Modelling and analyses for RDD&D priority setting

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Modelling and Analysis in R&D priority-setting and innovation
IEA’s programme of work in energy technology

- Where do we need to go?
- Where are we today?
- How do we get there?
This presentation

- Global perspective on the transformation required
- Modelling R&D
- Measuring R&D
- Challenges for future approaches
Scale of innovation required

- Energy innovation: Processes that take an idea for a new energy technology, device, organizational or market structure to the market.
Scale of innovation required

- Energy innovation: Processes that take an idea for a new energy technology, device, organizational or market structure to the market

- Global decommissioning curve
- Investment characterized by long lifetime and high upfront capital demand
- Decisions have to take into account long time horizon with uncertain or unknown conditions:
  - Technology development?
  - Market conditions?
  - Climate impacts?
  - Long-term energy prices?
  - Economic development?
  - Climate policies?
  - Operational aspects (variable renewables, electrification)?
The IEA’s long-term energy planning model

Based on TIMES, a framework developed by ETSAP (www.etsap.org)

Energy Technology Systems Analysis Programme (ETSAP)

- Since 1976 (Post Oil Crisis)
- Consortium of member country teams and invited teams
- 2 workshops per year
- A common, comparable and combinable METHODOLOGY

Used by more than 150 institutions in 63 countries
Regional structure of IEA TIMES

- 28 model regions representing individual countries or aggregations of countries
- One geographic point per model region
ETP modelling framework

- Supply-side: least-cost optimisation model based on TIMES methodology
- End-use sectors (industry, buildings, transport): spreadsheet-based simulation models
- World divided into 28-40 regions depending on sector
Modelling the innovation system

- Estimating the impact of R&D on technology development
  - Limited by lack of available data
- Incorporating the complexity of the innovation chain
- Incorporating uncertainty in technology outcomes/benefits
- Incorporating spillovers
- Difficult to separate energy R&D from deployment
- Future market design?

Source: Grubb 2013
Modelling the innovation system

- Complex system where both the input and the output are difficult to measure

**R&D**
- Capturing R&D benefits
- Spillovers
- High risk/uncertainty
- Long lead times

**Demonstration**
- Capturing benefits of demonstration
- Spillovers
- High risk/uncertainty
- High capital costs
- Uncertain costs
- Uncertain future markets
- Risk (technology/policy)

**Early deployment**
- Capturing current/future markets
- Finance
- Information
- Non-cost barriers

**Diffusion**
- Market creation

Direct energy R&D spending
- Education

Non-energy R&D

Other technology push policies

Price/quantity mechanisms

Difficult to align push and pull policies:
- Prevent untimely lock-in
- Interfaces among actors
- Stimulate physical & knowledge infrastructure
- Create conditions for learning and experimenting

Carbon pricing

Modelling the innovation system

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No straightforward way of measuring effectiveness of RDD&D

- Learning curves
- Expert elicitation
- Factor decomposition
  - Looking at the past
- Mixed approaches
  - (e.g. UK TINAs)

Source: Diaz-Anadon et al. 2013
The global energy system today

Global energy flows in 2011
A choice of 3 Futures

**2DS**
a vision of a sustainable energy system of reduced Greenhouse Gas (GHG) and CO₂ emissions

The 2°C Scenario

**4DS**
reflecting pledges by countries to cut emissions and boost energy efficiency

The 4°C Scenario

**6DS**
where the world is heading under current policy with potentially devastating results

The 6°C Scenario
To achieve the 2DS, energy-related CO₂ emissions must be halved until 2050.
Global energy flows in 2050
Scale of the challenge

Massive acceleration of deployment of low-carbon power technologies is needed over the next four decades.
Clean energy pays off – but how to allocate resources efficiently?
How are we doing?

- Renewable power
- Nuclear power
- Gas-fired power
- Coal-fired power
- Carbon capture and storage
- Industry
- Transport
- Biofuels
- Electric and Hybrid electric vehicles
- Buildings
- Smart grids
- Co-generation and district heating and cooling
Energy’s share in OECD RD&D budgets has gradually been decreasing since 1980s
Measuring R&D - indicators

Low carbon innovation activity is accelerating

- Annual growth rate of low carbon technology patenting
Measuring R&D - indicators

IEA investment data shows other positive trends

- Change in R&D investment by technology/area, 2003-07 vs 2008-12
Change in geography of energy innovation?

Measuring R&D - indicators

The current level of investment in R&D is 3-6 times lower than required.

2DS range required
2007, IEA members
2012, IEA members
Key challenges/barriers to be addressed

- High capital investment, esp. for low carbon technology (CCS?)
- Need to innovate with existing infrastructure
- Transformation required in some of the least innovative sectors
- In a low carbon world, innovation is as much about technology as it is about system design, usage and markets
- Delivering innovation at scale
To meet the 2DS, generation from subcritical plants would need to cease before end of their technical lifetimes.
Key challenges/barriers to be addressed

- Need to innovate with existing infrastructure

**Electricity generation**

- 35% from variable renewables in 2050

**Annual light-duty vehicle sales**

- Almost 60% of LDV sales are EVs or PHEVs in 2050
Key challenges/barriers to be addressed

- Need to innovate with existing infrastructure

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The real estate of these is conceptual only.
Key challenges/barriers to be addressed

- Transformation required in some of the least innovative sectors
Key challenges/barriers to be addressed

- Transformation required in some of the least innovative sectors
- Private sector is key - we don’t have enough information on:
  - Level and type of R&D investment
  - Where benefits of innovation are accrued
  - Process of prioritisation
- Difficult to characterise the impact of market-pull policies on technology development
Key challenges/barriers to be addressed

Delivering innovation at scale

Vastly different decarbonisation strategies across countries
Key challenges/barriers to be addressed

Delivering innovation at scale

- Literature on evolution of energy technology costs in non-OECD countries is lacking
- Important to understand dynamics of technology transfer and mature technologies in other markets
- Role of innovation policy in other countries

OECD analysis on clean energy technology knowledge flows in 2011 (Johnstone and Hascic)
Thank you

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