Modelling investment in RD&D - Will Mission Innovation make a difference?

Fionn Rogan et al
IEA-ETSAP Workshop on Energy Modelling and Applications
The University of Tokyo, December 14th 2016
Presentation Overview

• Mission Innovation
  • Overview
  • Challenges

• Modelling Technology Learning
  • Overview
  • Challenges

• UCC-EPMG Modelling & Analysis
  • TIMES Multiple Scenario Analysis
  • Innovation System Analysis
Mission Innovation

Clean Energy R&D Investment Chart for Mission Innovation

- Baseline ($15 Billion/y)*
- Additional Investment (> $35.0 Billion)
- Doubling (Extra $15 Billion/y)

Public Investment

- Launch of Mission Innovation
- Business as Usual (~ $75 Billion)

Source: Mission Innovation
Mission Innovation Challenges

1. Funding

2. Prioritisation

3. Uncertainty
1. Mission Innovation - Funding

Source: IEA
1. Mission Innovation - Funding

Centralised approach
- Government led, top down
- Collaboration prioritised over competition
- Government laboratories take the lead, e.g.
  - Fraunhofer in Germany
  - RISO in Denmark

Decentralised approach
- Market led, bottom-up model
- Competition prioritised over collaboration
- Start-ups and Original Equipment Manufacturers (OEMs) take the lead

Source: Hannon, 2016
# 2. Mission Innovation - Prioritisation

## Mission Innovation Clean Energy R&D Focus Areas

<table>
<thead>
<tr>
<th>Focus Area</th>
<th>Australia</th>
<th>Brazil</th>
<th>Canada</th>
<th>Chile</th>
<th>China</th>
<th>Denmark</th>
<th>European Union</th>
<th>Finland</th>
<th>France</th>
<th>Germany</th>
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<th>Indonesia</th>
<th>Italy</th>
<th>Japan</th>
<th>Kingdom of Saudi Arabia</th>
<th>Mexico</th>
<th>Netherlands</th>
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<th>United Arab Emirates</th>
<th>United Kingdom</th>
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</table>

Source: Mission Innovation
2. Historic Prioritisation - Public Sector

Note: for IEA countries only

Source: Rhodes et al, 2014
2. Historic Prioritisation - Private sector

Note: EC survey of top 1200 global companies

Source: Rhodes et al, 2014
3. Mission Innovation - Uncertainty

Inputs → Innovation → Outputs
3. Mission Innovation - Uncertainty

Cost Reductions

Market Uptake

Source: Mission Innovation
TECHNIQUES FOR MODELLING TECHNOLOGY LEARNING IN ENERGY SYSTEM MODELS

Elia, A. Rogan, F. Ó Gallachoir B

ABSTRACT

Investigating technological change has become a key research area in the last year to provide a better understanding of technology innovation and adoption in the context of an energy system. A common method used to investigate the innovation is the learning curve approach (LC), it can provide an exhaustive representation of the phenomena of technological learning.
## Modelling Technology Learning

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learning by Researching</strong></td>
<td>Technology improvements from Research Development &amp; Demonstration (RD&amp;D) particularly scientific advances</td>
</tr>
<tr>
<td><strong>Learning by Interacting</strong></td>
<td>Technology improvements from network interaction between all actors in technology development &amp; diffusion stages</td>
</tr>
<tr>
<td><strong>Learning by Doing</strong></td>
<td>Technology improvements achieved during the production process</td>
</tr>
<tr>
<td><strong>Scale Effect</strong></td>
<td>Technology improvements from economies of scale such as plant size, mass production</td>
</tr>
<tr>
<td><strong>Learning by Using</strong></td>
<td>Technology improvements from customer-firm feedback during market deployment</td>
</tr>
<tr>
<td><strong>Other Approaches</strong></td>
<td>Learning curves plus other methods (e.g. engineering, bottom-up technical approaches, expert judgement)</td>
</tr>
</tbody>
</table>
Modelling Technology Challenges

Source: Diaz et al, 2015 based on Nemet, 2007
UCC-EPMG Modelling & Analysis

1. Irish TIMES Energy System Model
2. Multiple Scenario Analysis
3. Resilient Technologies
4. Niche Technologies
5. Innovation System Analysis
1. Irish TIMES Energy System Model

The graph illustrates the projected % of 1990 CO₂ emissions across different sectors from 1990 to 2050. The sectors include Power Sector, Transformation, Residential, Services, Industrial Processes, Industry, Agriculture (Energy), and Transport. The red line represents the BAU scenario, showing an increase in CO₂ emissions over time.
2. Multiple Scenario Analysis

What level of electrification in 2050 for CO$_2$ reduction targets 1% - 95%?
2. Multiple Scenario Analysis

- Multiple scenarios based on different
  - Technology cost profiles
  - Technology availability factors
  - Emission reduction targets

- What technologies are installed in many scenarios?
  - Resilient technologies
  - E.g. Onshore wind energy

- What technologies are installed in few scenarios?
  - Niche technologies
  - E.g. Wave and tidal energy
4. Niche Technologies

€/MWh (2013 currency)

<table>
<thead>
<tr>
<th>Year</th>
<th>Tidal</th>
<th>Wave</th>
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<tbody>
<tr>
<td>2013</td>
<td>550</td>
<td>500</td>
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<tr>
<td>2020</td>
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<td>2050</td>
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ETRI, 50% red. costs, 30% red. costs
4. Niche Technologies

![Chart showing CO2-80, CO2-80 DB, and CAPEX -50% CAPEX -30% - DB with different energy sources like Gas, Gas CCS, Hydro, Oil, Solar, Ocean, TradeEn ELC, and Wind]
5. Innovation System

Source: Imperial University
### 5. Innovation System - Functions Analysis

<table>
<thead>
<tr>
<th>Functions</th>
<th>Examples of indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influence on direction of search</td>
<td>Numbers of key policies, targets, etc</td>
</tr>
<tr>
<td>Knowledge development</td>
<td>R&amp;D, TRL development, learning curves, etc</td>
</tr>
<tr>
<td>Knowledge diffusion</td>
<td>Networks of learning, public/private collaboration, training, etc</td>
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<tr>
<td>Market formation</td>
<td>Market support mechanisms, new entrants, etc</td>
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<tr>
<td>Entrepreneurial activity</td>
<td>Start-ups, mergers, etc</td>
</tr>
<tr>
<td>Resource Mobilization</td>
<td>Finance capital, human capital, etc</td>
</tr>
<tr>
<td>Legitimation</td>
<td>Alignment of interests for all stakeholders</td>
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</tbody>
</table>
Mission Innovation

• Multiple Scenario Analysis
  • E.g. TIAM energy system model
  • Range of prioritisation scenarios based on historical investment
  • Range of technology learning assumptions/formulae for different technologies

• Resilient technologies/scenarios

• Tipping point technologies/scenarios

• Niche technologies/scenarios

• Innovation System Analysis
  • Are the model assumptions too heroic?
Thank you

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