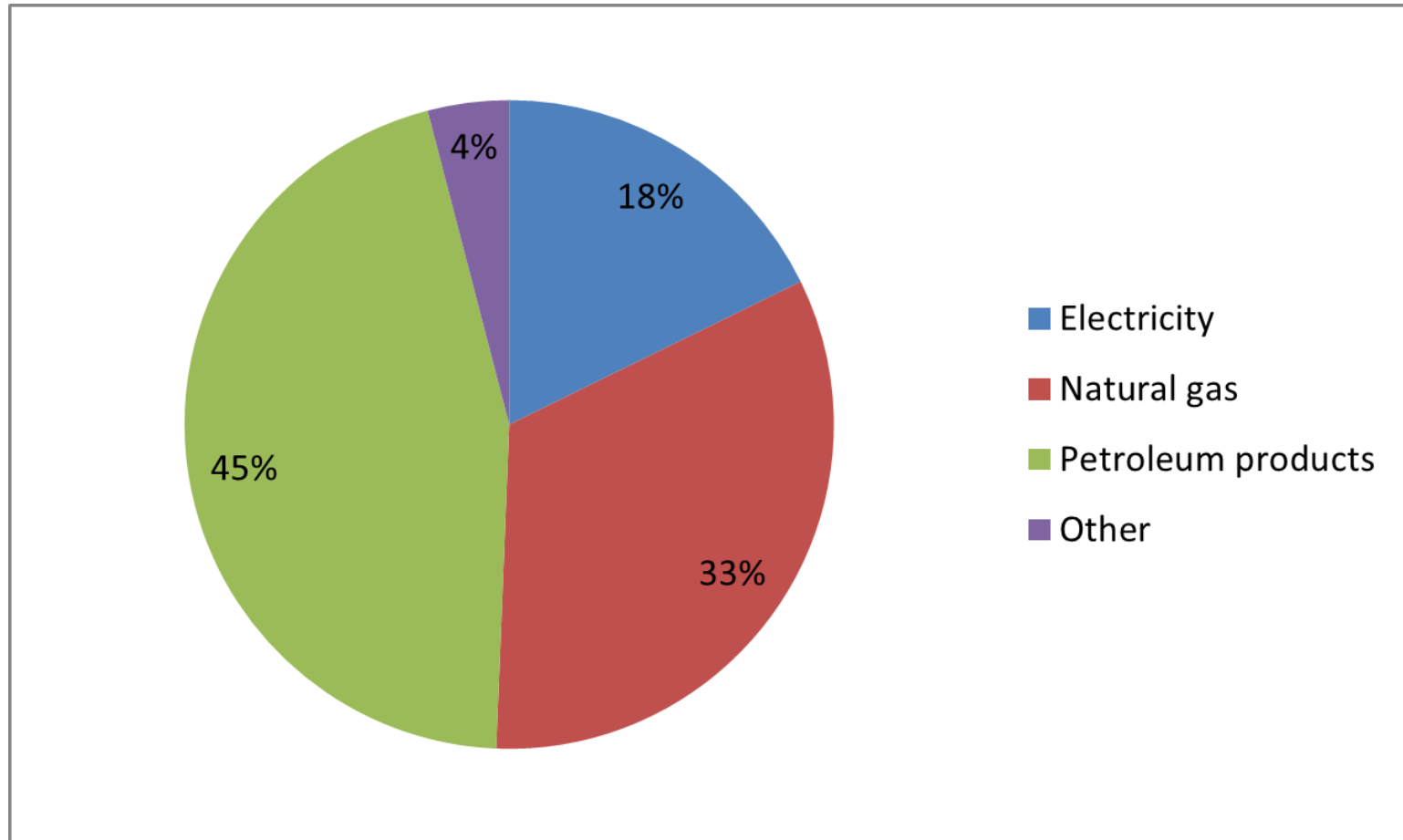
Introduction

1. The UK energy system in 2012
2. The existing nuclear fleet in the UK

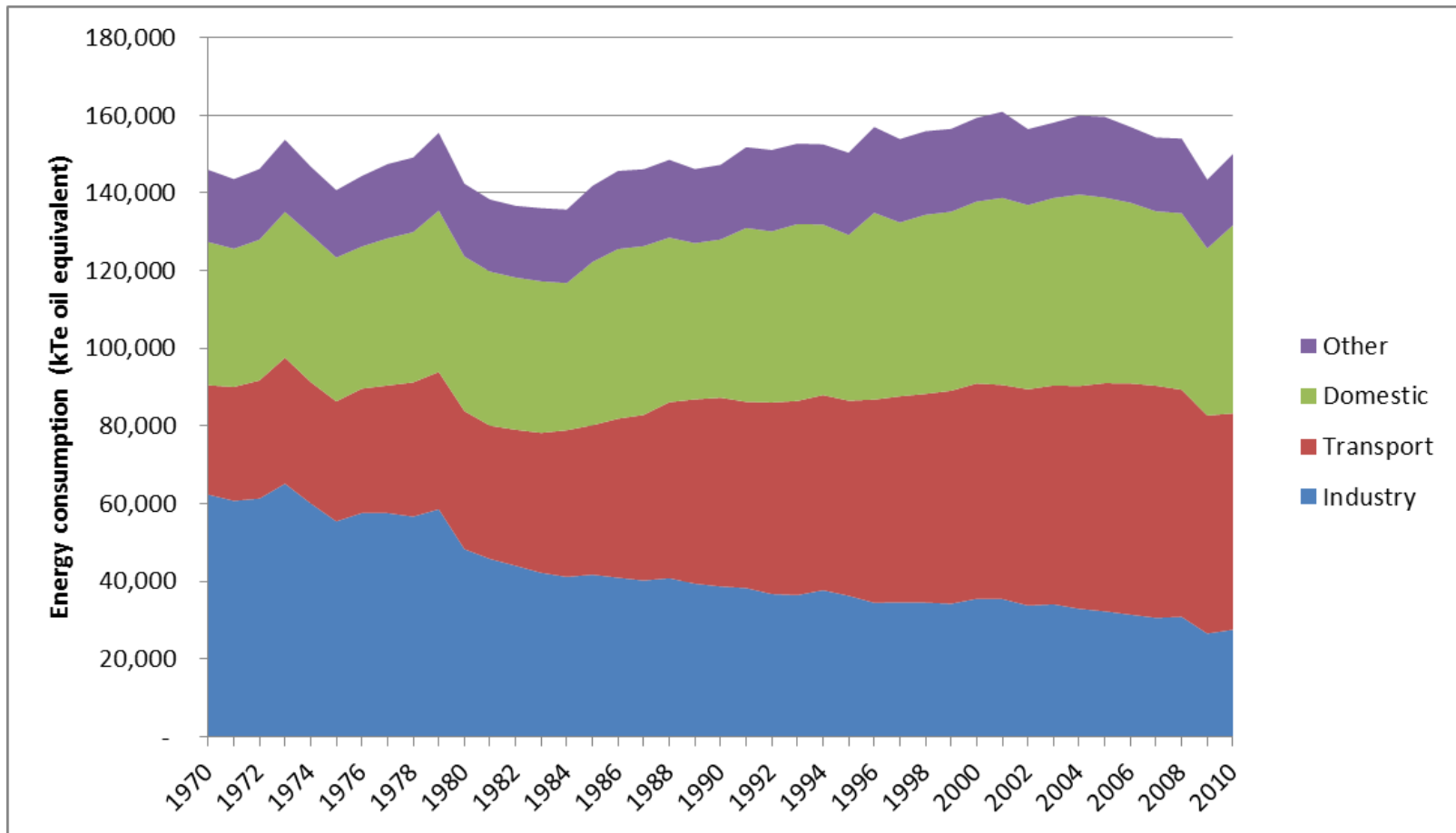
3. Climate change policy in the UK
4. The UK energy system in 2050

5. Response of the UK to the Fukushima disaster
6. Government policies for existing reactors and new build

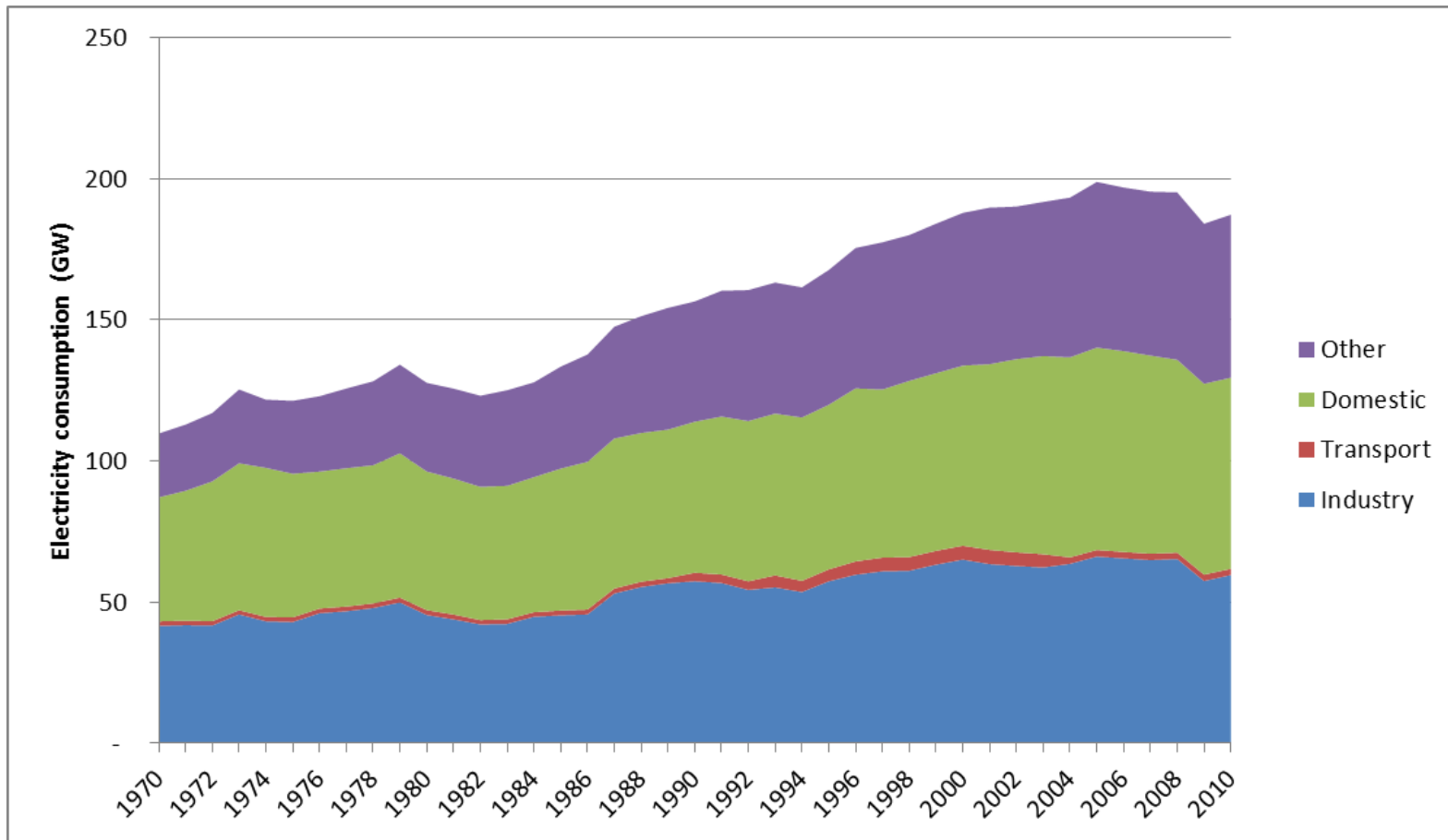
Final energy consumption in 2010



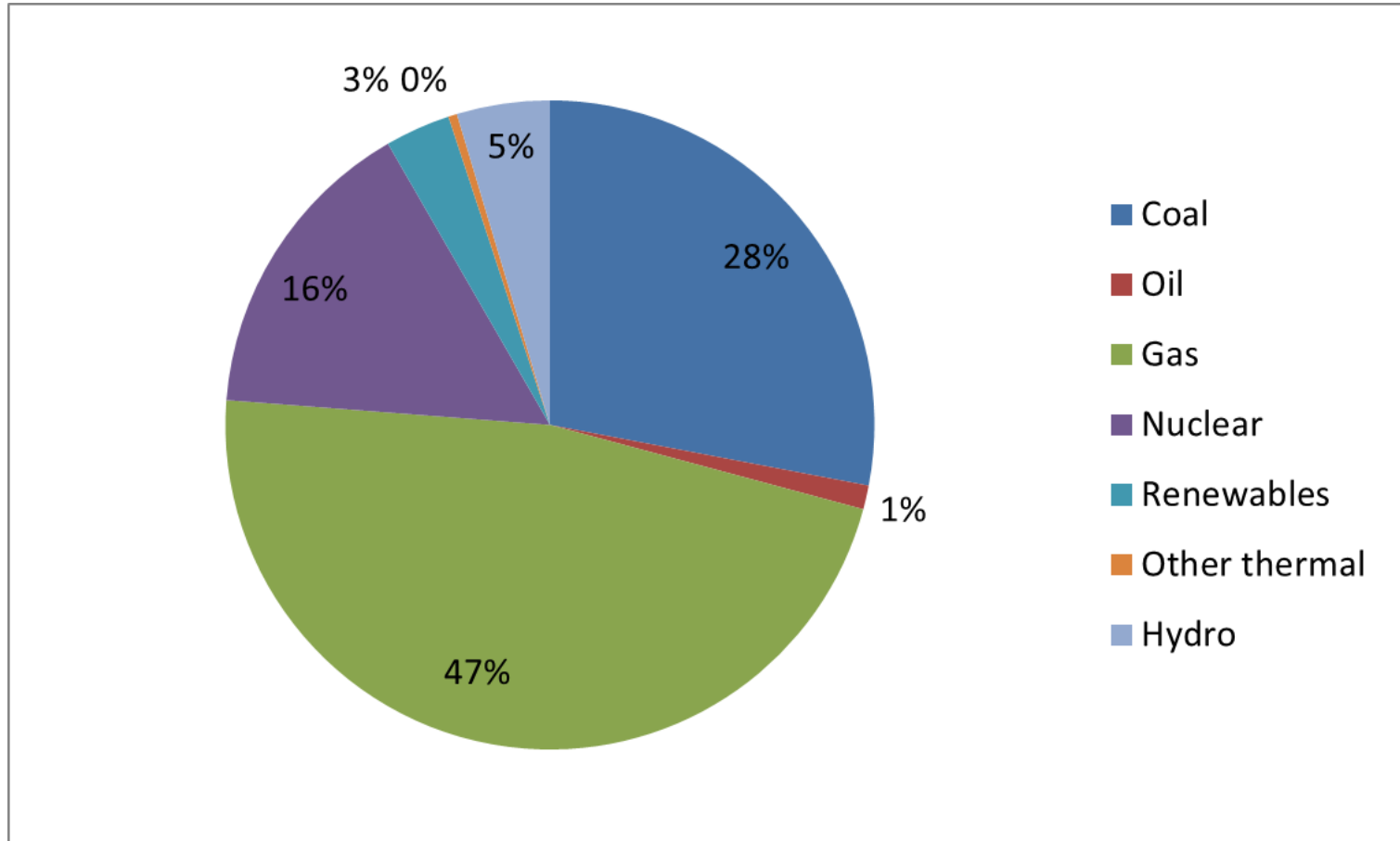
UK final energy consumption since 1970



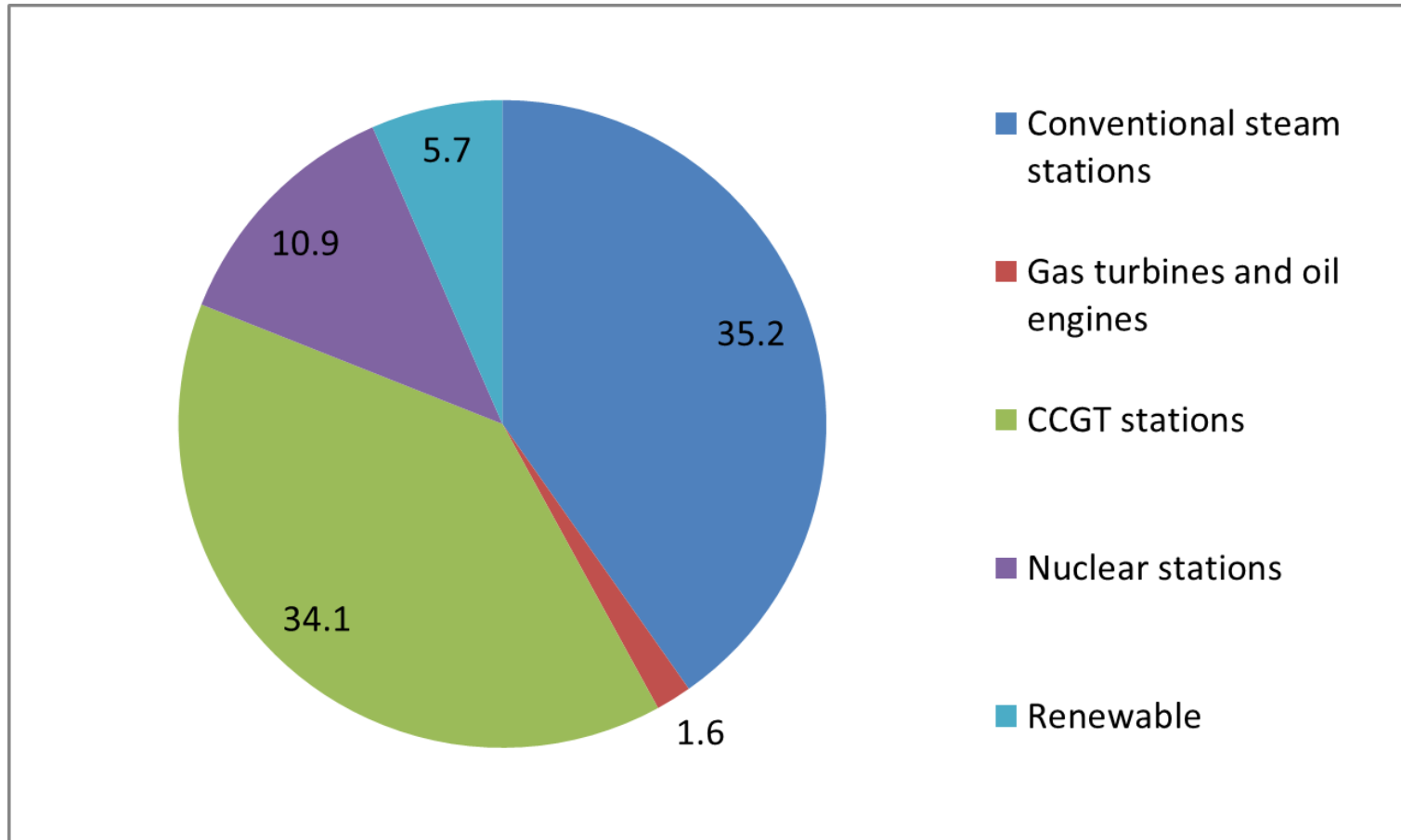
UK electricity consumption since 1970



UK electricity generation in 2010



UK electricity generation capacity in 2010 (GW)



Drivers of electricity system evolution since 1970

- Until the 1990s, all generation plants were owned by a single government body, the CEGB. They were responsible for energy research and long-term planning.
- Privatisation in 1990 created three generation companies (one with nuclear plants and two with fossil fuel plants).
- “Dash for gas” – between 1990 to 2002, the share of gas increased from 5% to 30% as CCGTs were built to replace coal power stations.

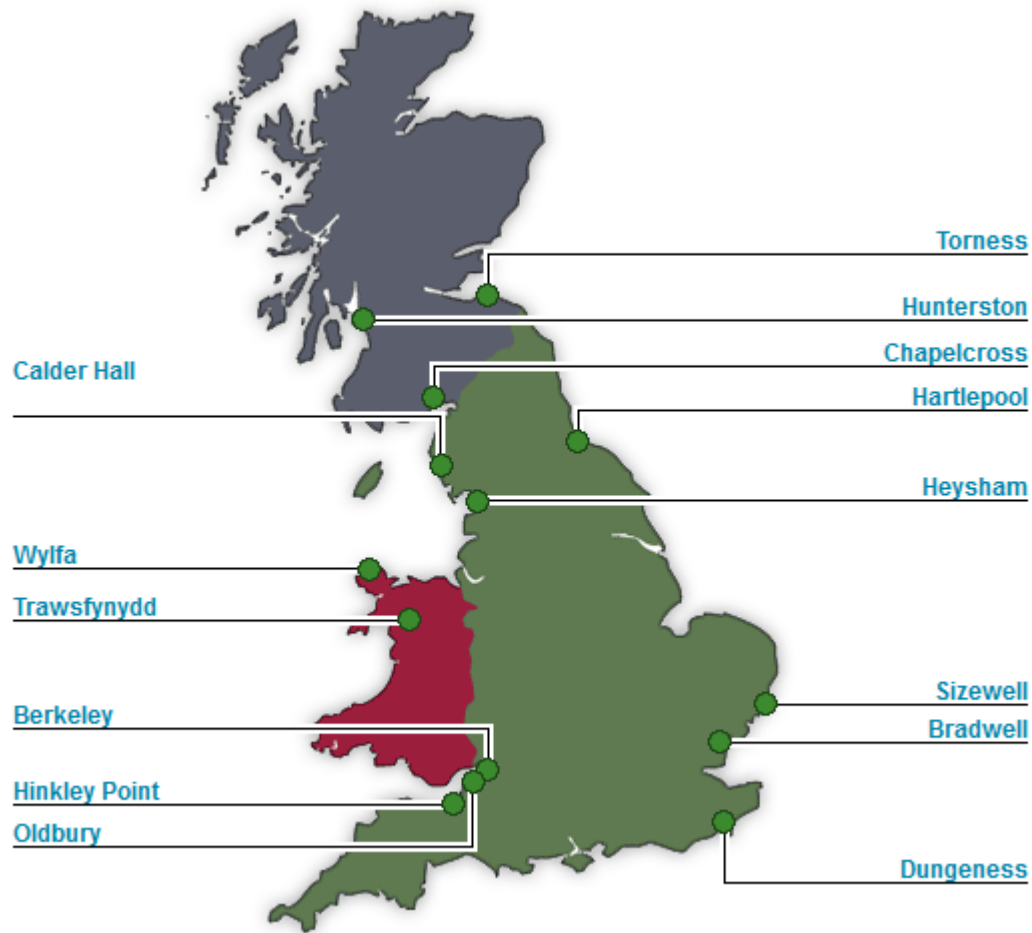
Drivers of electricity system evolution since 1970

- Electricity market design:
 - From 1990 to 2001, under the “Pool”, every generator in the market was paid the same price for the electricity that they generated.
 - New market design in 2001 (NETA) offered much higher prices to flexible generators (i.e. gas CCGTs), much reduced prices for baseload generators and heavily penalising intermittent renewable generators.
 - From 2002, the Renewables Obligation required a proportion of generation from each company to be renewable. Currently (in 2012) around 12% of all electricity generation.

Who owns the electricity generation plants?



Locations (including retired stations)



The existing nuclear fleet in the UK

- UK built prototypes of many types of reactor
- First civil fleet: Magnox gas-cooled reactors
- Second civil fleet: AGR gas-cooled reactors
- Third fleet: one PWR

- Last reactor commissioned in 1995
- Subsequent plan for a PWR fleet cancelled
- Gas-cooled reactors are now being progressively retired

The existing nuclear fleet in the UK

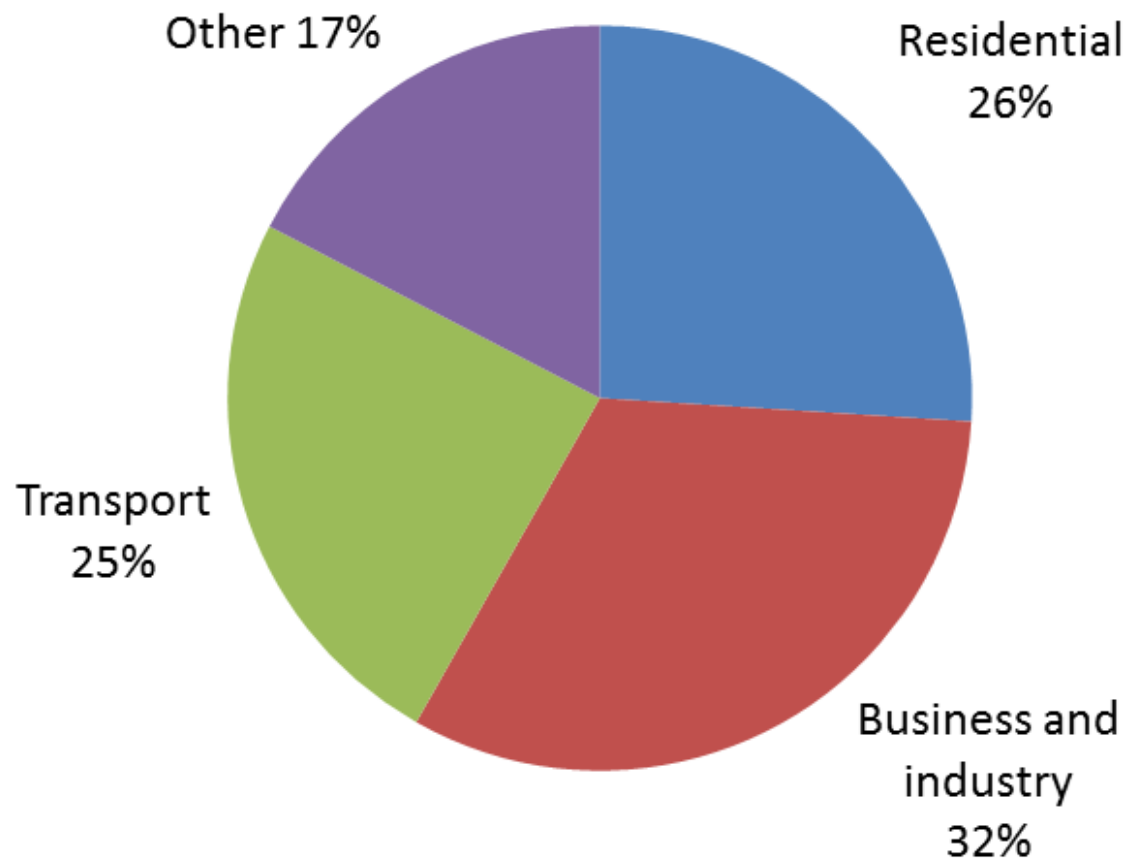
| Plant | Type | Present capacity (MWe net) | First power | Expected shutdown |
|------------------------|--------|-------------------------------|-------------|-------------------|
| Wylfa | Magnox | 2 x 490 | 1971 | 2012 |
| Hinkley Point B | AGR | 2 x 610 (operating at 70%) | 1976 | 2016 |
| Hunterston B | AGR | 2 x 610 (operating at 70%) | 1976 | 2016 |
| Dungeness B | AGR | 2 x 545 | 1983 | 2018 |
| Hartlepool | AGR | 2 x 595 | 1983 | 2019 |
| Heysham I | AGR | 2 x 580 | 1983 | 2019 |
| Heysham II | AGR | 2 x 615 | 1988 | 2023 |
| Torness | AGR | 2 x 625 | 1988 | 2023 |
| Sizewell B | PWR | 1188 | 1995 | 2035 |
| Total: 17 units | | 10,528 MWe | | |

Climate change policy in the UK

- The Climate Change Act 2008 requires the government to reduce UK greenhouse gas emissions in 2050 by 80% relative to 1990 emissions.
- The Committee on Climate Change produces annual progress reports and sets 5-year intermediate targets
- Department of Energy and Climate Change created in 2008



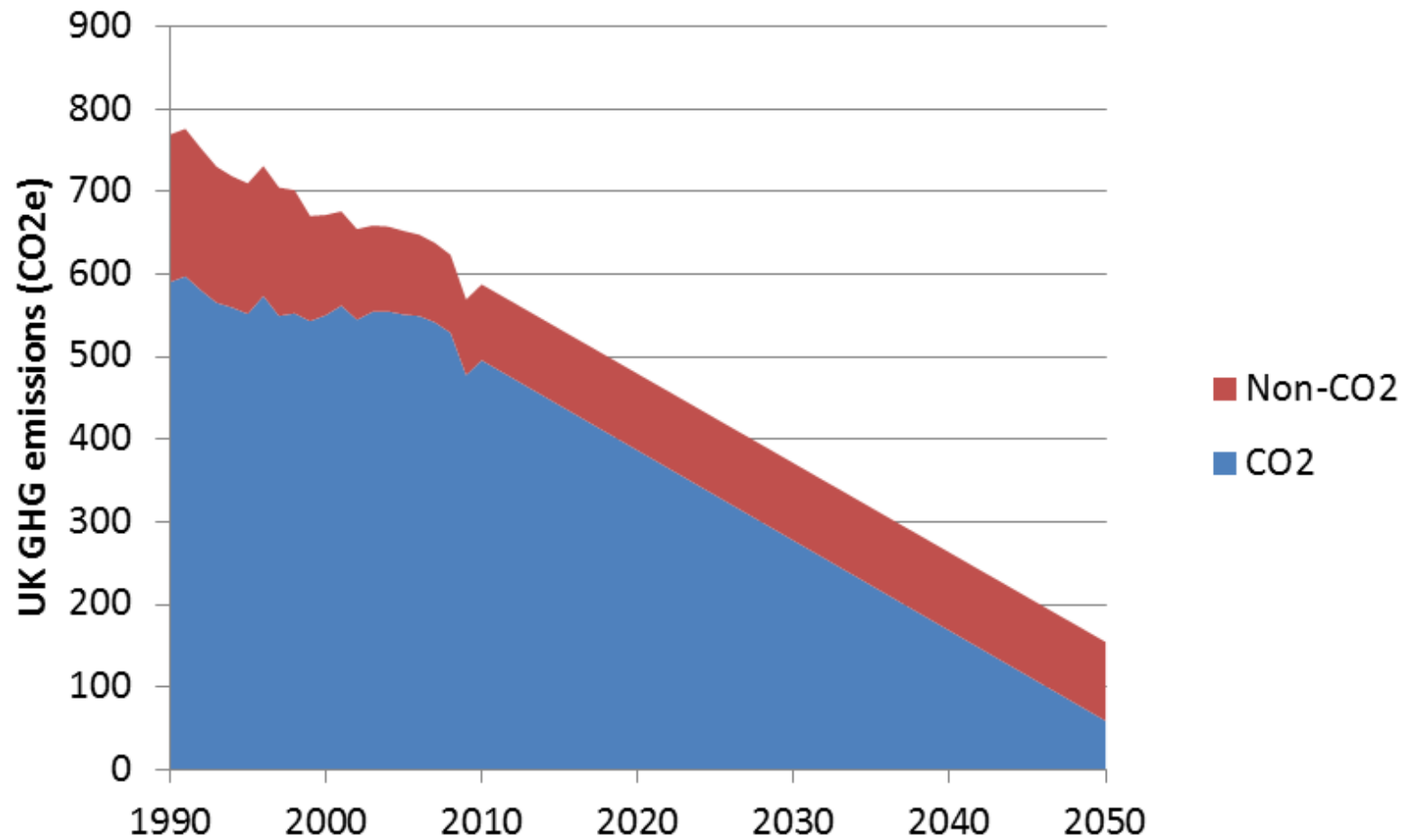
UK final user GHG emissions in 2009 (CO₂e)



Government policies (near-term) – 1990 to 2020

- “Easy wins” to reduce non-CO₂ gases
- Dash for gas – 1990 to 2002
- Renewables obligation (for large generators)
- Feed-in tariffs (for small generators) and market reform
- Renewable transport fuel obligation
- Energy efficiency measures for houses and other buildings
- Green bank

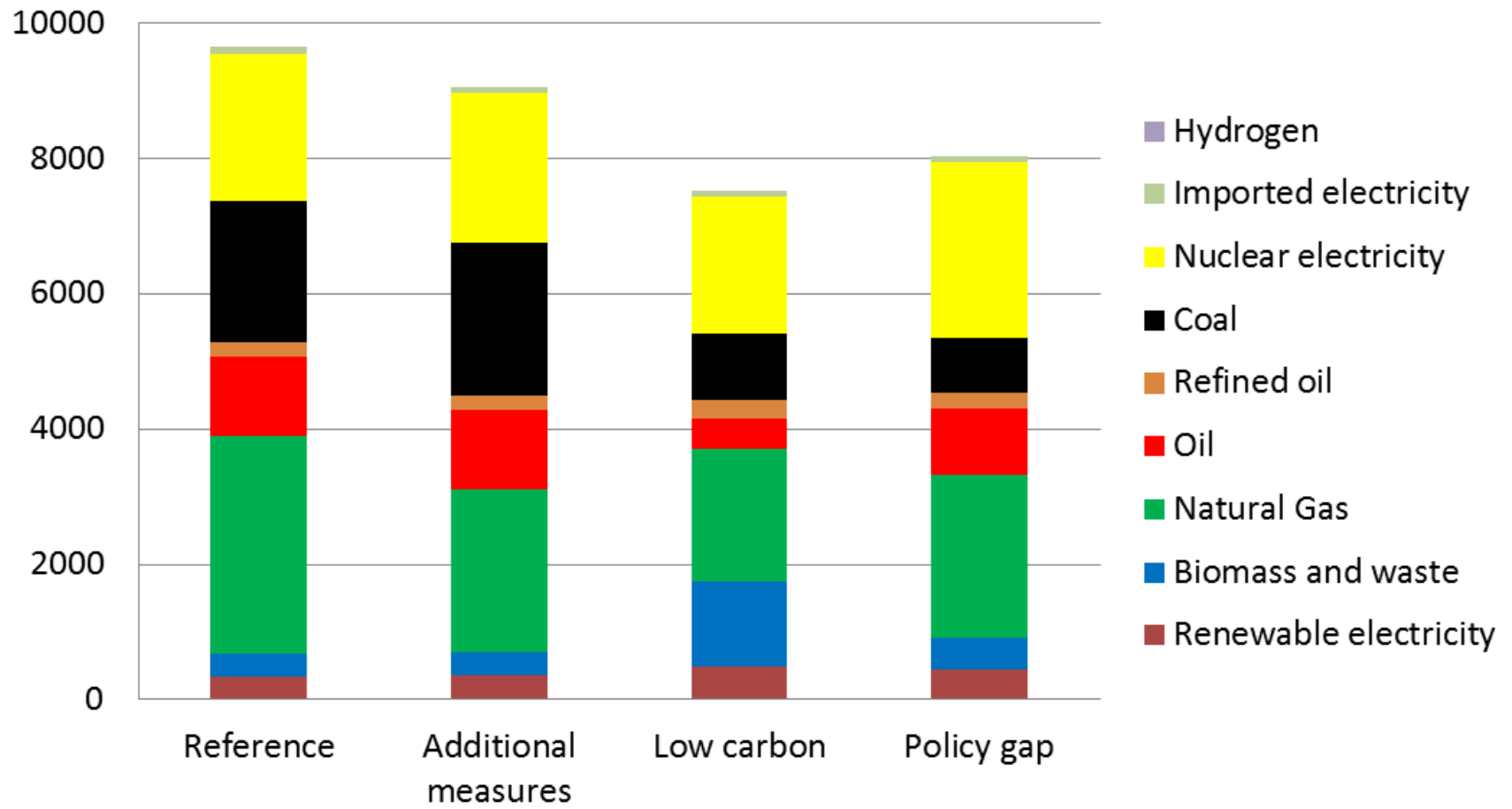
UK GHG emissions since 1990 (CO₂e)



Scenarios to 2050 (mostly from Ilkka Keppo)

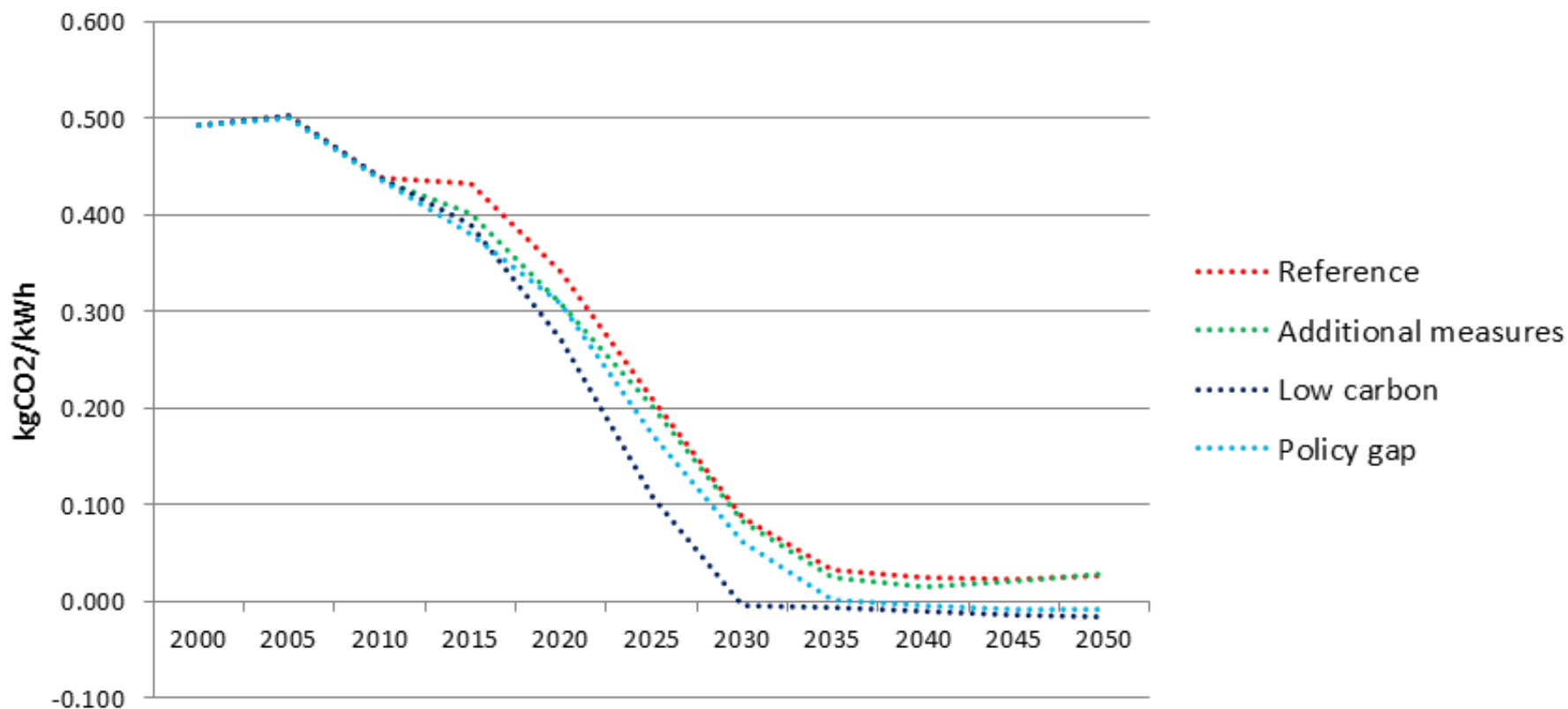
- Resilience
 1. No energy security consideration
 2. Each fuel has a maximum share of 40% of both primary energy and electricity; total final energy is reduced by 1.25%/year
- Climate
 1. Reference (no new policies except for a carbon price floor)
 2. Additional measures (CCS, renewable heat and the green deal)
 3. Low carbon (80% reduction in CO₂ by 2050)
 4. Policy gap (as low carbon but government policies only achieve 70% of targets)

Final energy demand in 2050 (PJ)

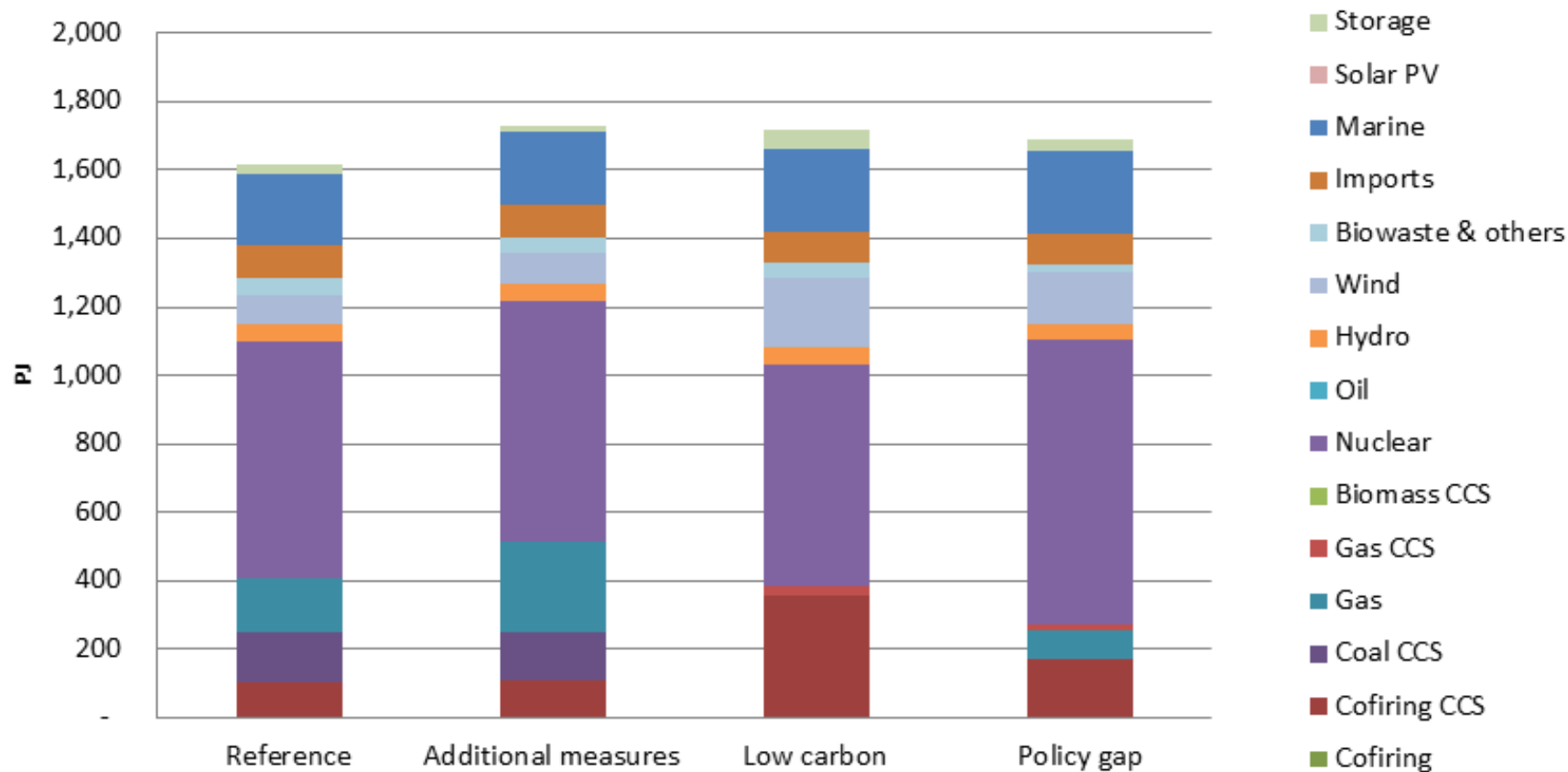


CO2 Intensity of Electricity (kgCO2/kWh)

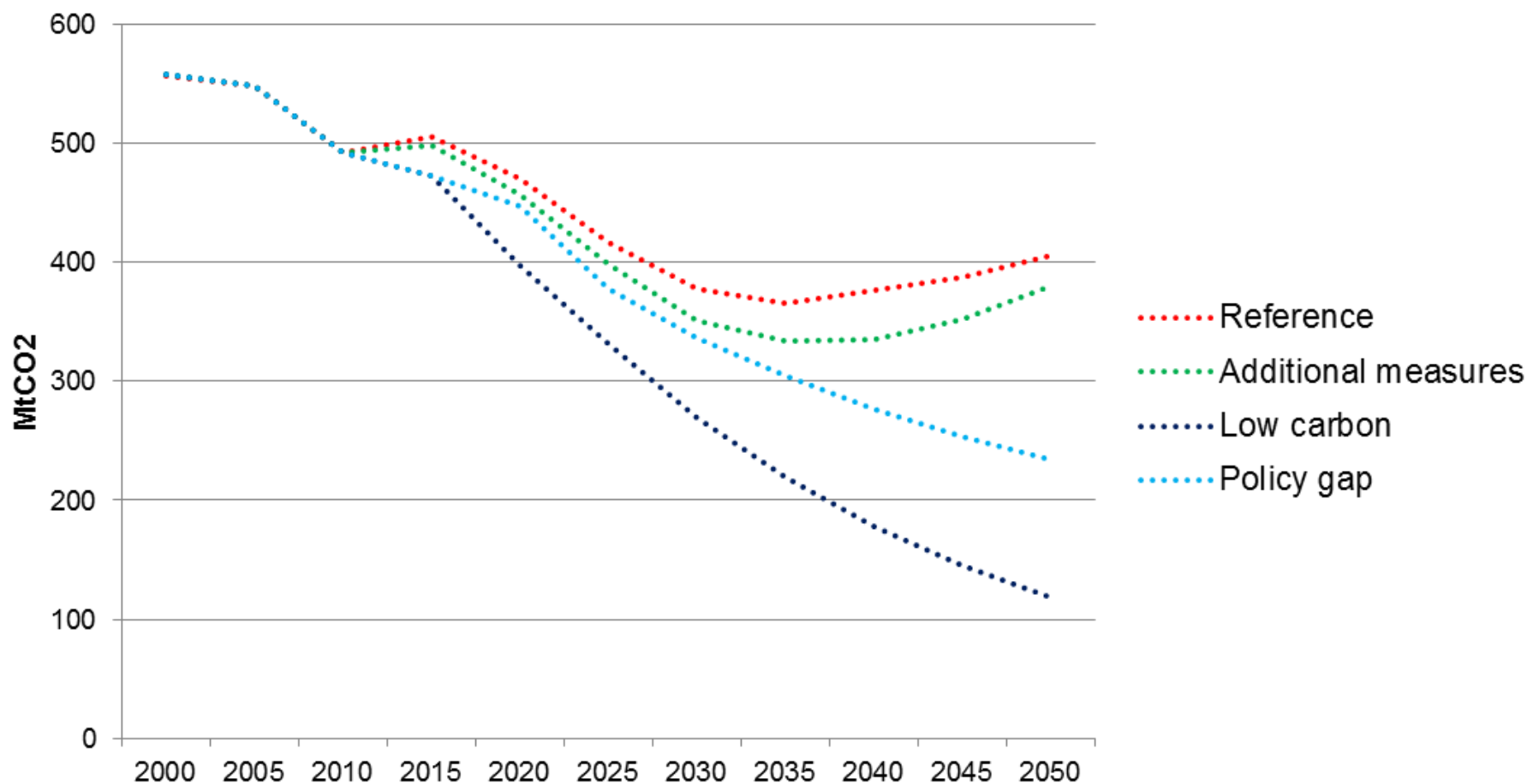
CO2 Intensity of Electricity (kgCO2/kWh)



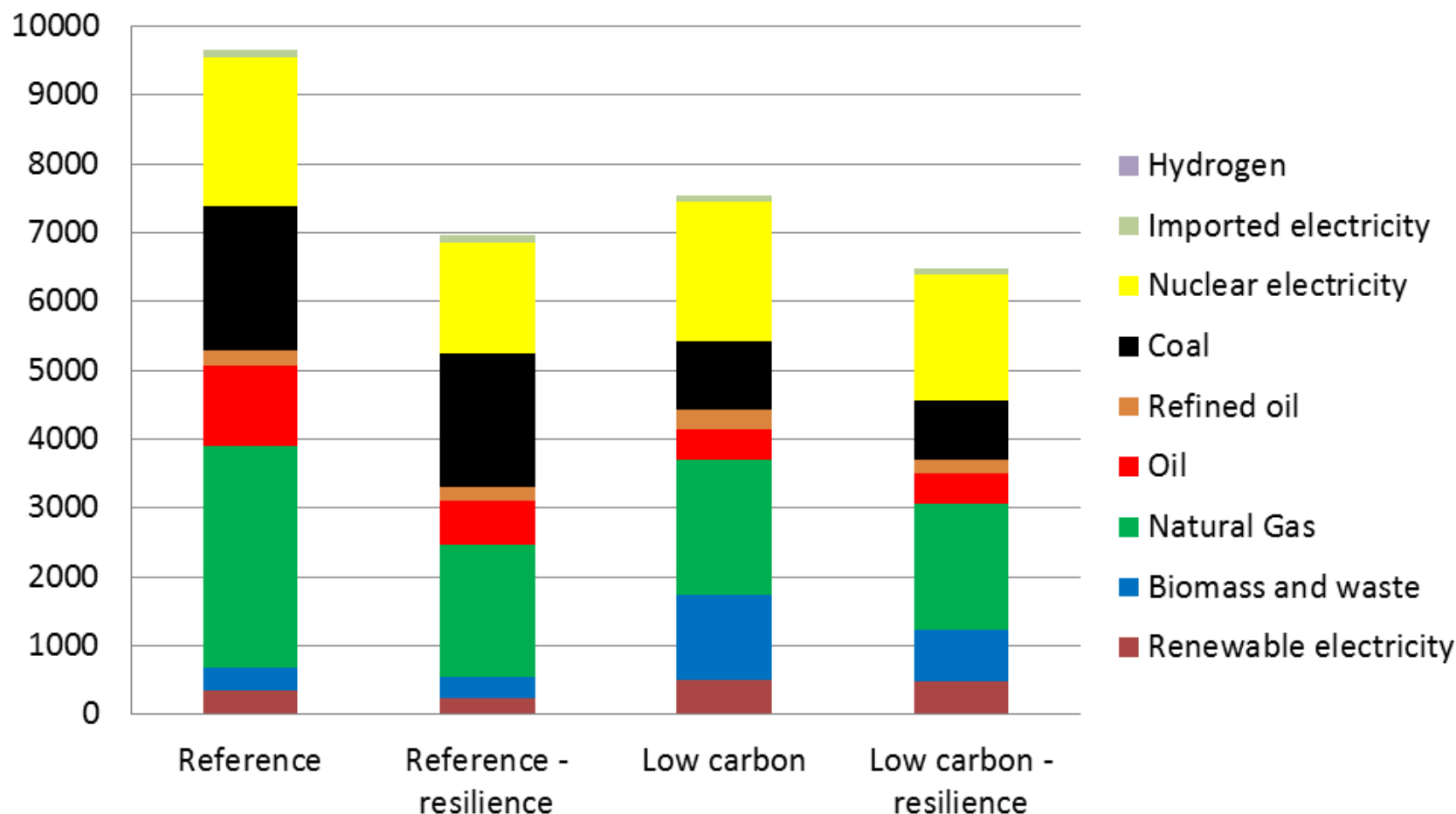
Electricity generation mix in 2050



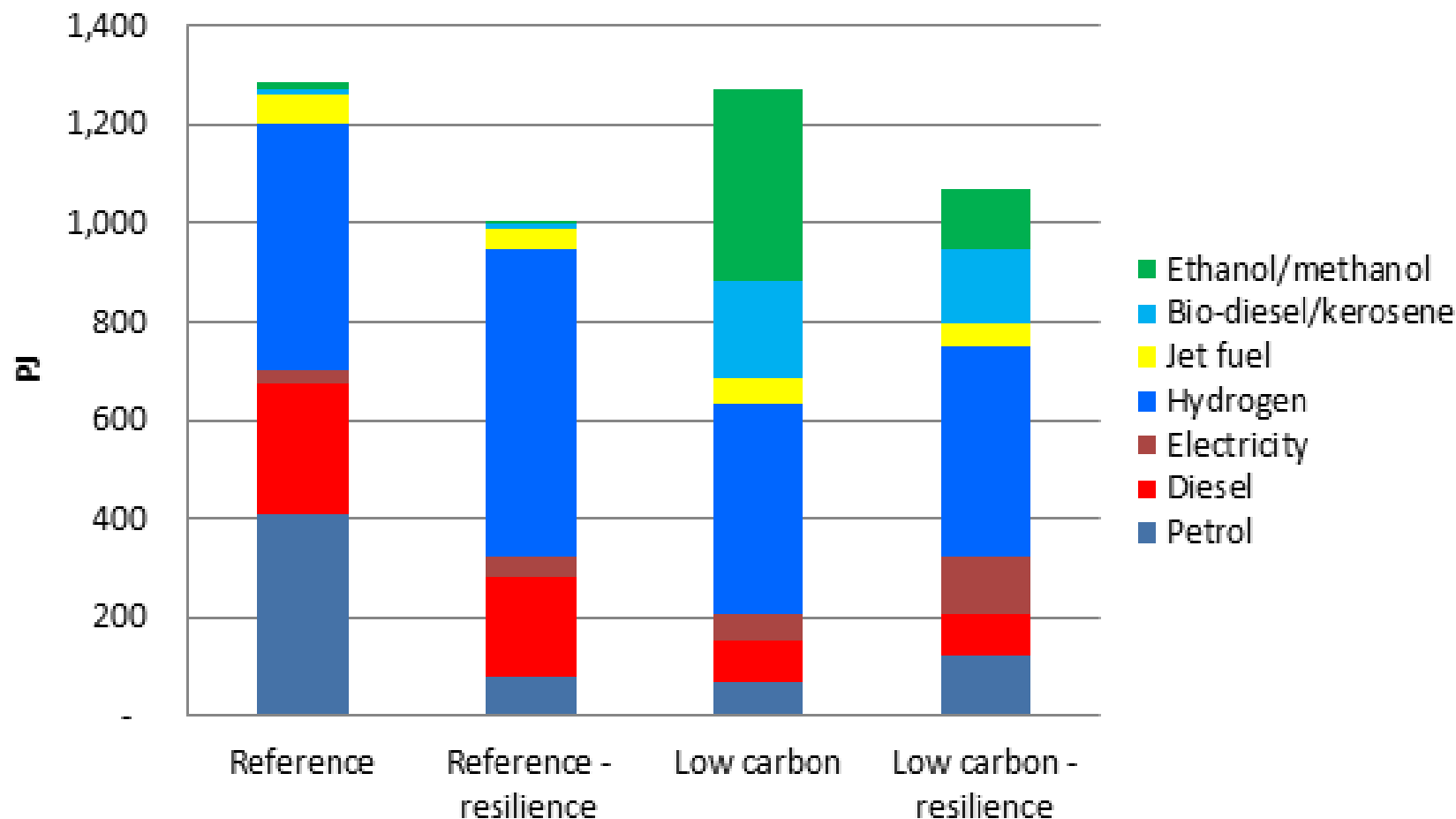
CO2 emissions – 80% cut in the low carbon scenario



Impact of resilience on final energy demand in 2050



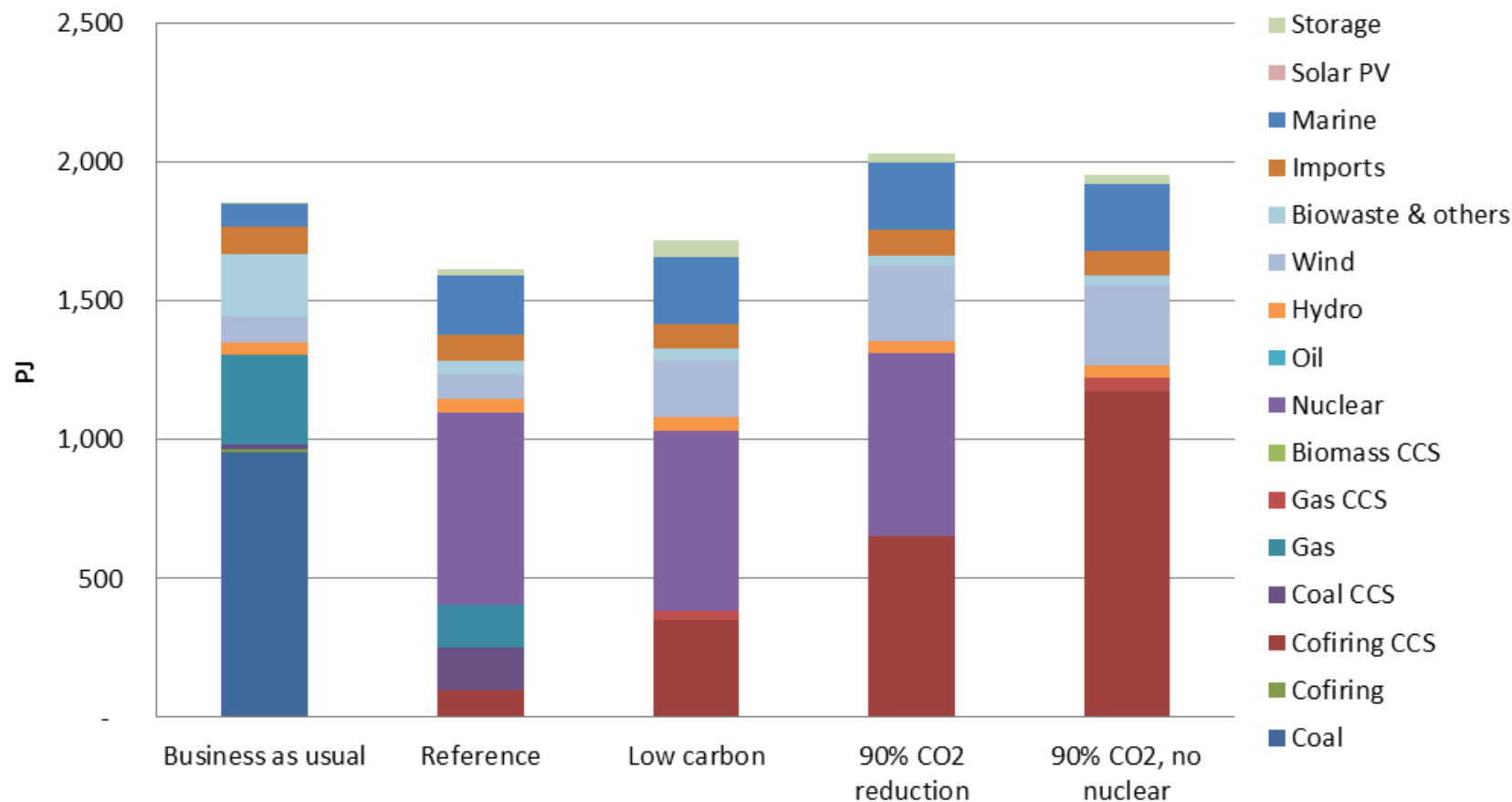
Impact of resilience on transport consumption in 2050



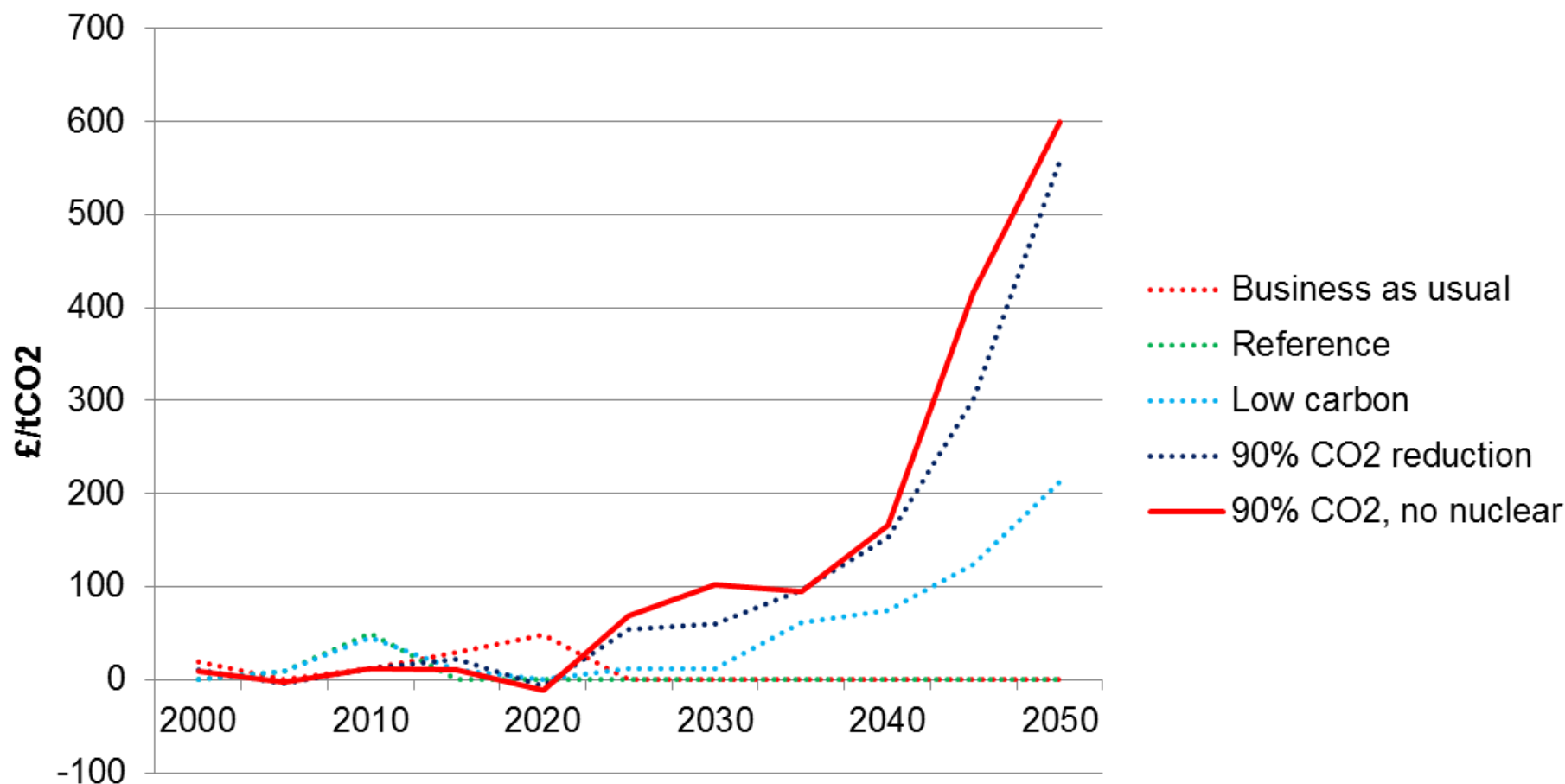
Alternative scenarios

- Business as usual: No climate change policies and no emissions constraints
- 90% reduction in CO₂: as assumed in the most recent government report
- 90% reduction in CO₂, and *no new nuclear power stations*

Alternative scenarios: electricity consumption



Alternative scenarios: marginal price of CO₂

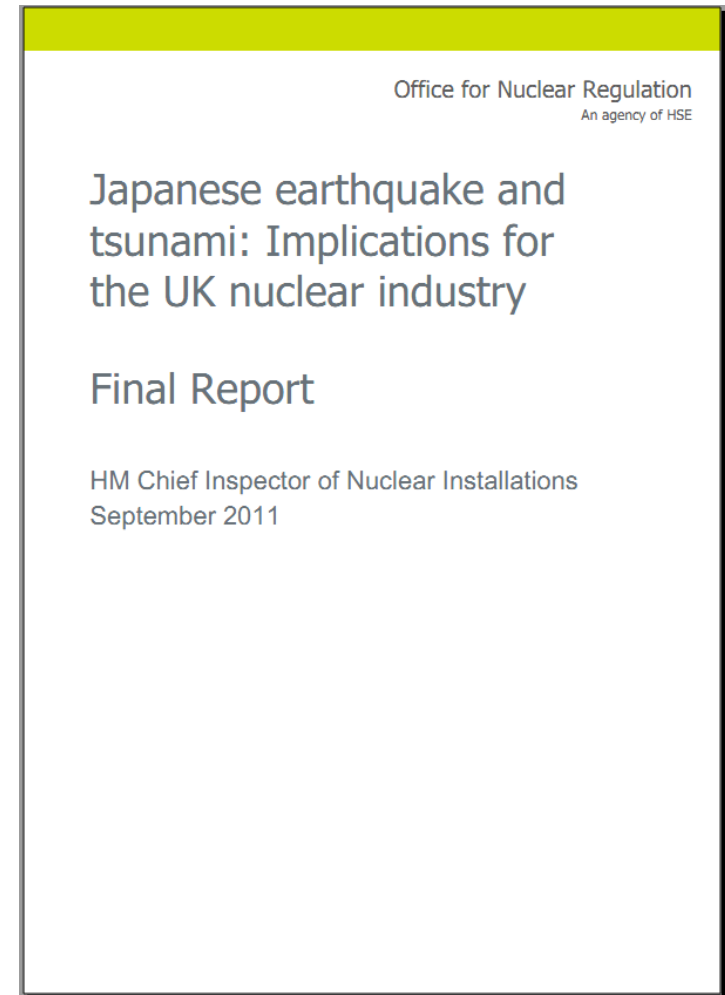


UK nuclear regulatory structure

- Government funded but independent safety authority – Office for Nuclear Regulation
- Safety policy based on international standards and lessons learned from past accidents
 - Windscale pile fire (1957)
 - Three Mile Island reactor meltdown (1979)
 - Piper Alpha oil rig fire (1988)
- Frequent accident response drills at local and national level

Fukushima response in the UK

- The “Weightman” report commissioned from the Chief Nuclear Inspector to examine UK implications:
 - The Fukushima accident gives no immediate reason for curtailing the operation of nuclear power plants in the UK.
 - The UK approach to safety in nuclear facilities is suitable.
 - Periodic Safety Reviews (PSRs) are performed properly in the UK.



Accident response in the UK

- Frequent accident response drills at local and national level
 - so the workers, police and nuclear companies have a good idea what to do immediately following an accident.
- What about other organisations and longer-term planning?
 - Local authorities have responsibilities that they cannot fulfil.
 - Would the police and companies be able to access all of the resources they might need? Equipment, army?

Government policy: 2000 onwards

| Event | Conclusions |
|-------------------------|---|
| 2002 Energy review | Energy review: energy efficiency and renewables |
| 2003 Energy White Paper | Energy White Paper: nuclear expensive, waste issues |
| 2006 Energy review | Energy review: nuclear required to meet CO ₂ targets and for energy security |
| 2007 Consultation | Confirmed 2006 conclusions |
| 2008 | Government gave permission for a new generation of nuclear power stations |

Party policy prior to the last election

Labour

Gave permission for new nuclear plants prior to the general election

Liberal democrat

Opposed any new nuclear power stations

Conservative

Supported new nuclear power stations if economically competitive

Current government policy: plans for new sites

- Planning process streamlined
 - Eight sites for new reactors
 - Interim approval from the ONR for:
 - EPR (Areva/EDF)
 - AP1000 (Westinghouse)
 - No nuclear-specific subsidies
-
- EDF/Centrica have applied to build two EPRs at Hinkley Point C in Somerset, South West England
 - £500m deal between British and French companies



Current government policy: Electricity market reform

- 1990: Privatisation of the electricity industry and creation of the 'pool'
- 2001: New Electricity Trading Arrangements (NETA) replaces the pool.
- 2005: NETA evolves into BETTA
- 2012?: Electricity Market Reform (EMR)
 - Carbon Price Floor
 - Long-term contracts for low-carbon electricity generation
 - Maximum CO₂ emissions 450 g CO₂/kWh – no new coal
 - Capacity Mechanism to ensure security of supply

Economics of nuclear

- According to the model, nuclear is economically competitive if a carbon emissions are taxed
- But is nuclear as cheap as suggested by the model?
 - Nuclear benefits from free liability insurance from the state
 - Is there a sufficient charge for radioactive waste disposal?
- Can the plants actually be built to the expected cost?
 - Currently estimated at £5bn each – but consider the last British reactor construction programme...

Merci beaucoup de m'inviter !

Questions?



**UCL ENERGY
INSTITUTE**

UKERC



UK-SHEC