Meeting energy challenges through technology and innovation

Implications for Japan and the rest of Asia

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Overview

• Global energy challenges and the role of technology
• Global and Asian energy technology innovation trends
• Accelerating innovation through better and more targeted policies
• Conclusions
Global energy challenges and the role of technology
World primary energy demand by fuel - New Policy Scenario (NPS)

Source: IEA World Energy Outlook 2012
Primary energy demand per unit of GDP and per capita (NPS)

Source: IEA World Energy Outlook 2012
Net energy self-sufficiency (NPS)

Source: IEA World Energy Outlook 2012
Spending on net imports of fossil fuels (NPS)

Source: IEA World Energy Outlook 2012
Energy-related CO₂ emissions (NPS)

Source: IEA World Energy Outlook 2012
The energy ‘trilemma’

Sustainable

Energy Policy

Secure

Affordable
Technology is key to a sustainable, secure and affordable energy future

Meeting global energy challenges requires a smarter, more unified and integrated energy system

Source: IEA Energy Technology Perspectives 2012
Achieving the 2DS will require contributions from all sectors and the application of a portfolio of clean technologies

Source: IEA Energy Technology Perspectives 2012
Progress with deploying clean energy technologies

Progress is too slow in almost all technology areas

Significant action is required to get back on track

Source: IEA Energy Technology Perspectives 2012
Renewables have seen notable success

Renewable power generation

42% Average annual growth in Solar PV

75% Cost reductions in Solar PV in just three years in some countries

27% Average annual growth in wind

Source: IEA Energy Technology Perspectives 2012
Fuel economy has improved, but large potential remains

The number one opportunity over the next decade in the transport sector, but few countries have standards in place

Source: IEA Energy Technology Perspectives 2012
Energy intensity must continue to decline

Significant potential for enhanced energy efficiency can be achieved through best available technologies

Source: IEA Energy Technology Perspectives 2012
Global and regional energy technology innovation trends
Deploying new energy technologies takes time

**Figure 1 | Global production of primary energy sources.** When a technology produces 1,000 terajoules a year (equivalent to 500 barrels of oil a day), the technology is ‘available’. It can take 30 years to reach materiality (1% of world energy mix). Projections after 2007 taken from Shell’s Blueprints scenario.\(^3\)

Source: Kramer and Haigh, 2009
The energy technology innovation system

Source: Global Energy Assessment 2012
Energy RD&D – IEA countries

Source: Data from IEA R&D statistics
Energy RD&D relative to GDP

Source: Data from IEA R&D statistics
Energy R&D vs total R&D in the OECD

Source: Global Energy Assessment 2012
Energy RD&D – Japan

Million USD (2011 prices and ex. rates)

- Energy efficiency
- Fossil fuels
- Nuclear
- Renewable energy sources
- Hydrogen and fuel cells
- Other

Source: Data from IEA R&D statistics
Energy RD&D trends in selected Asian countries

Source: Data from Kempener et al (2010) and IEA R&D statistics
Breakdown of RD&D spend (2008)

Source: Data from Kempener et al (2010) and IEA R&D statistics
Worldwide patent activity in environmental technologies

Patents filed in low-carbon technology areas have increased sharply since 2000, driven by renewable energy.

Accelerating innovation through better policies
Best practices on innovation policies

Source: IEA (2011a)
A mix of policies is needed

Source: Hood (2011)
Technology policies tailored to technology & market characteristics


**TECHNOLOGY CHARACTERISTICS**
- Nuclear
- Wind?
- Refineries
- CCS?
- CFLs / Wind
- Solar PV?
- NatGas
- CHP?

**MARKET CHARACTERISTICS**
- CFLs
- Hybrids?
- ICE Cars
- H2FC Cars?

**SYSTEM INTEGRATION**
- expanding production
- (substitution technologies)

**UNIT CAPACITY**
- returns to scale - technical &/or economic
- 'retrofitable' - process technologies
- modularity / not capital intensive
- flexibility / adaptability

**INDUSTRY SCALING**
- global markets
- regional markets

**UNIT NUMBERS**

**ACRONYMS:**
- CFLs = Compact Fluorescent Light Bulbs
- ICE = Internal Combustion Engine
- H2FC = Hydrogen Fuel Cells
- PV = Photovoltaic
- CHP = Combined Heat and Power
- CCS = Carbon Capture & Storage
Policies for supporting low-carbon technologies

Government support policies need to be appropriately tailored to the stage(s) of technological development

Source: IEA Energy Technology Perspectives 2010
Financial support alone is not enough

Impact vs remuneration for solar photovoltaics

Source: IEA (2011b)
Market barriers need to be addressed

Source: IEA (2011c)
Japanese roof-top PV systems

Source: Global Energy Assessment 2012
Heat pumps in Sweden and Switzerland

Source: Global Energy Assessment 2012
Top-Runner programme in Japan

Source: Arnulf Grübler
International co-operation leads to increases in co-invention

Joining an IA increases co-invention by 150% - 200% for CCS and PV, and by 100% for biofuels, fuel cells and wind power.

Source: OECD (2012)
Lessons from best practice policies

• Establish clear, stable, aligned support framework - to attract investments

• Support a wide portfolio of technologies – there are no silver bullets.

• Set up transitional incentives decreasing over time – to foster technological innovation and move towards market competitiveness

• Support knowledge flows and strengthen collaborative links between actors

• Engage in appropriate international collaboration

• Don’t be afraid to experiment – failure is an inherent part of the innovation process
Rebalancing the innovation portfolio
Supply is important, but demand is even more so.

<table>
<thead>
<tr>
<th></th>
<th>Innovation (RD&amp;D)</th>
<th>Market formation</th>
<th>Diffusion</th>
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<tbody>
<tr>
<td>End-use &amp; efficiency</td>
<td>&gt;&gt;8</td>
<td>5</td>
<td>300 – 3500</td>
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<tr>
<td>Fossil fuel supply</td>
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<td>&gt;&gt;2</td>
<td>200 – 550</td>
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<tr>
<td>Nuclear</td>
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<td>0</td>
<td>3 – 8</td>
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<tr>
<td>Renewables</td>
<td>&gt;12</td>
<td>~20</td>
<td>&gt;20</td>
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<tr>
<td>Electricity (gen &amp; T+D)</td>
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<td>~100</td>
<td>450 – 520</td>
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<tr>
<td>Other &amp; unspecified</td>
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<td>&lt;15</td>
<td>-</td>
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<tr>
<td>Total</td>
<td>&gt;50</td>
<td>&lt;150</td>
<td>1000 - &lt;5000</td>
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</tbody>
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Source: Global Energy Assessment 2012
RD&D portfolios vs mitigation needs

Source: Global Energy Assessment 2012
Phases of technology diffusion

Learning rates for supply and end-use technologies

Source: Data from Arnulf Grübler
Future direction of Japan’s energy policy?

1. Realising the world’s most advanced energy-saving society: Reform of the demand structure

2. Realising a distributed next-generation energy system: Reform of the supply structure

3. Need for technical innovation to support the energy mix conversion and reform of the energy supply-demand structure

Source: Presentation by Hiroshi Asahi, ANRE, June 2012
Impacts of improved energy efficiency for Japan

Source: IEA World Energy Outlook 2012
Accelerating the development and deployment of clean energy technologies is central to meeting global energy challenges. Range of possible technology options, with energy efficiency and renewables some of the most important. Current progress on deployment is not sufficient. Appropriate technology policies have an important role to play in accelerating progress. Need to learn from best practice policies and ensure a balanced innovation portfolio.
Conclusions (2)

- Current review of energy policy likely to see Japan increase its focus on distributed supply technologies and energy efficiency
- Provides opportunity for Japan to build on its global leadership in energy RD&D
- Asia is a major driver of energy trends and fast becoming a global force in energy innovation
- Chance for Japan to work with other Asian nations to drive forward successful energy innovation to meet global and regional energy challenges


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