CECILIA 2050
OPTIMAL EU CLIMATE POLICY

Changes to the Energy System to 2050: Insights from CECILIA2050

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SEVENTH FRAMEWORK PROGRAMME

Energy policy objectives (low carbon +)

The objectives of energy policy for European countries are basically three:

- Transition to a low-carbon energy system (involving cuts of at least 80% in greenhouse gas (GHG) emissions by 2050, which will require the almost complete decarbonisation of the electricity system), and a wider 'green economy'
- Increased security and resilience of the energy system (involving reduced dependence on imported fossil fuels and system robustness against a range of possible economic, social and geo-political shocks)
- Competitiveness (some sectors will decline as others grow – allow time for the transition); cost efficiency (ensuring that investments, which will be large, are timely and appropriate and, above all, are not stranded by unforeseen developments); and affordability for vulnerable households (special arrangements if prices continue to rise)

Options and choices

- Different countries have different options and are likely to make different choices across all these dimensions, depending on their energy history, culture, resource endowments and international relations.
- Choices are essentially political (though industry will be inclined to argue that the country concerned 'needs' their favoured option).
- The options will play out differently in terms of energy security and cost
- The economic and political consequences of making the wrong choices are potentially enormous
- Balance between developing portfolios (diversity) and going to scale (picking winners – economic as well as energy).
- Importance of demand side (historically supply needs have been substantially over-estimated)

The demand side

- Buildings (residential, commercial)
- Transport (road vehicles, rail, aviation, shipping)
- Industry (energy, process)
- Agriculture

The supply side

- Vectors: electricity, heat, liquid fuels, hydrogen
- Fossil sources: coal, oil, gas (last two conventional and unconventional)
- Low-carbon sources: ambient renewables (wind, solar, wave), bioenergy, nuclear
- Low-carbon technologies: CCS, geo-engineering

Major possible, but uncertain, developments (1)

Energy Demand: determines *how much* supply, and *what kind of* supply, is required

- **Demand reduction:** efficiency (rebound effect), lifestyles
- **Demand response:** smart meters/grids, load smoothing, peak/back-up reduction, storage, leading to implications for
- **Network design**
- **Key demand technologies:** most importantly likely be *electric vehicles* (with or without fuel cells), which could also be used for electricity storage/load smoothing, and *heat pumps*, both of which would use the decarbonised electricity. However, both technologies are in substantial need of further development and their mass deployment raises important consumer/public acceptability, as well as infrastructure, issues.

Major possible, but uncertain, developments (2)

- **Decarbonisation of electricity** (and its use for personal transport and residential heat). This depends on the development and deployment of four potentially important low-carbon options:
  - *Large-scale renewables*: issues of incentives, deployment, supply chain, storage technologies
  - *Small-scale renewables*: issues of planning, institutions
  - *Nuclear power*: issues of demonstration, cost, risk (accident, attack, proliferation, waste, safety, decommissioning), public acceptability
  - *Carbon capture and storage (CCS)*: issues of demonstration, feasibility, cost, risk (storage, liability)
- **Market redesign** for intermittency, inflexibility and zero marginal cost renewables (e.g. payments for capacity, storage)

Major possible, but uncertain, developments (3)

Bioenergy - thorny issues related to**:**

- *Carbon reduction*: how is biomass produced?
- *Environmental sustainability*: issues of land use, biodiversity
- *Different uses of biomass*: competition between bioenergy and food
- *Social issues*: issues of power, livelihoods, ownership and control

Major possible, but uncertain, developments (4)

Internationalisation in relation to:

- *Technology*: e.g. global research, innovation, technology transfer. Balance between competition and co-operation
- *Trade*: e.g. bioenergy, electricity, carbon, border taxes
- *International integration*: grids (e.g.high-voltage DC electricity), markets (European Roadmap 2050, EU Energy Union)

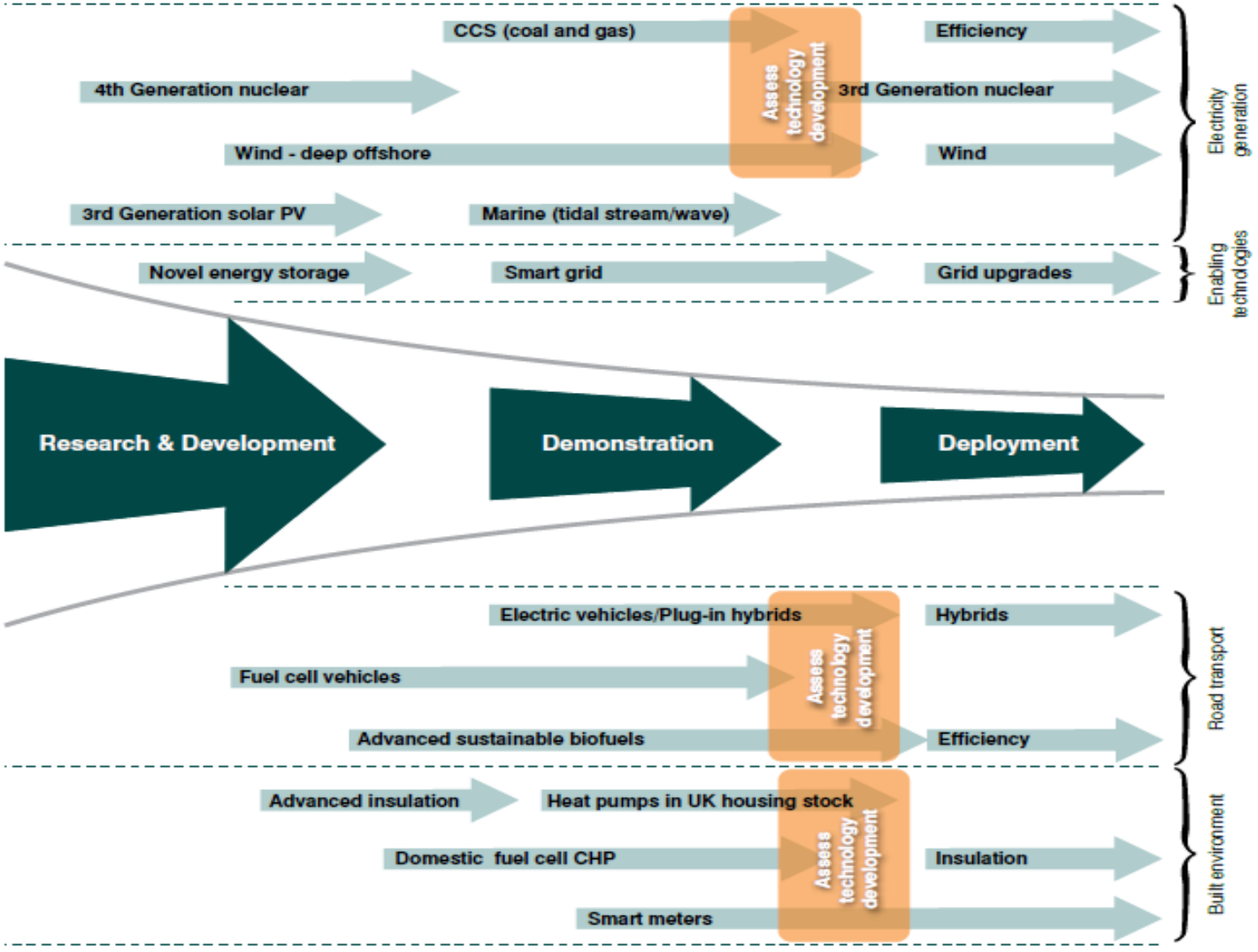
Possible timeline, 2010-2050 (1)

2010-2020:

- Results relating to the EU Renewables Directive
- European 2030 package and associated target(s)
- Supply-side options are clarified (In EU how much beyond 20% renewables? Does CCS work? Which countries will go for nuclear? How much distributed generation?)
- Trajectory of demand reduction is clarified
- Trajectory of electrification of personal mobility and residential heat is clarified
- Demand response technologies are installed
- Requisite institutional reforms (e.g. Electricity Market Reform in UK, Energy Union reforms in EU) are put in place
- Internationalisation agreements (e.g. interconnectors) are put in place

Pipeline of selected energy technologies showing progress required by 2020

- Source: Energy Research Partnership 2010 *Energy innovation milestones to 2050*, March, ERP, London
  www.energyresearchpartnership.org.uk/tiki-download_file.php?fileId=233


CCS (coal and gas)
Efficiency
4th Generation nuclear
3rd Generation nuclear
Assess technology development
Wind - deep offshore
Wind
3rd Generation solar PV
Marine (tidal stream/wave)
Electricity generation
Novel energy storage
Smart grid
Grid upgrades
Enabling technologies
Research & Development
Demonstration
Deployment
Electric vehicles/Plug-in hybrids
Hybrids
Fuel cell vehicles
Assess technology development
Advanced sustainable biofuels
Efficiency
Road transport
Advanced insulation
Heat pumps in UK housing stock
Domestic fuel cell CHP
Assess technology development
Insulation
Smart meters
Built environment

Possible timeline, 2010-2050 (2)

2020-2030:

- Large-scale roll out of different supply technologies
- Establishment of new demand patterns
- Roll out of grid redesign
- Re-think/re-orientation where possible/desired to take account of new technologies and options

2030-2050:

- Large-scale deployment of chosen options
- Limited scope for trajectory change without large costs

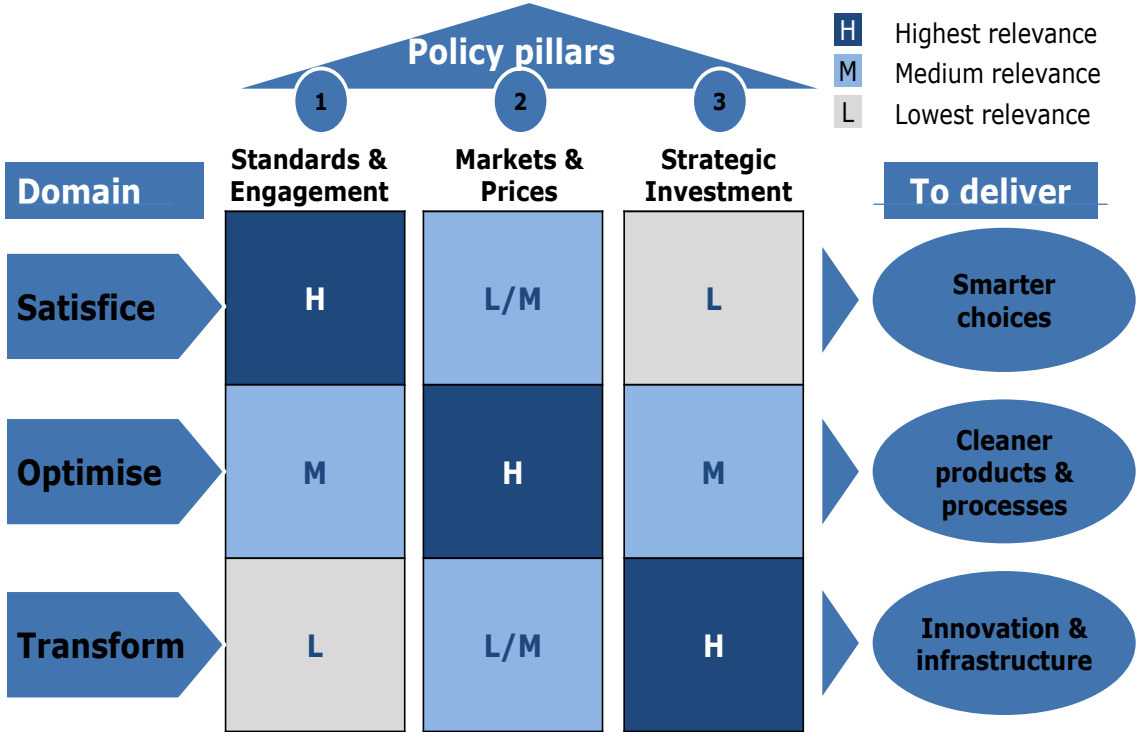
Climate change: an unprecedented policy challenge

The Stern Review Policy Prescription

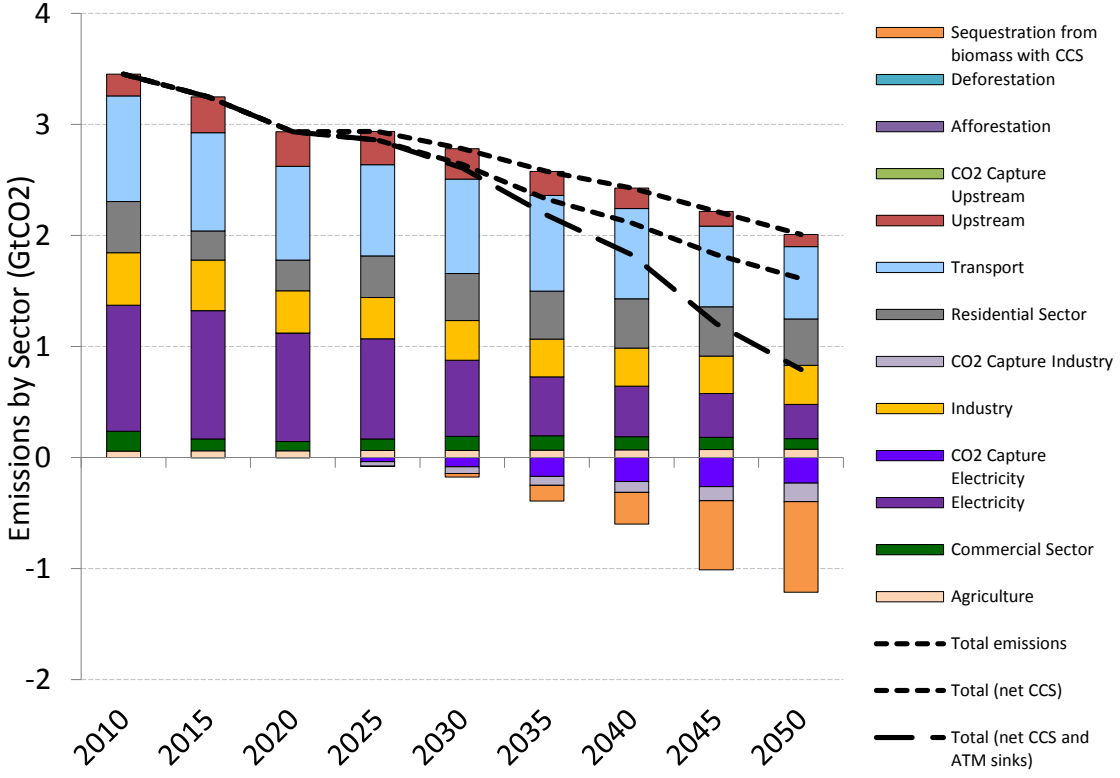
- Carbon pricing: carbon taxes; emission trading
- Technology policy: low-carbon energy sources; high-efficiency end-use appliances/buildings; incentivisation of a huge investment programme
- Remove other barriers and promote behaviour change: take-up of new technologies and high-efficiency end-use options; low-energy (carbon) behaviours (i.e. less driving/flying/meat-eating/living space/lower building temperatures in winter, higher in summer)
- Carbon pricing will both stimulate investment in low-carbon energy sources and promote behaviour change. But in the presence of market barriers and innovation failure, either prices will need to be infeasibly high, or they will need to be supported by complementary policy

Three 'Domains of Change' and 'Pillars of Policy'

Acknowledgement: Grubb *et al* (2014) *Planetary Economics*



CECILIA2050 Modelling – CO_2 trajectory



Key Modelling Assumptions for 2DS

- 80% CO_2 reduction by 2050 from 1990 levels (CO_2 only because other GHGs poorly characterised)
- 2020 RES and emission targets met (202020 targets) – but not efficiency
- Power Sector largest contributor to abatement (relatively and absolutely)

Energy commodity prices for oil, coal and gas equal to IEA's 2012 2-degree scenario levels (2DS, lower prices than reference scenario – reduced global demand)

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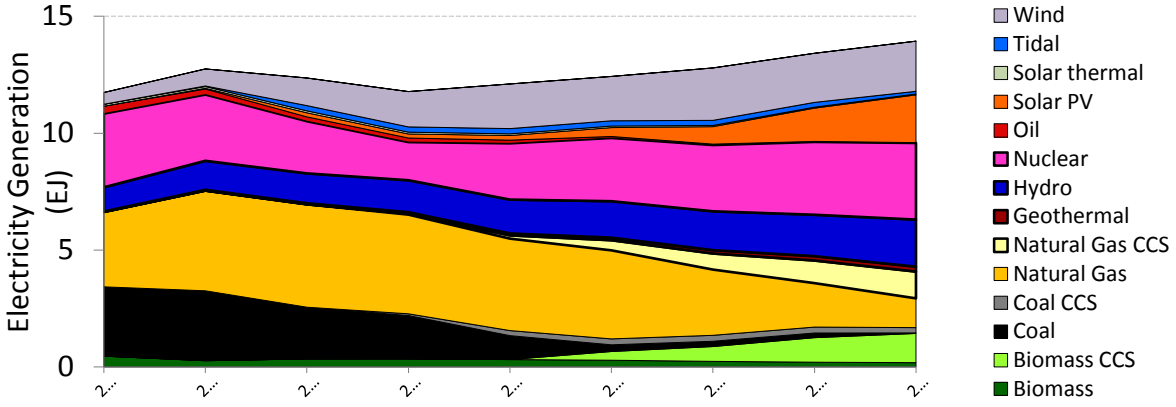
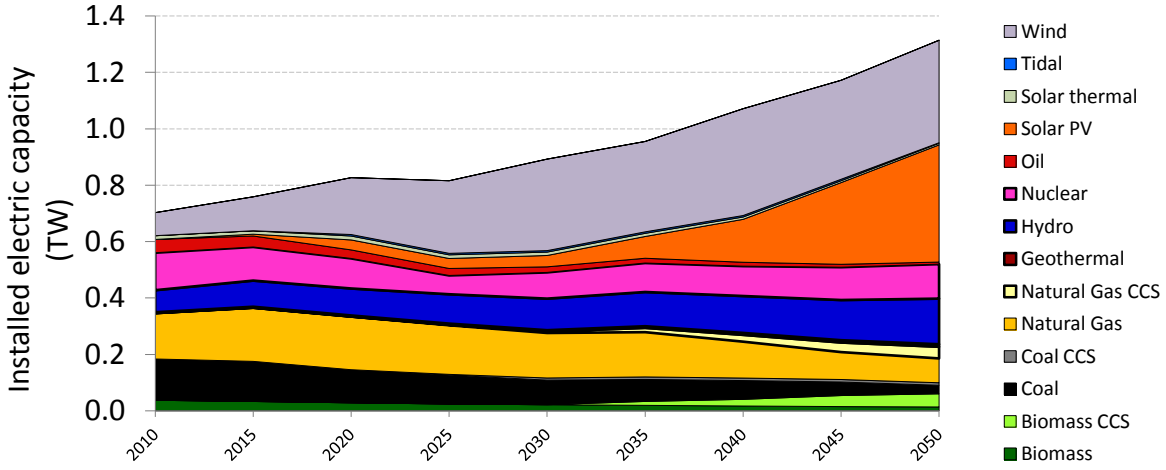
Power Sector

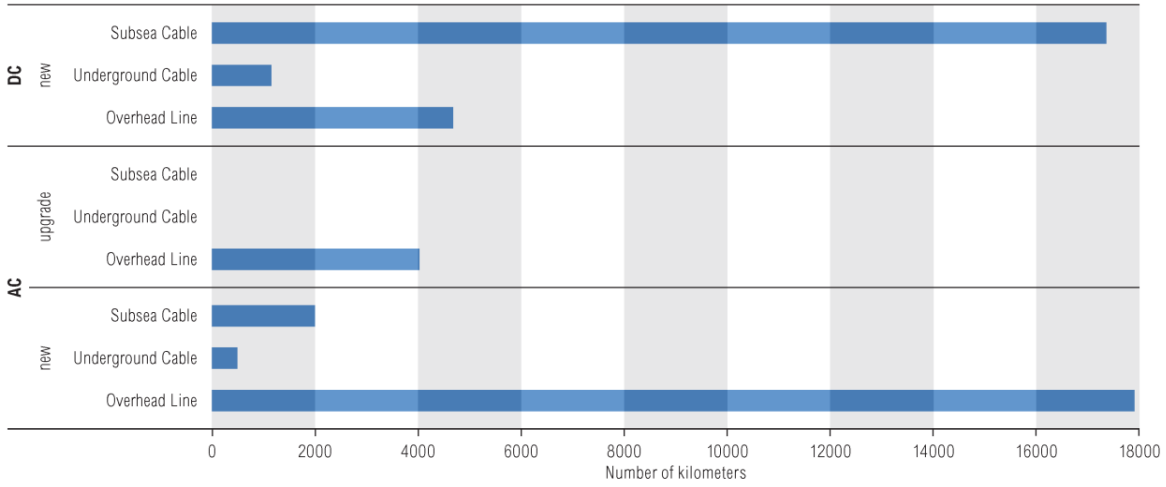




- Negative emissions in electricity generation by 2050 (biomass CCS)
- CO_2 intensity of around 170gCO_2/KWh by 2030, -50gCO_2/KWh by 2050.
- Nuclear new build allowed up to 2010 capacity.
- If no new nuclear capacity permitted, gap is filled with additional wind/PV. Very little investment cost difference.

Power Sector – Short-Term Options

- **Incentive-Based option**– substantial ETS reform to reach at least €70/tCO_2 by 2030 (including possible sectoral expansion)
- **Technology-Specific option** – ETS reform, but less drastic. CO_2 intensity limit for new installations introduced, set to at least prevent construction of new, unabated coal-fired power stations (e.g. 450gCO_2/kWh)
- **Other options/requirements, regardless of which short-term direction taken**
  - Single, redesigned electricity market must be in place ASAP (certainly by 2030)
    - Grid expansion (including interconnectors)



***Source**: ENTSO-E (2014)*

- Transmission network length increase = 44,000km - 1%/year to 2030 (inc. doubling of interconnector capacity on average)

Power Sector – Short-Term Options

- **Other options/requirements, regardless of which short-term direction taken**
  - **Single, redesigned electricity market must be in place ASAP (certainly by 2030)**
    - Grid expansion (including interconnectors)
    - 3rd Energy Package (unbundling, regulated energy pricing, network codes, etc.)
  - **'Smart' redesign and alignment of RES-E support mechanisms where not already present**, and 'smart', aligned **Capacity Mechanisms**
    - Including conversion to 'premiums', stability mechanisms (e.g. degression) and inclusion of demand-side measures. All act to reduce cost.
  - **Financing is likely to be an increasing issue**, with increasing RES-E deployment and capital investments in transmission infrastructure in particular
    - Keeping such financing 'on-bill' increases stability, but reduces acceptability. Compensatory measures likely required (inc. reduction of other levies, provision of efficiency measures, use of central EU funds, carbon price revenue).
  - **Non-financial barriers must also be reduced, such as complex administrative procedures and unfavourable planning regimes.**

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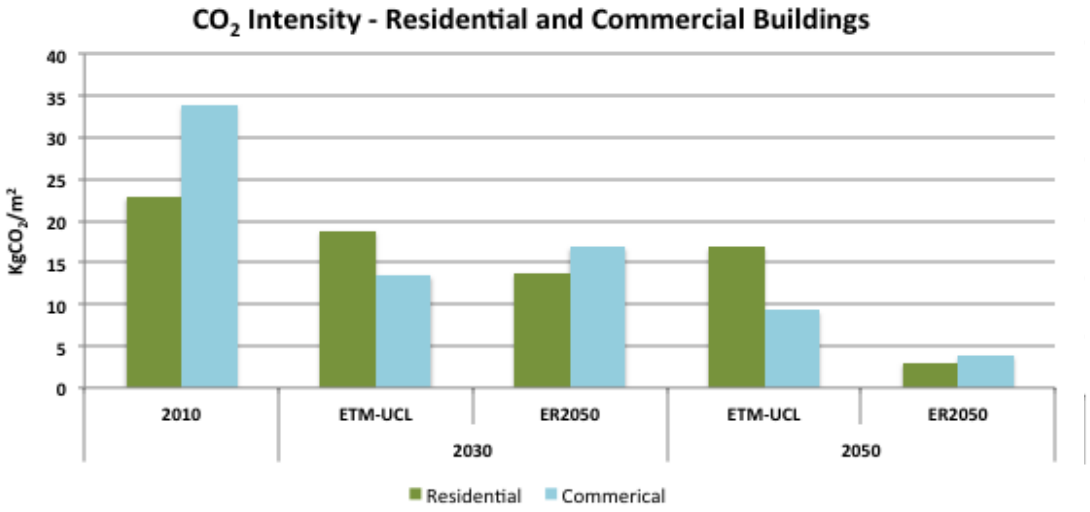
Road Transport – Short-Term Options

- **Incentive-Based option** – First choice - harmonisation of fuel excise duties, with inclusion of carbon price component. Supported by reform/expansion of registration/circulation taxes, and road pricing (major cities and 'all-EU' for HGVs – reduces 'fuel tourism' incentive)
- **Technology-Specific option** – Expansion of CO_2 intensity regulations to all road transport. 'Super credits' removed, compliance mechanism revised. Parallel instruments (e.g. registration/circulation taxes, LEV subsidies) may be removed.
- **Other options/requirements**
  - **Revision of company car taxation** – reform 'in-kind' benefit on CO_2-intensity basis, ensure driver is liable for a proportion of fuel consumption
  - **Introduction/revision of 'information' instruments** – including CO_2-labelling of passenger cars (e.g. harmonisation, include cost-saving information), and use of 'soft' measures (e.g. Personalised Transport Planning)
  - **Provision of Infrastructure** – If required, expand Alternative Fuelling Directive (2014/94/EU) to charging infrastructure to allow electric vehicles able to travel **between** large urban areas by 2025?

Buildings

- Overall, total energy demand in both residential and commercial sector remains largely the same, despite increase in both types of property. Challenges then in deploying significant efficiency measures and low-carbon technologies on both new and existing stock.



- **Household heating is key at the EU level** – increasing proportion from gas (40% to 50%)) and electricity (25% to 35%) by 2050, fuels of a higher CO_2-intensity reduced (e.g. heating oil, coal)

Buildings – Short-Term Options

- **Incentive-Based option** – expansion of the EU ETS to heating fuels (particularly natural gas), providing a carbon price. Coupled with improved access to finance and legal adjustments to help overcome landlord-tenant dilemma
- **Technology-Specific option** – Reform and extend 2020 'near-zero energy' requirements for new buildings to 'net-zero CO_2' by 2030. Extend 2020 energy efficiency obligations for existing buildings to 2030. Expand and 'tighten' Ecodesign Directive – 'aim for the best' rather than 'eliminate the worst' (Japanese Top Runner)
- **Other options/requirements**
  - **Remove distorting subsidies** – such as regulated energy prices, and reduced-rate levies (e.g. 5% VAT in UK rather than 20% = £5 billion annual subsidy)
  - **Revise 'labelling' Instruments** – Particularly Energy Labelling Directive, to remove 'A plus' categories, ensure even spread of products between rankings.
  - **Improved use of 'nudging' instruments** – Comparative information required by EED. Also include information on simple efficiency options and cost savings.

Other Challenges and Options

- **Long-term planning**
  - Member States may produce long-term plans (e.g. to 2050), setting out proposed pathways to for decarbonisation within their jurisdiction. Allows identification of synergies/conflicts (inc. between MS), uncertainties to be reduced, and innovation focus
- **Innovation policy**
  - Greatly increased R&D budgets, funding for development and deployment of new and immature technology (e.g. CCS, energy storage, industrial abatement technologies), including from carbon price revenue
  - Green Public Procurement (GPP) may be enhanced to stimulate innovation (e.g. 'forward commitment procurements')
- **Subnational/regional governance mechanisms**
  - Promotion of these governance levels may overcome barriers that exist at EU/MS level. Allows emergence of 'frontrunners' and policy and technology 'laboratories' to stimulate learning and reduce uncertainties

Conclusion

- Substantial transformation of the energy system required. Policy instruments must be in place soon in order to drive investments into low-carbon, **particularly long-lived infrastructure**
- Such an instrument mix must meet the demands of the **'trilemma'**
- In the short-term, two directions for instrumentation may be taken – **'incentive-based'** or '**technology-specific**'.
- Whichever the focus, the instrument mix must include elements of **all three 'pillars of policy'**
- Many options are available in the short-term that **would be beneficial** regardless of instrumentation focus

Thank you

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