Japan Roadmaps toward a Low-Carbon Society by backcasting

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http://2050.nies.go.jp

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What are the Asian Low Carbon Societies in the study?

By the middle of this century (2050), the target societies will satisfy the followings;

1. Harmonized with drastically changing future Asian society and economy,

2. Complying with each country’s national reduction target that consists with the global low carbon target, under the global, national and regional constraints on fossil and renewal energy resources, and land resource,

3. Developing/devising/promoting LCS policies based on each region’s characteristics,

4. Also utilizing effectively co-benefits of LCS policies and neighboring policies.
**Item to be considered...**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Domestic and Commercial</th>
<th>Transportation</th>
<th>Energy supply</th>
<th>Social system</th>
<th>Cross-sectional</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>iv) Passenger transportation</td>
<td></td>
<td></td>
<td>ix) Economic consistency</td>
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<tr>
<td></td>
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<td>v) Freight transportation</td>
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</table>

### Japan Low Carbon Society Scenarios toward 2050

Study environmental options toward low carbon society in Japan

**Techno-Socio Innovation Study**
- Green buildings
- Self-sustained city
- Decentralized services
- Energy saving
- Tech. innovation
- EE improvement
- New structure change
- New energy
- Life-style change

**Urban structure**

**IT-society**

**Transportation system**

**Reduction Target study**

**GHG reduction target** (eg. 60-80% reduction by 1990 level)

**Intervention scenario**

**Valid**

**Effective**

**Equity**

**Propose the direction of long-term global warming policy**

[60 Researchers]

2010/01/22 Joint TERI-ETSAP Workshop@New Dheli, India
**Low-Carbon Scenarios for Asian cities**

1. Depicting narrative scenarios for LCS
2. Quantifying future LCS visions
3. Developing robust roadmaps by backcasting

**Policy Packages for Asia LCS**

- Sustainable development through LCS
- Future trends on socio-economic conditions, energy, resources, regional diversity, culture, lifestyle, etc.
- Institutional design for international cooperation, regional regime, etc.
- Low Carbon Society
  - Low Carbon City with LC transport system
  - Grand design for future transport system

**Low Carbon Asia Research Project (S-6)** funded by MOEJ

http://2050.nies.go.jp/LCS/
Steps towards Japan LCS Scenarios

- **Step 1**: Depicting socio-economic visions in 2050
- **Step 2**: Estimating energy service demands
- **Step 3**: Exploring innovations for energy demands and energy supplies
- **Step 4**: Quantifying energy demand and supply to estimate CO$_2$ emissions

**Outcome 1)** Feasibility study for 70% CO$_2$ emission reduction by 2050 below 1990 level

- **Step 5**: Investigating “When and Which options and How much” of each option should be introduced in order to achieve the goal.

**Outcome 2)** Roadmap and Dozen Actions toward LCS

Two different but likely future societies

<table>
<thead>
<tr>
<th>Vision A</th>
<th>Vision B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vivid, Technology-driven</td>
<td>Slow, Natural-oriented</td>
</tr>
<tr>
<td>Urban/Personal</td>
<td>Decentralized/Community</td>
</tr>
<tr>
<td>Technology breakthrough</td>
<td>Self-sufficient</td>
</tr>
<tr>
<td>Centralized production</td>
<td>Produce locally, consume locally</td>
</tr>
<tr>
<td>/recycle</td>
<td></td>
</tr>
<tr>
<td>Comfortable and Convenient</td>
<td>Social and Cultural Values</td>
</tr>
<tr>
<td>2%/yr GDP per capita growth</td>
<td>1%/yr GDP per capita growth</td>
</tr>
</tbody>
</table>

Joint TERI-ETSAP Workshop@New Delhi, India
Current status of our study

- We have shown feasibilities of Low-carbonization in Japan by 2050.
  - Some journal articles and reports have been published.
  - Our outcomes (probably) affects national policy/strategy about climate change (esp. CO2 reduction).

Next question: “How to reach the future?”
How to make a roadmap to the LCS?:

- We already have several roadmaps by experts. But...

- These roadmaps (usually) focuses one technology/segment in a society.

- In order to find “comprehensive” roadmaps towards LCS, we need to combine the information appropriately.

Issues to be considered in depicting comprehensive roadmaps

- Each roadmap (explicitly/implicitly) aims to the LCS?

- Combination of roadmaps brings inconsistency in energy balance, economic structure etc?

  Halving energy consumption + Halving energy consumption + Reduction in X Mtoe = Minus energy consumption??

In order to find comprehensive roadmap with keeping consistency in energy balance and/or economic activity, an “AIM/Backcast” model has been developed.
Overview of the AIM/Backcast model

- The model investigates and selects which options (countermeasures and policies) to introduce and when and at what intensity in order to best achieve the future social and economic activities portrayed in the scenarios while satisfying the service demand today and throughout the period up to the target year based on certain criteria.
- The model also presents a Gantt chart with pathways of CO₂ emission, investment.

How to address existing roadmaps in the model?
(1) Decompose to individual technology and/or policy

Ex. A roadmap contains five types of technologies and three policies:
How to address existing roadmaps in the model?

(2) Set relationships/order between components

Ex. A roadmap contains five types of technologies and three policies:

Order has been set in order of time.

How to address existing roadmaps in the model?

(3) Set quantitative data for each technology/policy

Input

- Future target vision
- Social/Economical conditions
- Set of options
- And, each options’
- Sequential order
- Elapsed time
- Kick-off period

Output

- Feasibility of the target
- Roadmaps
- CO₂/Cost trajectories
Application to Japan Low-Carbon Society Study
- How to reach the society with 70% reduction in CO2 emissions in 2050? -

- Future society visions: Scenario A and Scenario B

- Individual roadmaps and technology/policy are set based on “Dozen Actions” which is one of comprehensive and qualitative study about roadmaps towards LCS.

- Criteria : Cost minimization

Results: CO2 pathways towards LCS

- When the CO2 target for 2050 is set 70% lower than the 1990 level, the pathways to reach the target in scenarios A and B are quite similar.

- The optimum course in terms of total cost is to start introducing measures by as early as 2010 and reduce emissions by 17% compared to the 1990 level by 2020 and by 30% by 2030.
Investment pathways for achieving LCS under the total cost minimization

- The investigation has also revealed a key piece of information to be determined for prompt action, namely, the necessary initial investment.
- In both scenarios sharply as a consequence of learning-by-doing effects and reductions in the demand for transportation services due to changes in the structure of cities. By 2020, the costs reach close to zero.
- Meanwhile, however, the additional fixed costs in the residential and commercial sectors stay at around 2 trillion JPY per year until 2030.

Gantt Chart towards LCS (a part)
Viewpoints of future pathways: Four reasons for taking early actions

1. Technologies have learning-by-doing effects: the additional cost of low-carbon technologies will fall as the technologies spread.

2. If actions are delayed, learning-by-doing effects may fail to work sufficiently, resulting in higher total investment requirements to achieve a LCS.

3. No infrastructure can be built immediately; hence it would be difficult to switch suddenly to a LCS in the years just before 2050.

4. Future technological development has several uncertainties. If one of the currently dominant technologies falls behind schedule, it will fail to spread as expected and CO₂ emission targets will not be met. Early actions will open up new opportunities for the spread of alternative actions toward the LCS should a dominant technology fail in some way.

Point 1: Learning-by-doing effects

- In the absence of learning-by-doing effects, the CO₂ reduction pathway will be delayed.
- The introduction of major CO₂ reduction options through the early-stage investment of large sums will not only gradually reduce the cost via learning-by-doing effects but also reduce the total investment required for achieving a LCS.
Point 2: Delays in initiating action will push up costs

- If actions are taken quickly, the total additional investment will be 12.7 trillion JPY in scenario A and 7 trillion JPY in scenario B.
- If action is delayed by 10 years, the total additional fixed costs will increase to 93 trillion JPY in scenario A and 91 trillion JPY in scenario B. The fuel cost savings, meanwhile, will come to only 54 trillion JPY in both scenarios, as these options will spread late. Thus, the resultant additional investment from 2010 to 2050 will be 39 trillion and 37 trillion JPY in scenarios A and B, respectively.

Point 3: It takes time to construct infrastructure

- Infrastructure (city infrastructure, transportation systems, energy infrastructure, buildings, etc.) generally has a long service life and cannot easily be modified once constructed.
- The infrastructure built today is likely to be in use in 2050. Thus, the framework of a LCS is already being established.

<table>
<thead>
<tr>
<th>Sector/Asset</th>
<th>Average service life (Yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>51</td>
</tr>
<tr>
<td>Harbor</td>
<td>49</td>
</tr>
<tr>
<td>Airport</td>
<td>16</td>
</tr>
<tr>
<td>Former Japan National Railways</td>
<td>22</td>
</tr>
<tr>
<td>Japan Railway Construction Public Corporation, etc</td>
<td>26</td>
</tr>
<tr>
<td>Subways, etc</td>
<td>34</td>
</tr>
<tr>
<td>Former Nippon Telegraph and Telephone Public Corporation</td>
<td>18</td>
</tr>
<tr>
<td>Sewerage</td>
<td>57</td>
</tr>
<tr>
<td>Waste disposal</td>
<td>40</td>
</tr>
<tr>
<td>Water works</td>
<td>39</td>
</tr>
<tr>
<td>City park</td>
<td>43</td>
</tr>
<tr>
<td>Education (Schools and academic facilities)</td>
<td>39</td>
</tr>
<tr>
<td>Education (social education, physical education and cultural facilities)</td>
<td>41</td>
</tr>
<tr>
<td>Flood control</td>
<td>85</td>
</tr>
<tr>
<td>Forestry conservation</td>
<td>50</td>
</tr>
<tr>
<td>Coastal protection</td>
<td>30</td>
</tr>
<tr>
<td>Agriculture</td>
<td>44</td>
</tr>
<tr>
<td>Forestry</td>
<td>49</td>
</tr>
<tr>
<td>Fishery</td>
<td>50</td>
</tr>
<tr>
<td>Postal service</td>
<td>58</td>
</tr>
<tr>
<td>Natural forest</td>
<td>47</td>
</tr>
<tr>
<td>Water works for industrial use</td>
<td>38</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Delays in infrastructure</th>
<th>Early actions</th>
<th>Start in 2020</th>
<th>Start in 2030</th>
<th>Start in 2040</th>
<th>Start in 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario A (compared to the 1990 level)</td>
<td>85.2(-70%)</td>
<td>86.7(-69.5%)</td>
<td>109.5(-61.4%)</td>
<td>134.6(-52.6%)</td>
<td>161.3(-43.2%)</td>
</tr>
<tr>
<td>Scenario B (compared to the 1990 level)</td>
<td>85.2(-70%)</td>
<td>85.2(-70%)</td>
<td>106.2(-62.6%)</td>
<td>131.7(-53.6%)</td>
<td>158.3(-44.3%)</td>
</tr>
</tbody>
</table>
Point 4: There are uncertainties in technological research, development, and deployment

- Taking action now to achieve a LCS will encourage active technology development, improve efficiency, reduce costs by learning-by-doing effects, spread the portfolio of alternative actions, prepare us for future uncertainties, and thus raise the possibility of achieving a cost-efficient LCS.

Summary

What did we do?
- We draw up future roadmaps for technologies, policies, and optimal investment timing toward the achievement of a low-carbon society in Japan by 2050 using an analytical model based on a backcasting methodology.

What did we find?
- Early actions can lead to pathways for minimizing the costs toward an LCS in Japan. However, to take early actions, large investments will be needed at the initial stages. Because:
  1. Technologies have learning-by-doing effects: the additional cost of reducing CO2 emissions will fall as the technologies spread.
  2. If actions are delayed, learning-by-doing effects may fail to work sufficiently, resulting in higher total investment requirements for achieving a LCS.
  3. No infrastructure can be built immediately; hence it would be difficult to switch suddenly to a LCS in the years just before 2050.
  4. Future technological development has several uncertainties. Early actions will open up new opportunities for the spread of alternative actions toward the LCS should a dominant technology fail in some way.
Further information

- [Report] Japan Scenarios and Actions towards Low-Carbon Societies (LCSs)

ALL INFORMATION CAN BE ACCESSED THROUGH http://2050.nies.go.jp

Thank you for your attention!