P6.1-1 Energy Innovation Milestones to 2050

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

- Transition to a low-carbon energy system (involving cuts of at least 80% in GHG (GHG) emissions by 2050, which will require the almost complete decarbonisation of the electricity system);
- 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); and
- Cost efficiency (ensuring that investments, which will be large, are timely and appropriate and, above all, are not stranded by unforeseen developments)

In the realisation of these objectives over the next 40 years, the uncertainties are fundamental and profound. With time it is likely that the uncertainties will be reduced. However, this does not imply a 'wait-and-see' strategy because across a number of issues the availability of future desirable options will depend on present actions. The need is to identify correctly these present actions and pursue them with vigour, but also with prudence. It will not be easy to combine these qualities of action.

The uncertainties may be divided into four broad areas, which will be discussed in the presentation, together with the possible timescales for their resolution:

1. **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:
   a. *Large-scale renewables*: issues of incentives, deployment, supply chain, storage technologies
   b. *Small-scale renewables*: issues of planning, institutions
   c. *Nuclear power*: issues of demonstration, cost, risk (accident, attack, proliferation, waste, safety, decommissioning), public acceptability
   d. *Carbon capture and storage (CCS)*: issues of demonstration, feasibility, cost, risk (storage, liability)
2. (i) **Demand reduction: efficiency** (rebound effect), lifestyles
   (ii) **Demand response**: smart meters/grids, load smoothing, peak/back-up reduction, storage, leading to implications for
   (iii) **Network design**
   (iv) **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.)
3. **Bioenergy**. Thorny issues related to:
   a. *Carbon reduction*: how is biomass produced)
   b. *Environmental sustainability*: issues of land use, biodiversity
   c. *Different uses of biomass*: competition between bioenergy and food
   d. *Social issues*: issues of power, livelihoods, ownership and control
4. **Internationalisation** in relation to:
   a. *Technology*: e.g. global research, innovation, technology transfer. There will be a difficult balance to strike here between the quest for competitive advantage from the new technologies, and the need to international cooperation in

research to avoid delay and duplication

b. *Trade*: e.g. bioenergy, electricity, carbon, border taxes

c. *European integration*: grids (electricity, gas), markets (Roadmap 2050)

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. For all but a very few (resource-constrained) countries, the choices between focusing on demand reduction or supply, and the different options for low-carbon supply, 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 (where demand reduction and diversity of supply are likely to be the most influential variables) and cost, where the political skill will initially be to allow a thousand flowers to bloom and then to give targeted support to those options (on the supply or demand side) than provide the most politically acceptable and cost effective mix, taking into account public acceptability, industrial and employment, as well as other economic, considerations. Different EU and other countries are in very different phases of these choices in respect of the supply side. Demand side measures are less well developed in nearly all countries, but will become increasingly important as low-carbon sources increase their penetration, because these sources tend to be less flexible than coal and gas plants. The political and economic consequences of getting the choices wrong, in terms of technology or timing, are potentially enormous.

Very broadly the timeline might look something like this:

2010-2020:

- 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 are put in place
- internationalisation agreements are put in place

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