Dynamic Transition Analysis with TIMES
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Introduction

Previous work has compared the impact of innovative energy technologies in various world regions using static scenario analyses [1, 2, 4, 5, 7, 8]. We will simulate dynamic transition scenarios [3, 9] aimed at minimizing carbon emissions in Japan by 2050. These scenarios will include realistic constraints regarding technology readiness, and will combine multiple technologies in a single heterogeneous system model.

Methodology

The Integrated MARKAL-EFOM System (TIMES) model generator [6, 10] optimizes energy systems using linear and mixed-linear algorithms. A user-defined objective function (such as minimizing carbon emissions or costs) is solved within user defined constraints such as energy generation demand. Scenario simulation: 2010-2050 iCNER driven.

Objective Function

\[ \text{minimize: } \sum_{g} C_{g} x_{g} \]

subject to:

\[ \sum_{g} x_{g} = d \]

where

\[ C_{g} = \text{carbon emissions from generation component } g \]

\[ x_{g} = \text{deployment of generation component } g \]

\[ d = \text{generation demand} \]

A simple static formulation is straightforward to write, as above. However this formulation is quickly complicated by including dynamic time as well as additional constraints (energy storage, variable demand, CO2 sequestration, efficiency, costs, etc.)

Constrained Optimization Modeling technology deployment transition as a constrained optimization problem will drive insights.

The key objective function is minimization of carbon emissions in 2050 and a key constraint will be that deployed generation capacity must meet energy demand. This can naively be written:

Take Aways

- Dynamic simulation of Japan’s energy system transitions in the TIMES model generator will help develop near-term decarbonization strategies.
- Policymakers will benefit from identification of high impact technologies, and creation of R&D investment and infrastructure development timelines.
- Simulations will quantify system sensitivity to technology readiness.
- Dynamic analysis will identify potential transition bottlenecks.

Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb. 2018</td>
<td>Data collection: Japan’s current grid.</td>
</tr>
<tr>
<td>Aug. 2018</td>
<td>Data collection: iCNER storage technology.</td>
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</tbody>
</table>

2019 • Sensitivity analysis: Vary key parameters.

References


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