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Multi-Regional Enduse model in Japan

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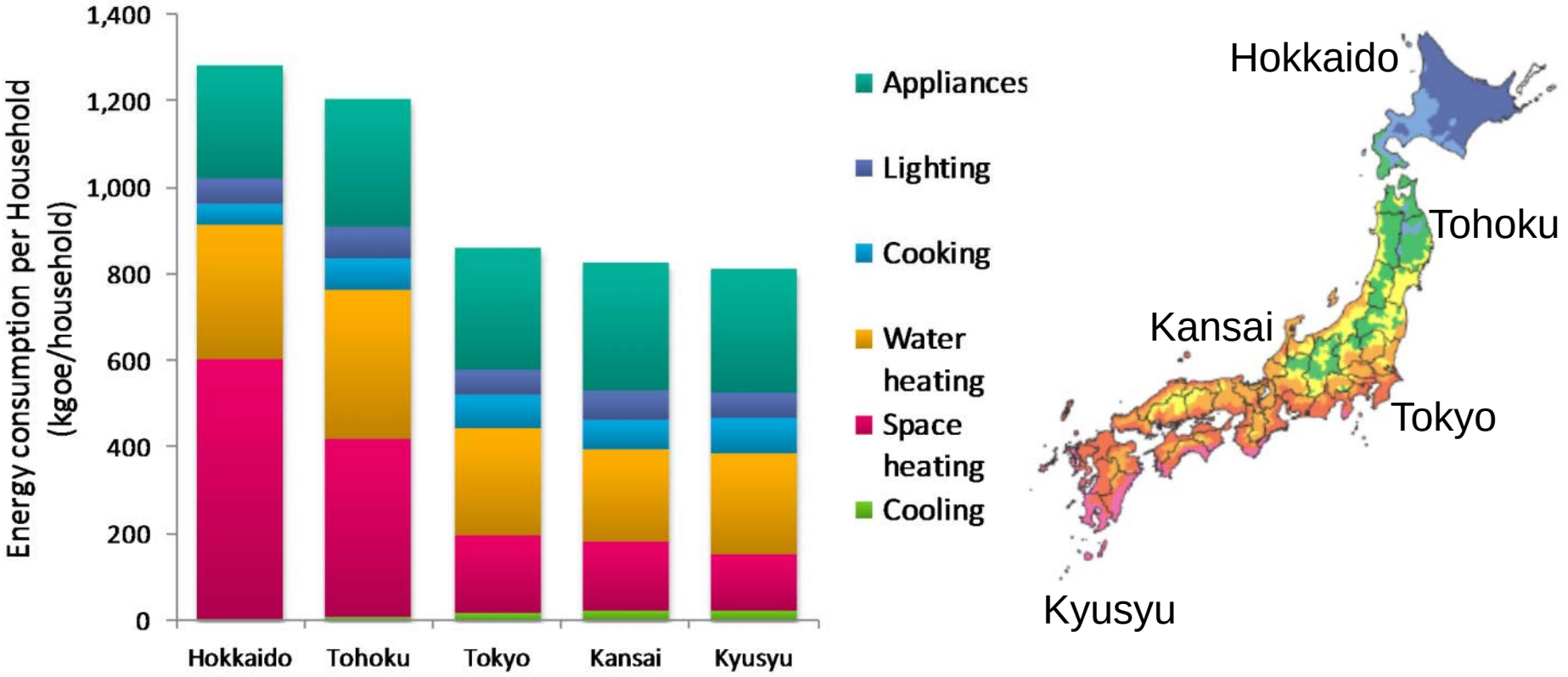
Why is the Multi-regional model required ?

- Climate condition, renewable energy potential, electricity grid condition and other factors are different among regions in Japan, and they affect energy consumption strongly.
- Similar studies have already done, however they were often based on few data.
- New statistics are published in recent years, especially in residential, commercial and power sector.
- This study is intended to revise the model data based on new statistics, and modify the model.

Regional climate condition in Japan

- Energy demand varies according to regional climate condition greatly.

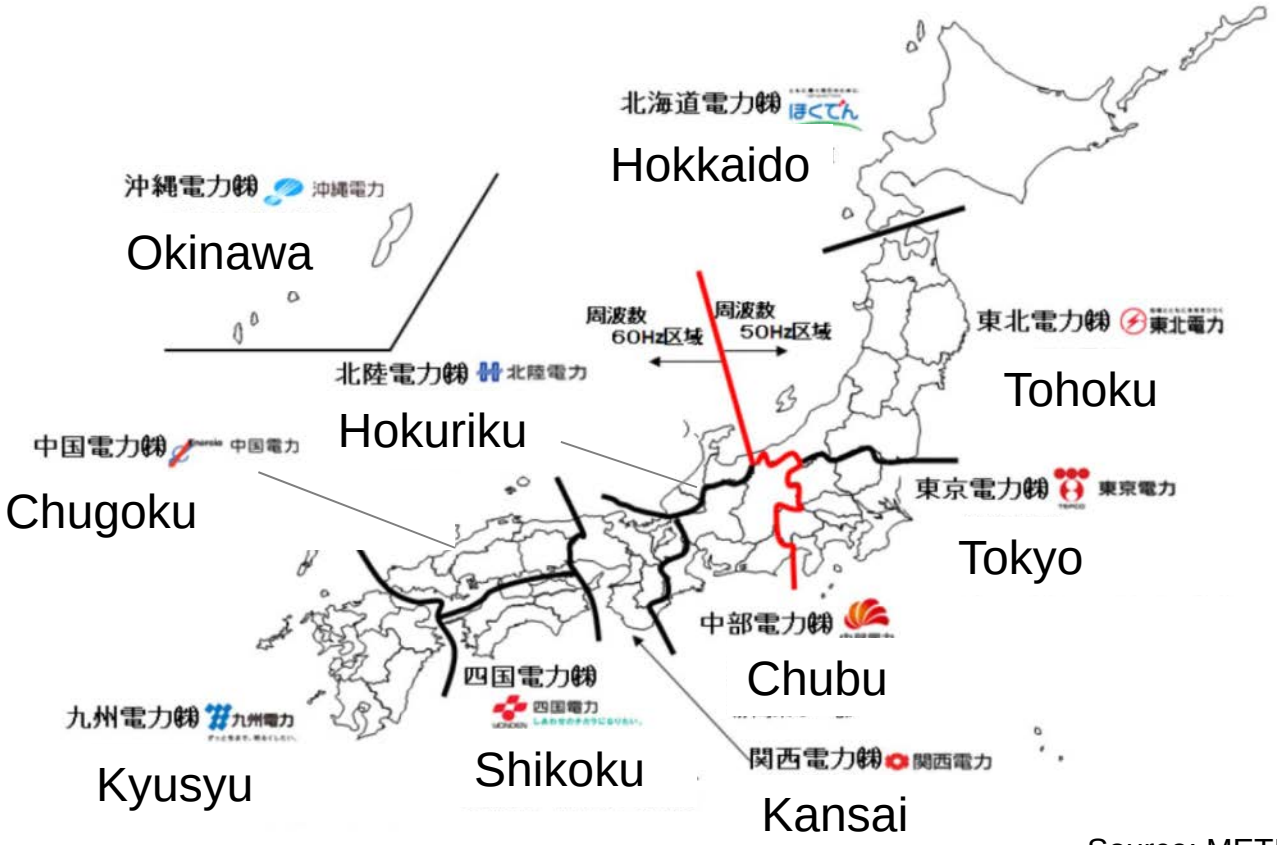
<Household energy consumption (2009)>



Source: Agency for Natural Resources and Energy

Electricity grid in Japan

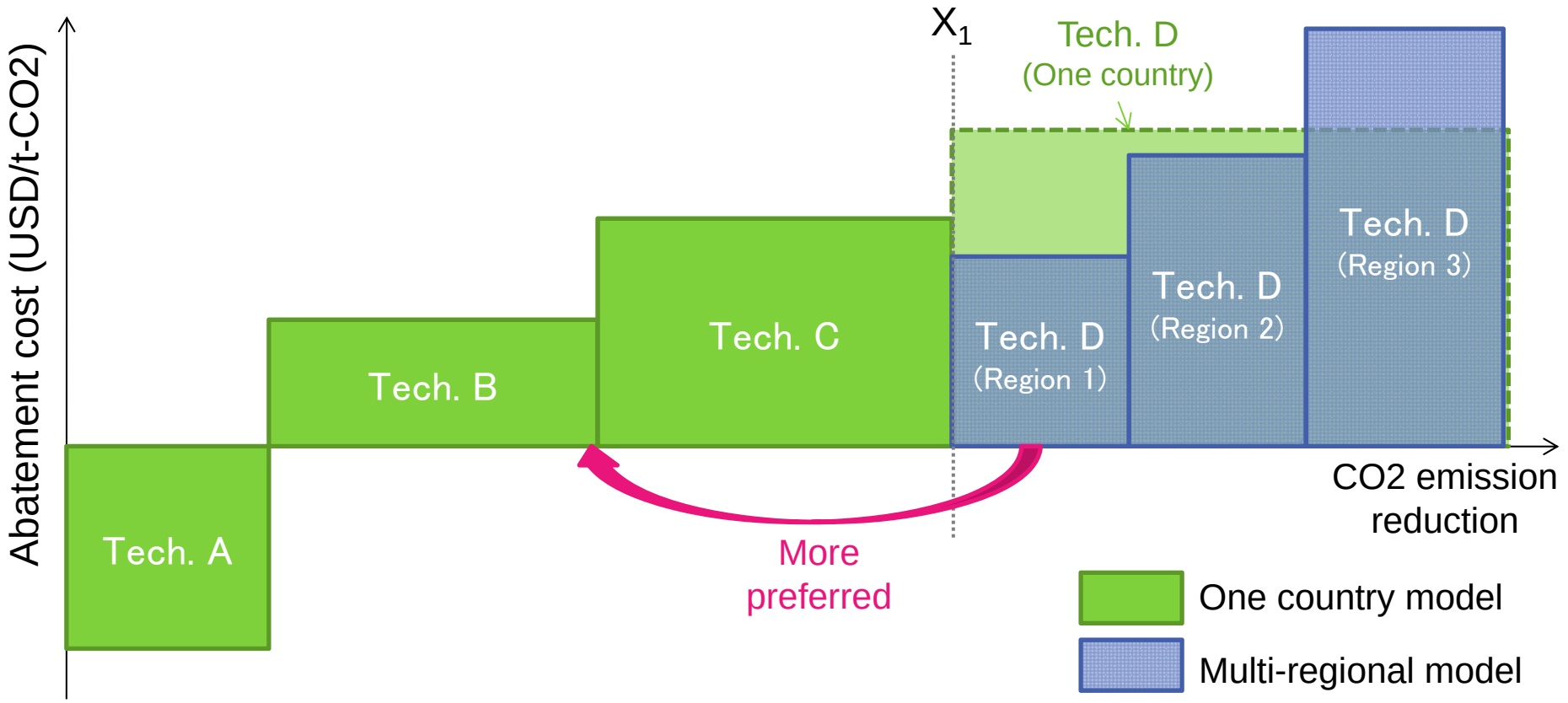
- Separated into 10 areas by 10 major utility companies and electricity interchange capacity is limited very little.
- Multi-regional model is required to analyze supply-demand balance in detail.



Source: METI

Technology preference in Multi-regional model

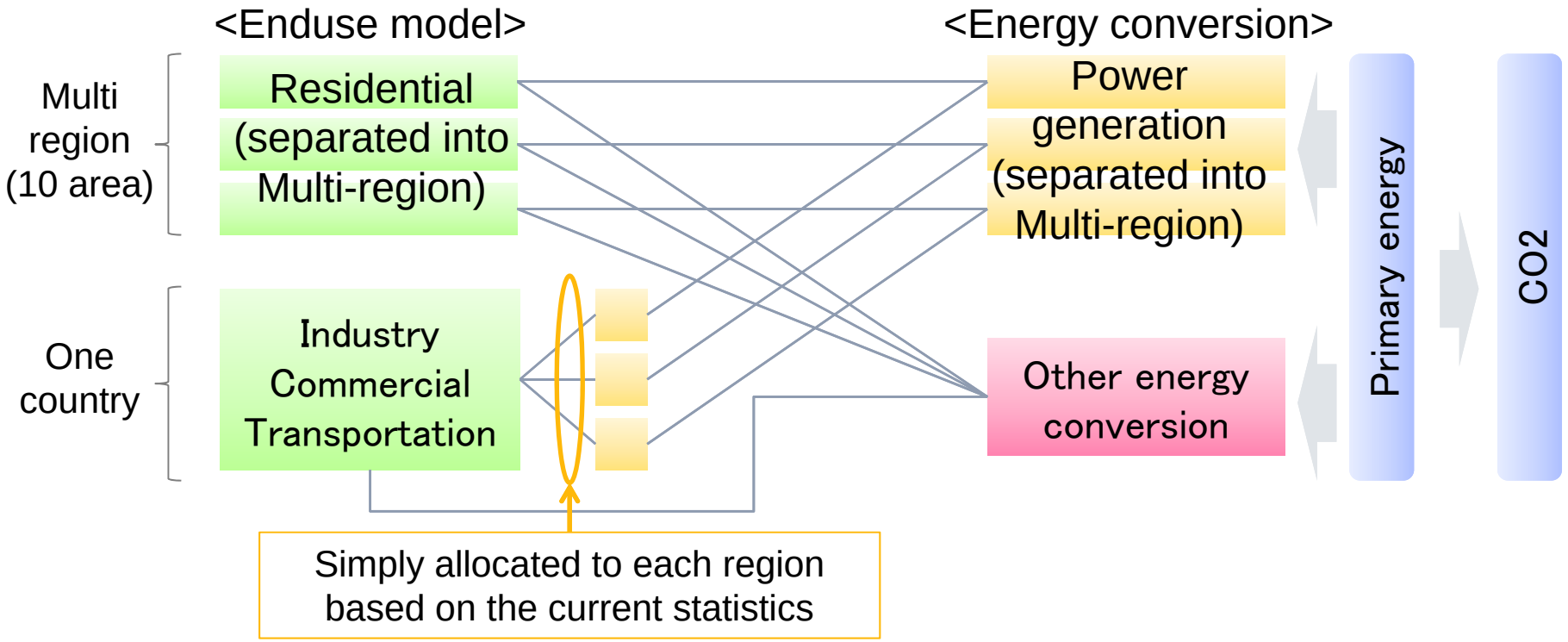
- Technology D is not recruited by one-country model (green) under carbon constraint of X_1.
- By multi-regional model, technology D is more preferred than C in region 1.



Framework of the model (Tentative)

- Residential and power generation:
  - ➢ Divided into 10 regions consistent with electricity grid areas.
- Industry, commercial, transportation and other energy conversion:
  - ➢ Not yet divided, still one-country model.
- Other sectors (non-energy, etc.) are not yet included.

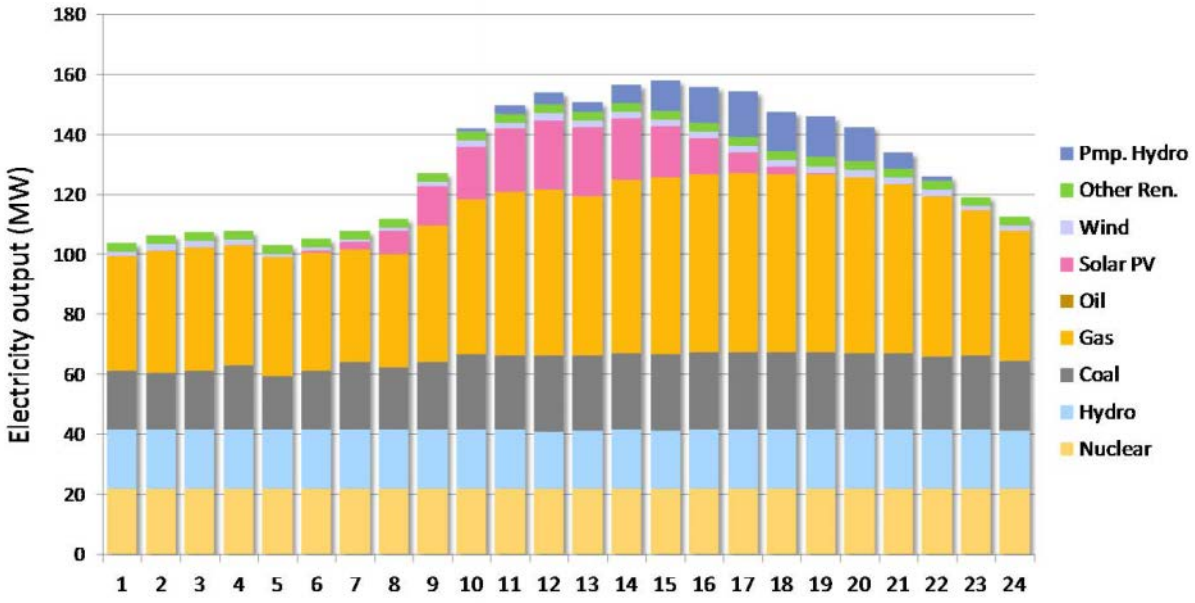
<Image of model structure>



Power generation module

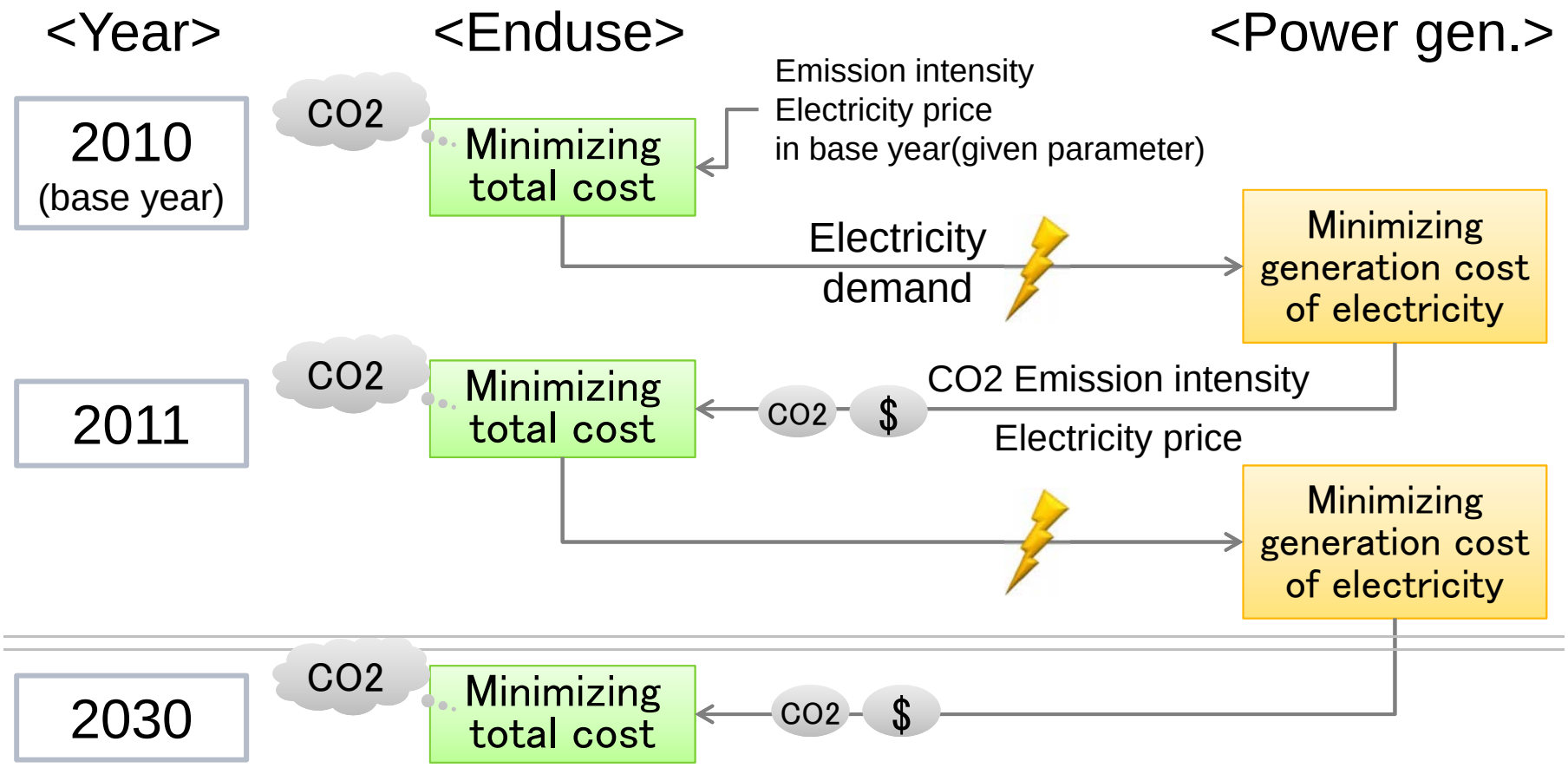
- Divided into 10 areas.
- Time resolution:
  - 3 seasons (summer, winter, intermediate)
  - 5 weekdays and 2 holidays in a week
  - 24 hours in a day
- Electricity demand curve is based on current status
  - Shape is assumed to be constant into the future, but height of curve is determined by yearly total electricity demand.

<Example of model output (Weekday of summer, 2020)>



Relation between Enduse and Power generation

- The models are separated at present.
- Parameters such as electricity demand, emission intensity and electricity consumer price, are shared between them as follows.



Technology

- Following technologies have regional own parameter
  - Residential insulation:
    Efficiency differs by climate condition.
  - Residential heat pump:
    Efficiency is lower in cold climate region.
  - Renewable energy:
    Availability differs by regions.

- CCS is not yet included.

Key assumptions

- Exogenous parameter
  - Renewable energy supply: complied with national policy (higher case)
  - Nuclear power plant operation: operating no more than 40 years.
  - Fuel cost
  - Activity level and service demand

- Carbon price variation
  1. Baseline case: no price
  2. 100USD case: 1000USD/t-CO2

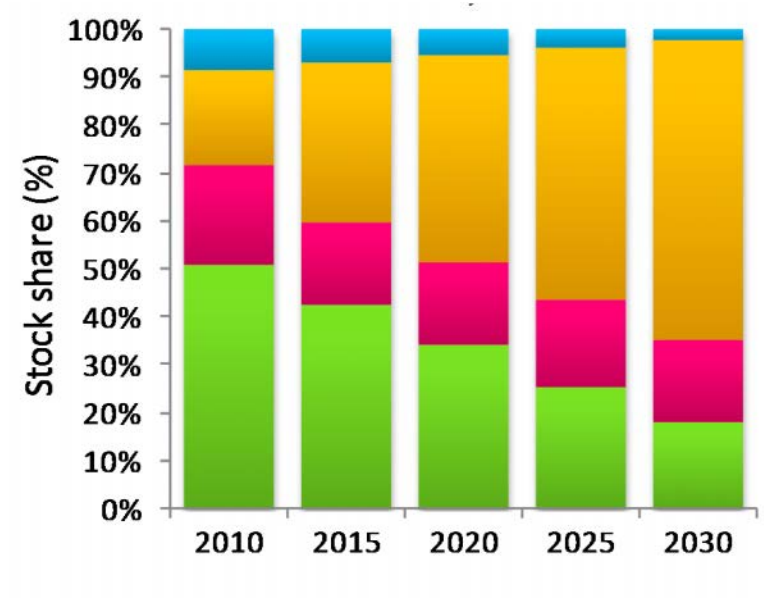
- Time horizon: 2010-2030

- Model modification and data collection is ongoing.
  - The models and these results are tentative, so some unreasonable result will be modified in the near future.

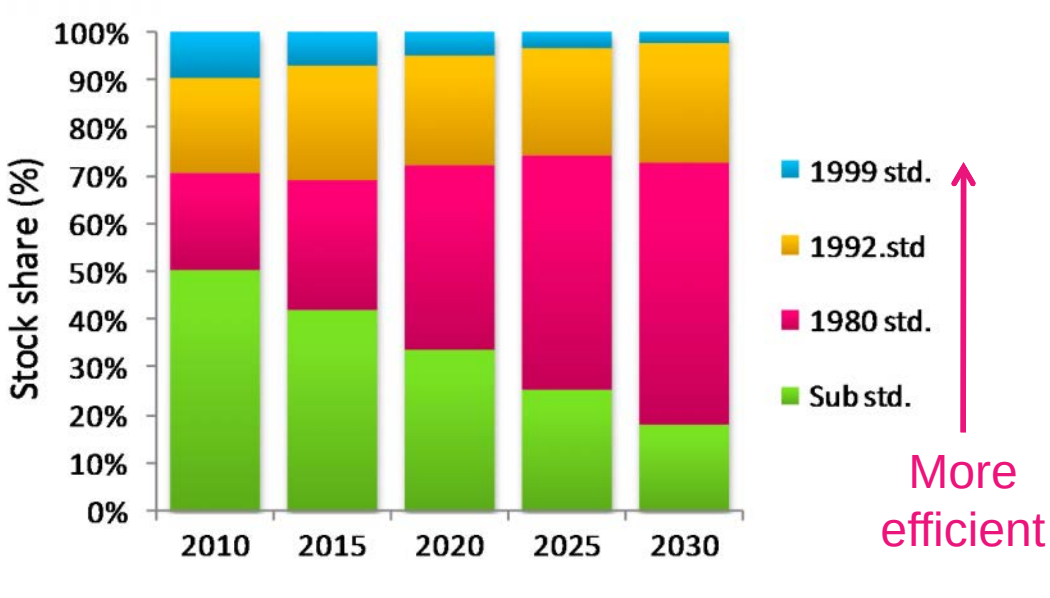
Results: Preferred technology difference by regions

- Residential insulation technology is preferred more in Hokkaido region.

<Hokkaido (cold climate)>



<Okinawa (hot climate)>

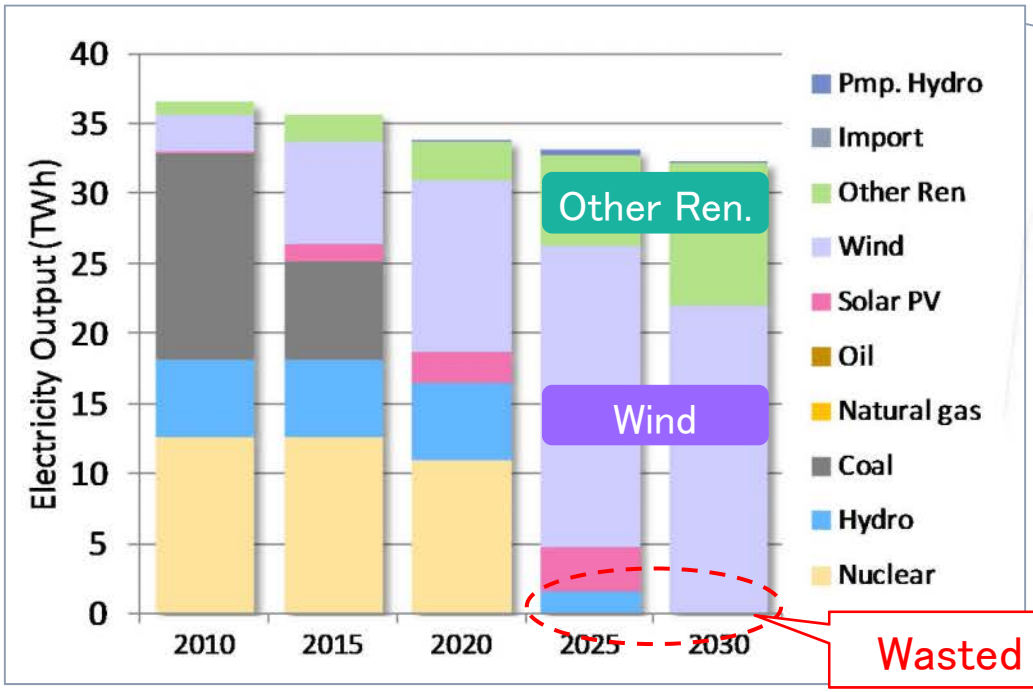


*Baseline case

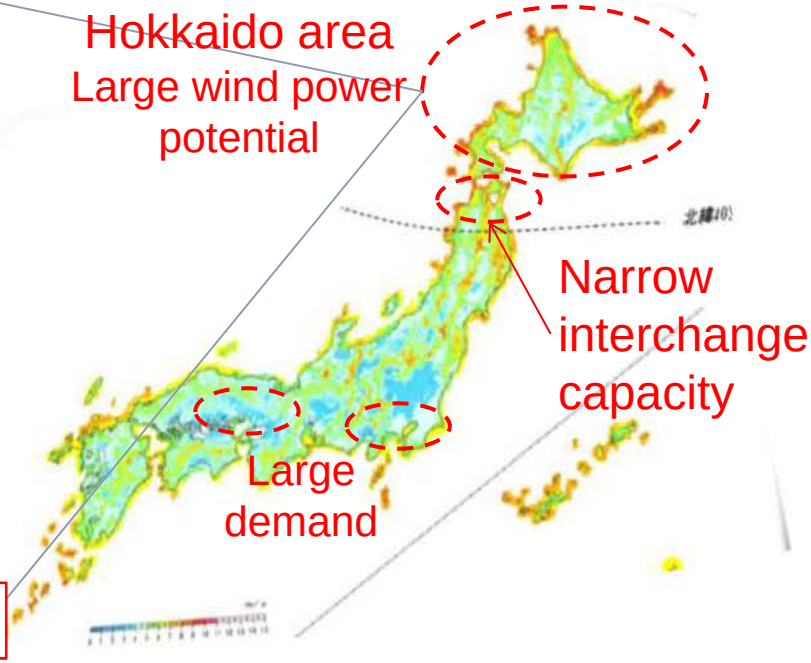
Results: Constraint of renewable energy availability

- Renewable electricity is not fully used in Hokkaido area.
- Reinforcing interchange capacity and storage system would be effective.

<Electricity output in Hokkaido area>
(100USD case)



<Wind power potential in Japan>



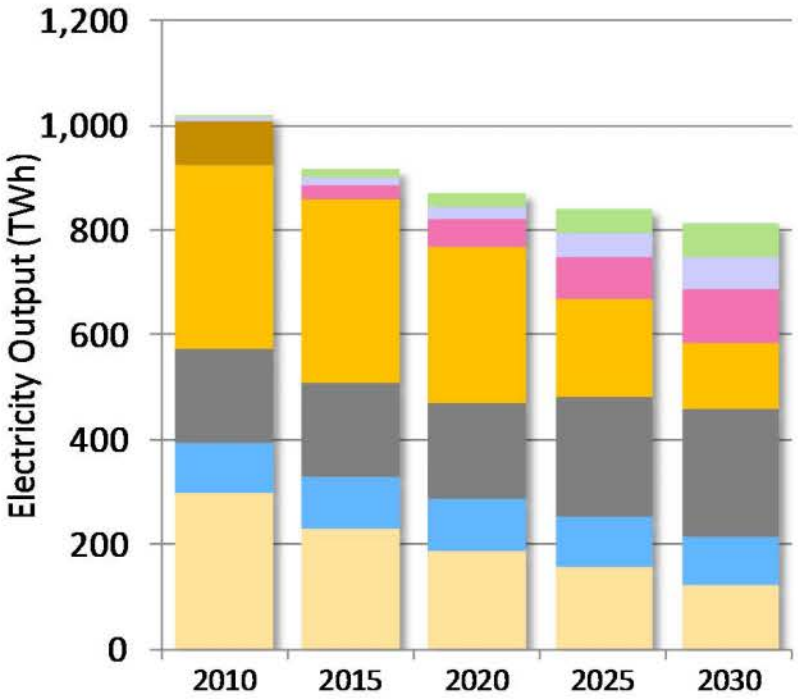
*The power generation module cannot analyze high frequency control at present.

Source: METI

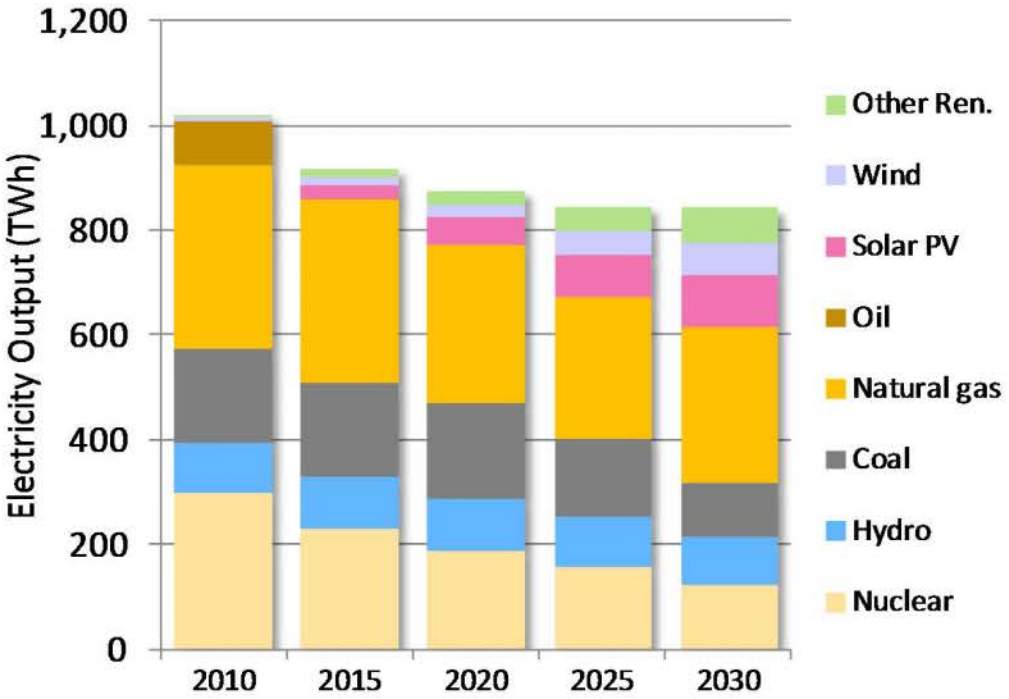
Results: Power generation

- In baseline case, share of coal increases in place of nuclear power phase out.
- In 100USD case, share of gas increases and electricity demand also slightly increases in 2030.

<Baseline>



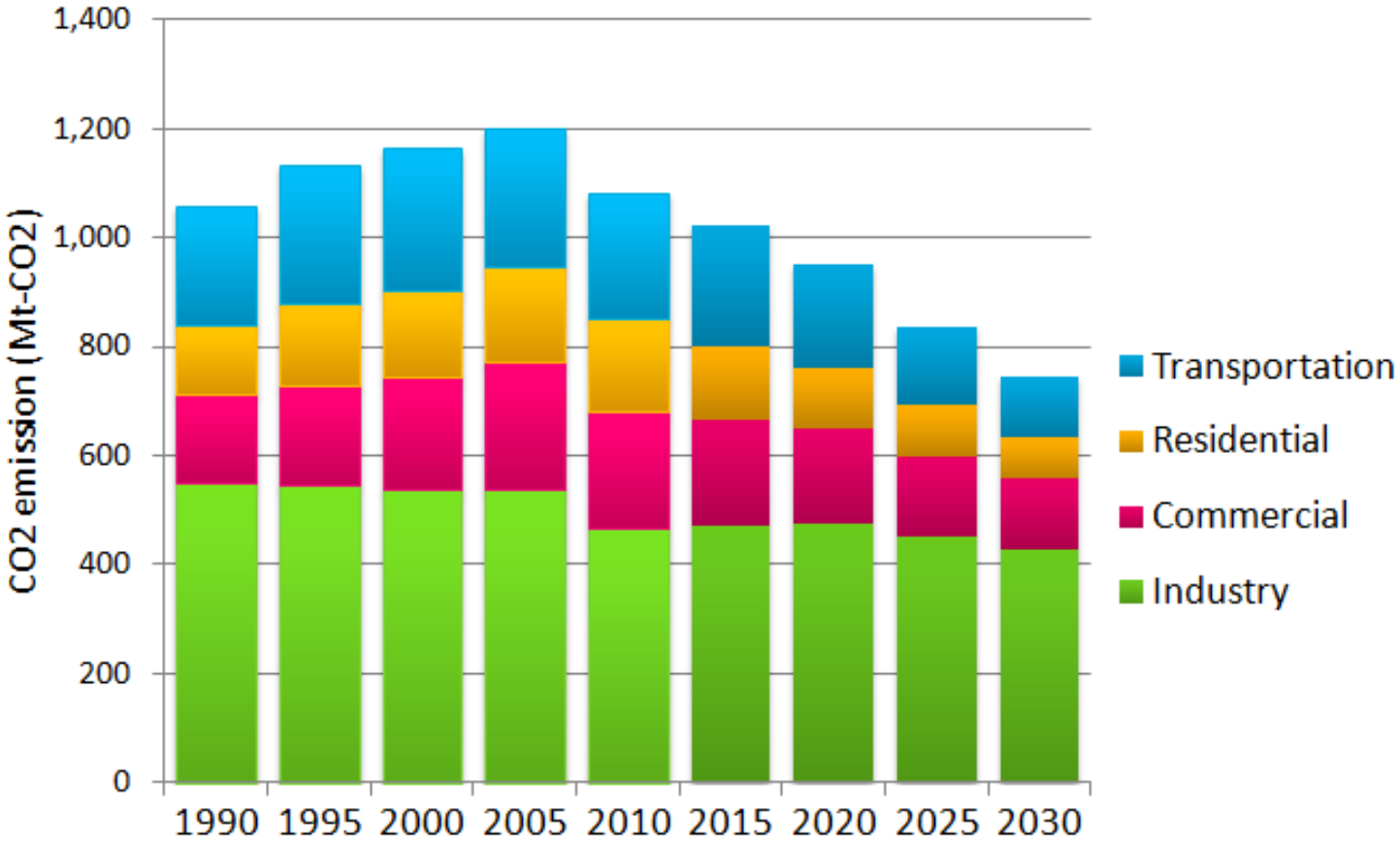
<100USD>



Results: CO2 emission

- About 30% reduction in 2030 compared to 1990.

<CO2 emission (100 USD case)>



*Energy related CO2 only.

Summary

- Findings from tentative analysis
  - Preferred technology is different by regional condition in residential sector, such as insulation.

- The future work planning
  - Modifying the models and collecting data in all sectors, as well as residential and power sector.
  - Combining Enduse model and power generation module.

Thank you for your attention