19th AIM International Workshop
(December 14, 2012)

Regional Model

Feasibility of 80% reduction in Japan

Ken Oshiro — Mizuho Information & Research Institute Inc. and Tokyo Institute of Technology

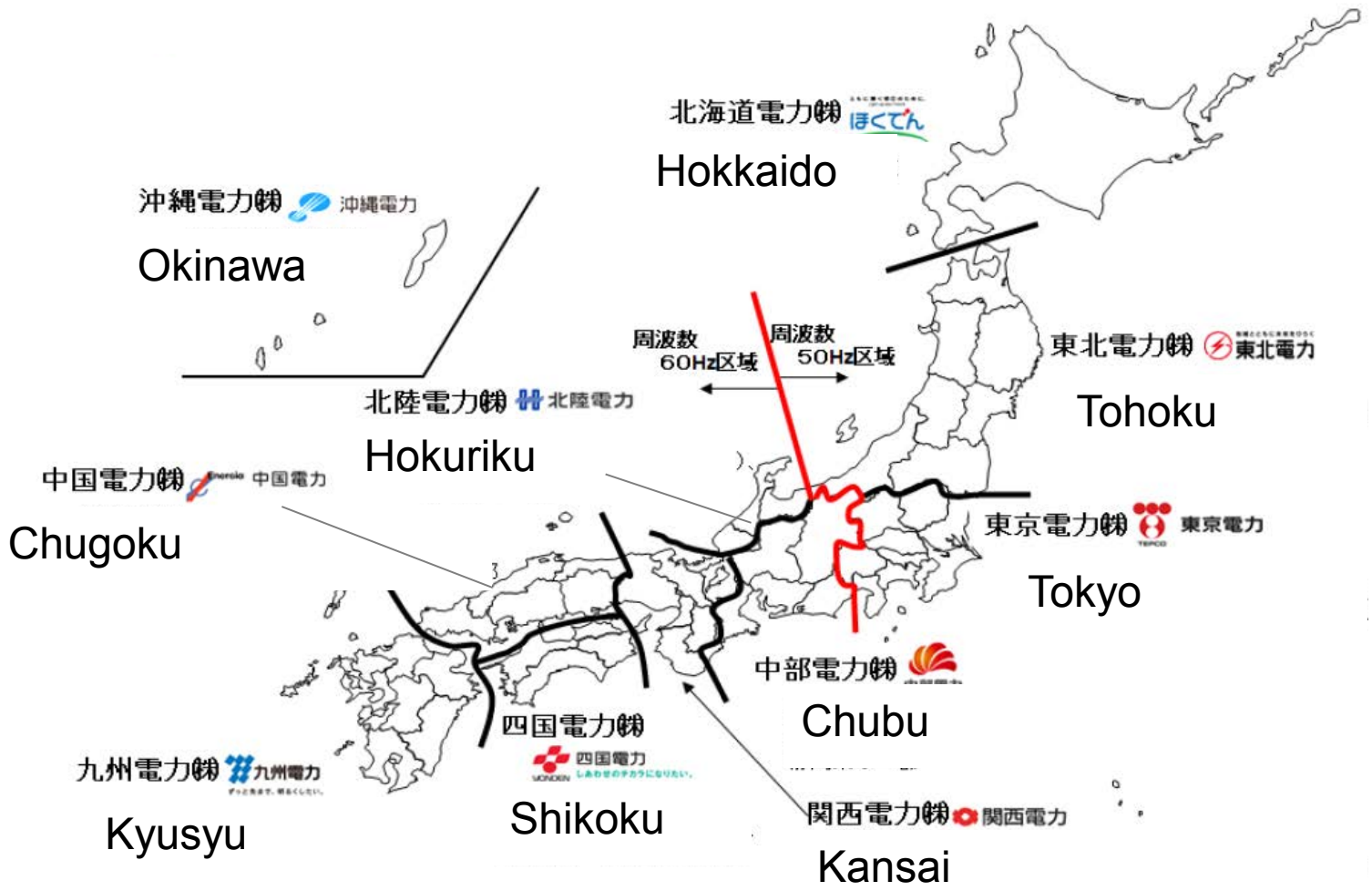
Go Hibino — Mizuho Information & Research Institute Inc.

Background

- Japan's long-term target is reducing GHG emission by 80%.
- Now no nuclear power plant is operating, and availability of nuclear power in 2050 is uncertain.
- This study estimates a possibility to achieve 80% reduction target without nuclear power, by using regional model in Japan.

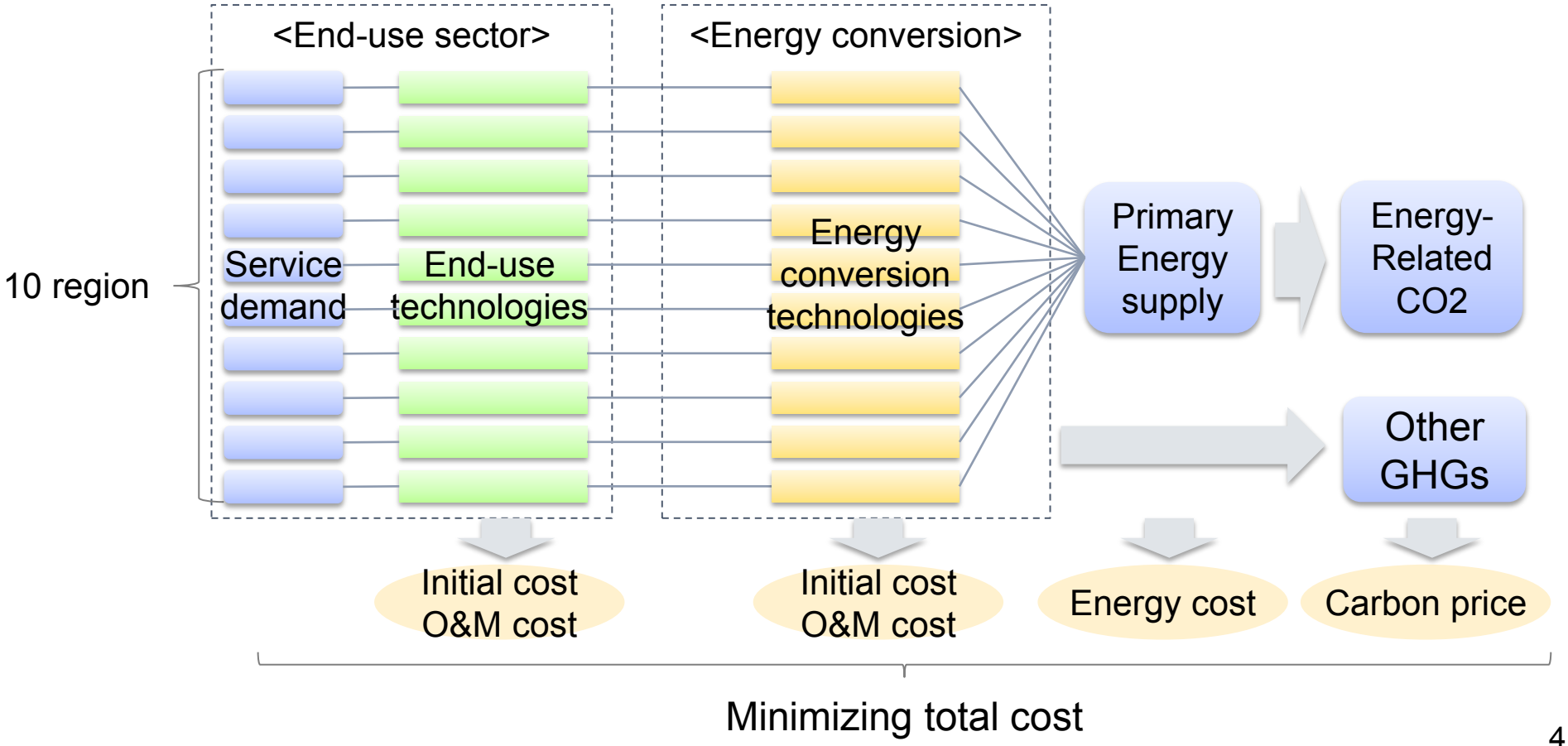
Region classification

- 10 regions: 10 electricity power company's distribution areas



Framework of the model

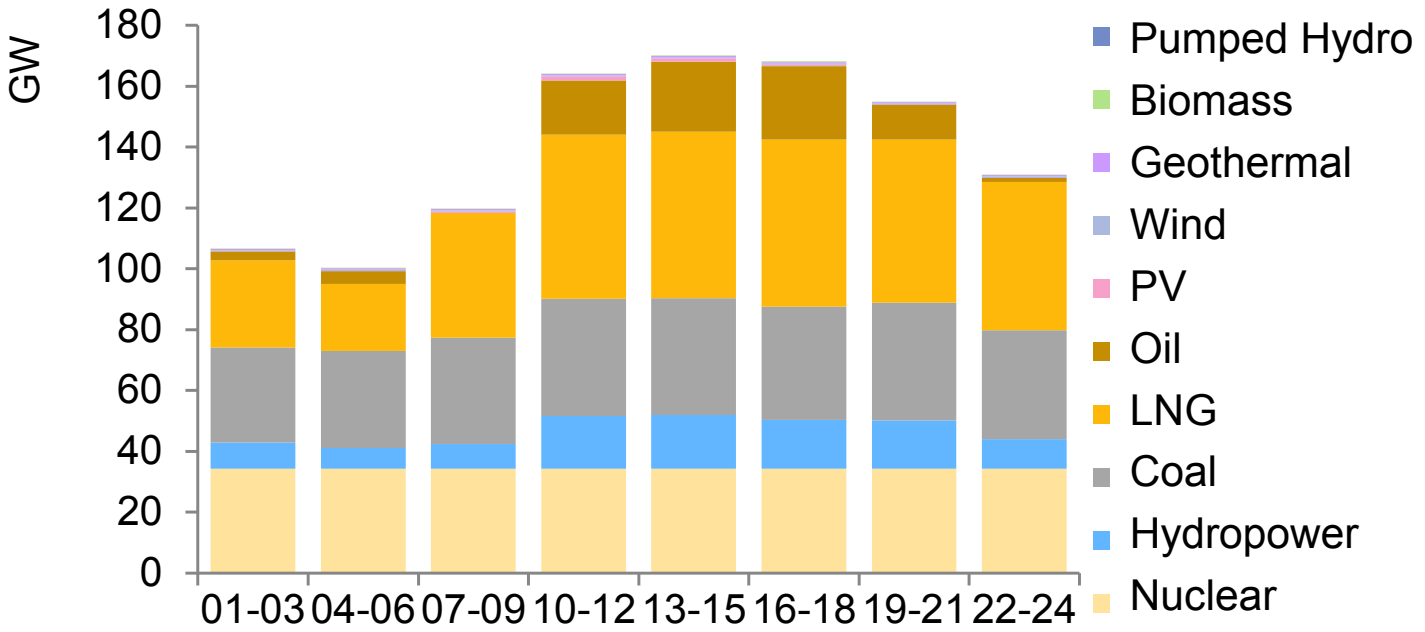
- The model structure is based on AIM/Enduse [Japan]
- Greenhouse gases
  - energy-related CO2, non-energy-related CO2, CH4, N2O, HFCs, PFCs, SF6
- Time horizon: 2010-2050



Power generation

- Region classification :10 regions
- Period of time:
  - 3 seasons (summer, winter, intermediate)
  - weekdays and holidays
  - Electricity supply must meet demand every 3 hours

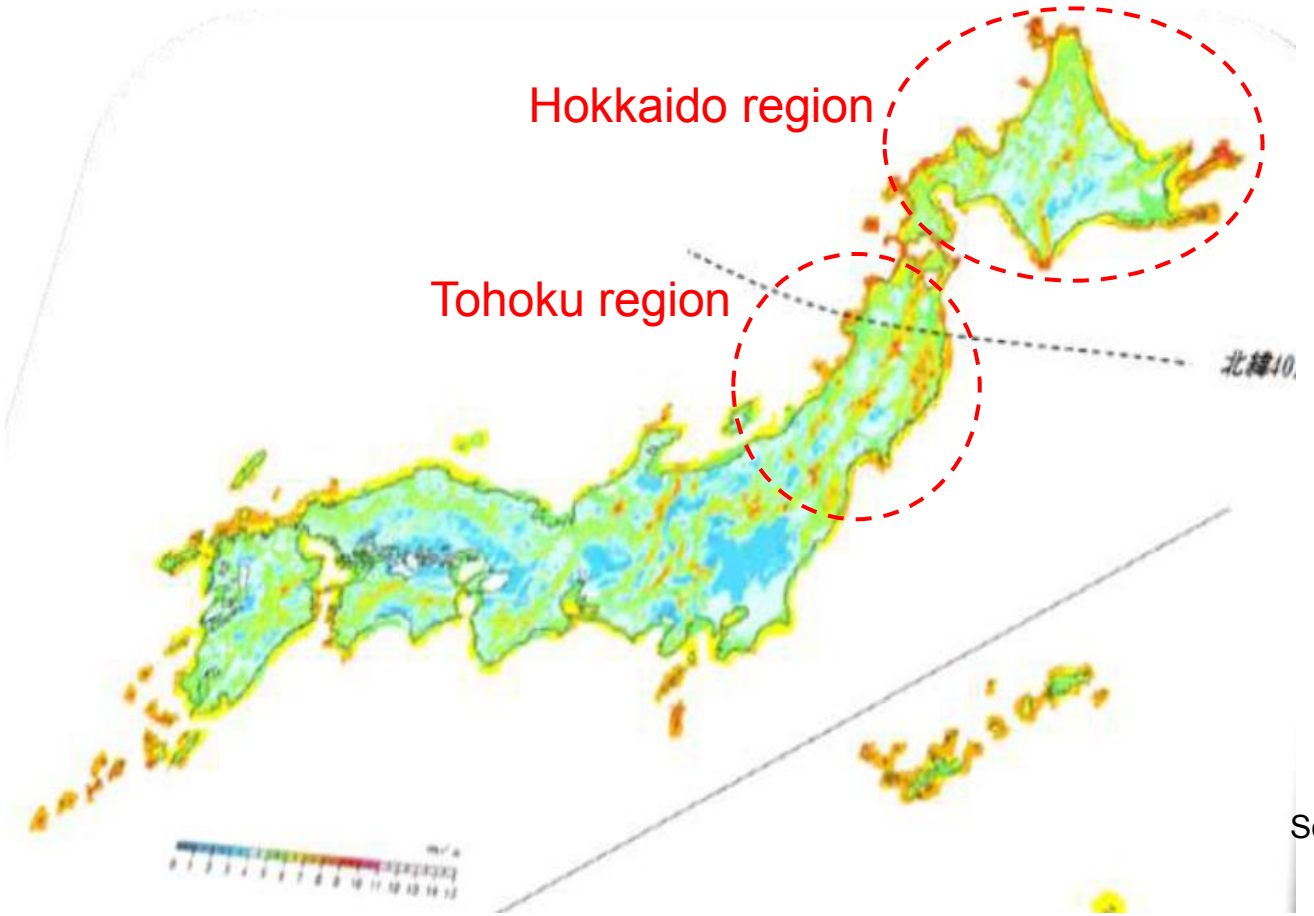
<Example of model output>



Renewable energy potential by region

- Hokkaido and Tohoku region have large potential
- Upper limit of potential by region is reflected in the model

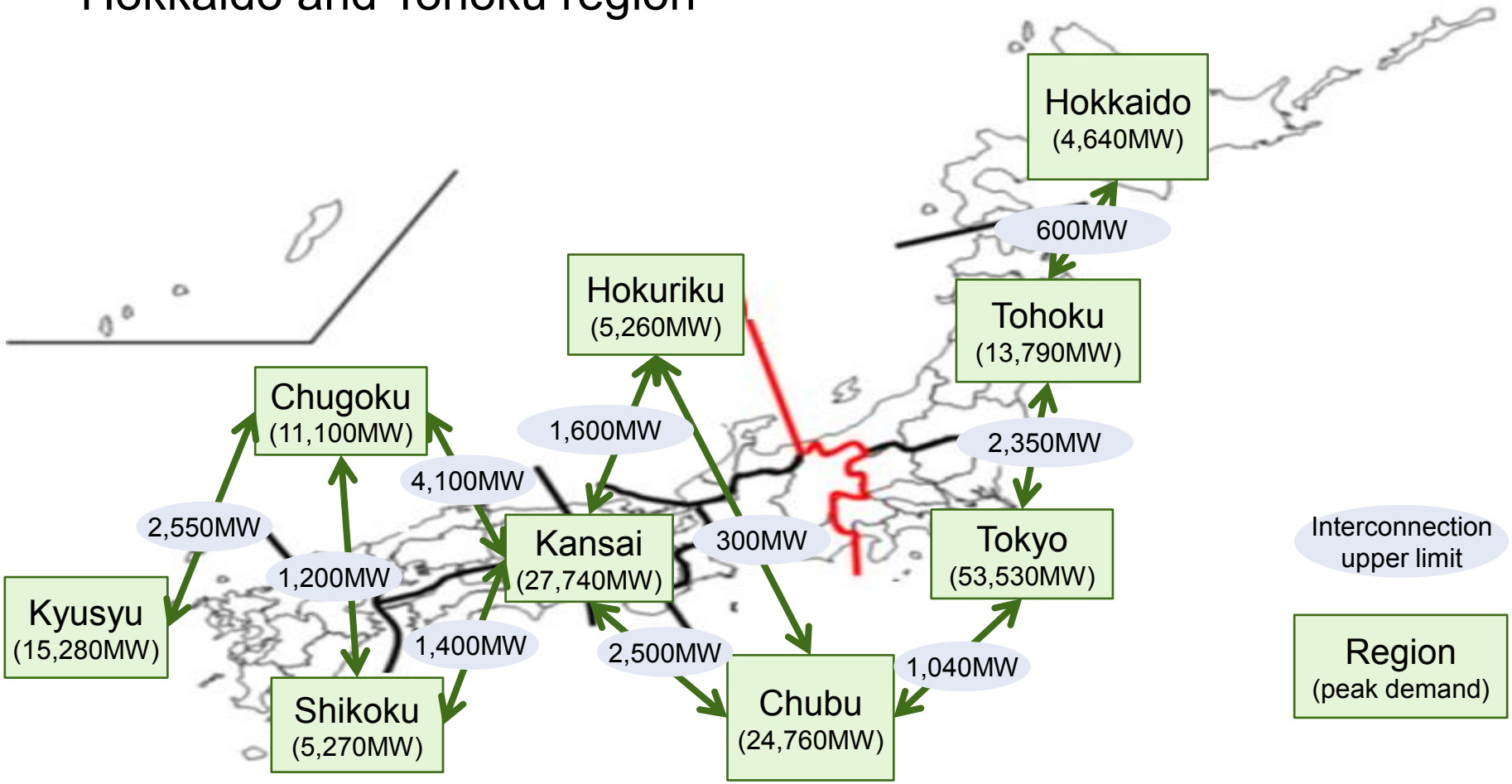
<Wind power potential in Japan>



Source: METI, Japan

Electricity interconnection between regions

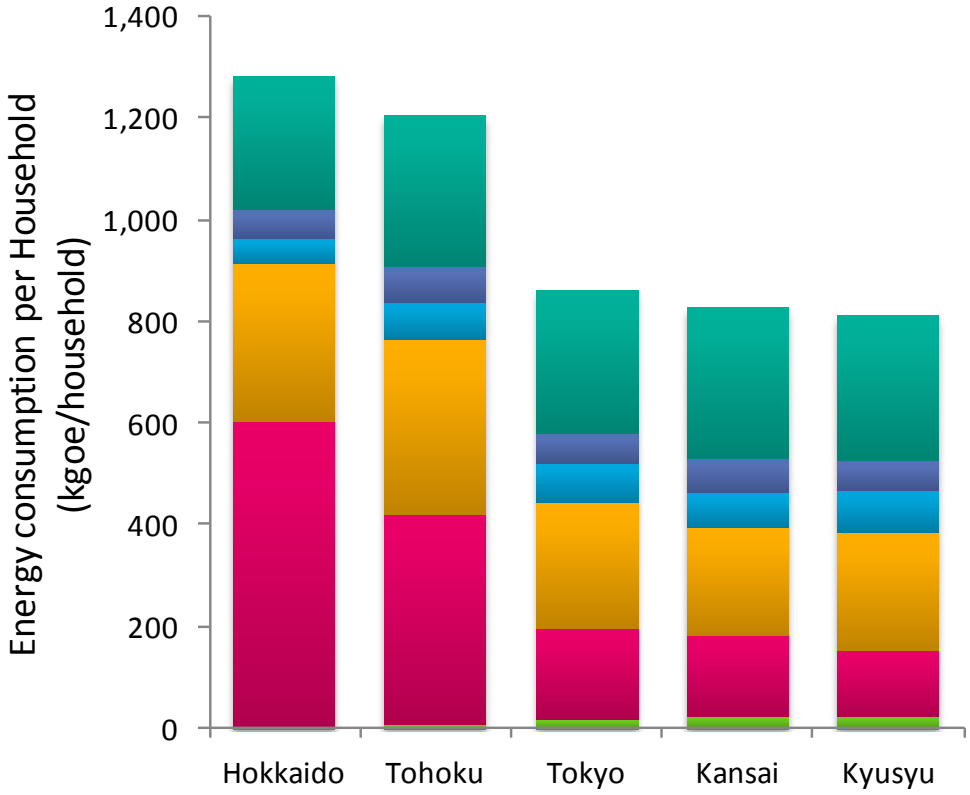
- Interconnection capacity is much lower compared to electricity demand
- It is one of the major barrier of renewable energy generation in Hokkaido and Tohoku region



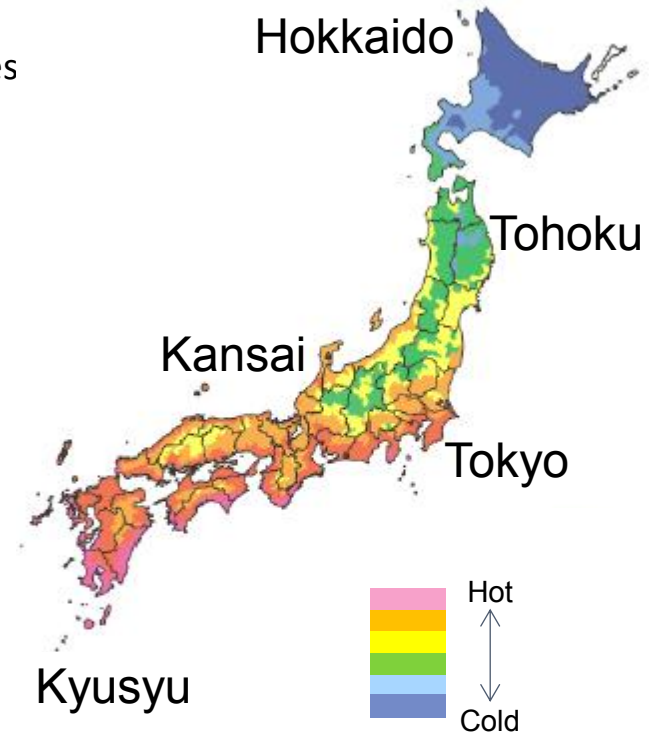
Energy demand by region

- Energy demand varies greatly according to regional climate condition
- It is also reflected in the model

<Household energy consumption (2009)>



Source: Agency for Natural Resources and Energy, Japan



Technology

- Following technologies have regional own parameter
  - Energy efficiency of residential / commercial insulation
  - COP of heat pump technology

- CCS
  - Power sector, iron and steel and cement process (Biomass energy CCS is not included)
  - Storage volume is limited to 200 Mt-CO2/year

- Reinforcement of electricity interconnection capacity
  - Initial cost: 4,000 USD/kW

Scenarios

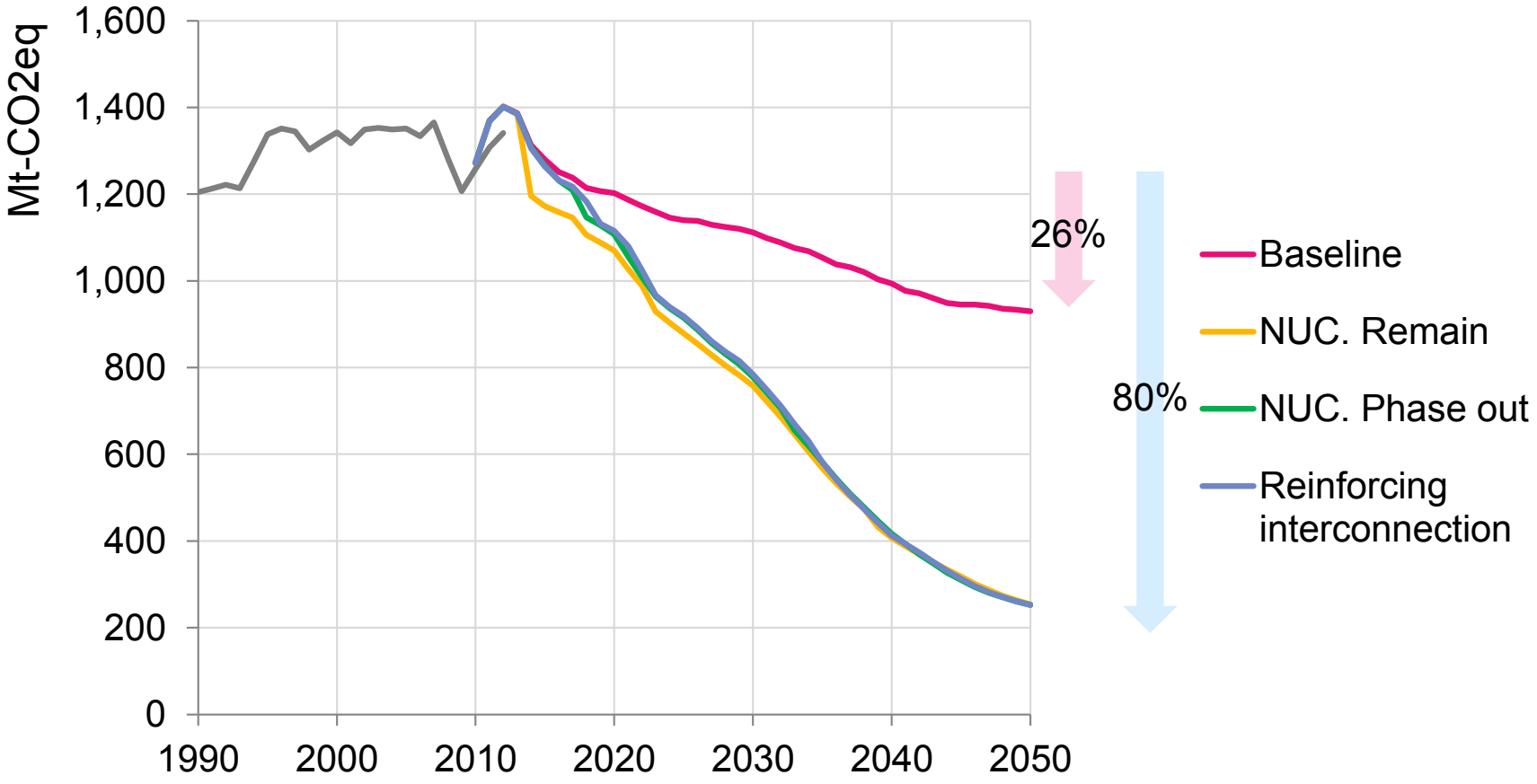
Scenario		Carbon constraint	Nuclear scenario	Reinforcing electricity interconnection
Baseline		0 USD/t-CO2	Operate no more than 40 years*1	Not allowed
80% reduction scenario	Nuclear remain	80% reduction by 2050	Current capacity*2 remain by 2050	Not allowed
	Nuclear phase out	80% reduction by 2050	Operate no more than 40 years	Not allowed
	Reinforcing interconnection	80% reduction by 2050	Operate no more than 40 years	Allowed

*1 Complying with the plan of the former political administration. It means all nuclear power phase out by 2050.
*2 Except Fukushima nuclear power plant.
*3 In 80% reduction scenario, carbon price is increasing linearly from 2010 to 2050

Result: GHG emission by scenario

- Baseline scenario: 26% reduction compared to 1990
- Other scenarios: 80% reduction

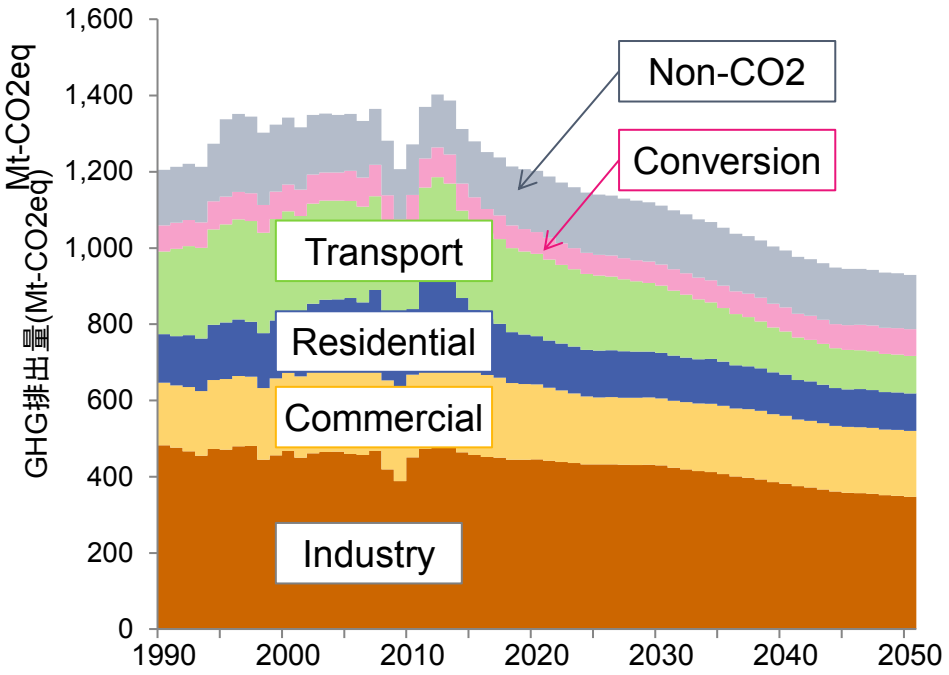
<GHG emission>



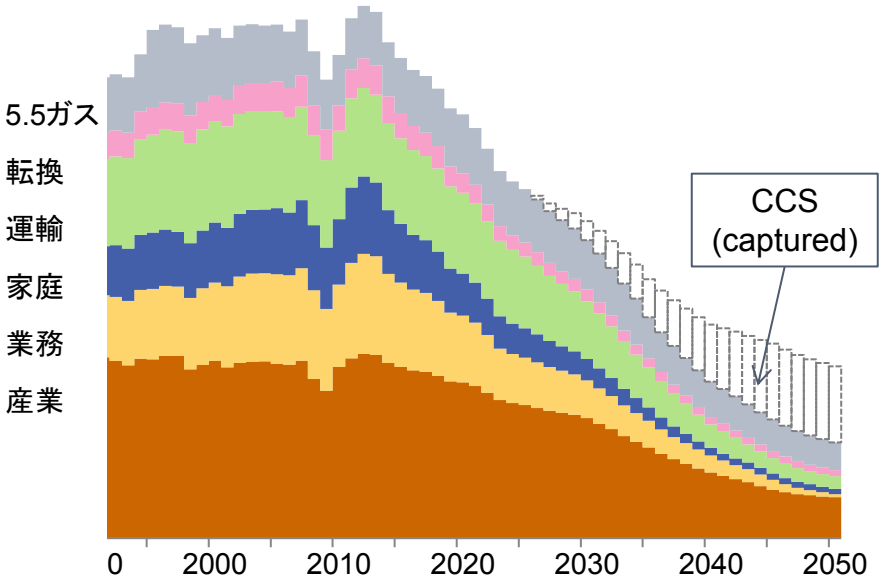
GHG emission by sector

- About a half of GHG emission in 2050 is emitted from industry sector
- Residential and commercial sector achieve nearly zero emission in 2050

<Baseline scenario>



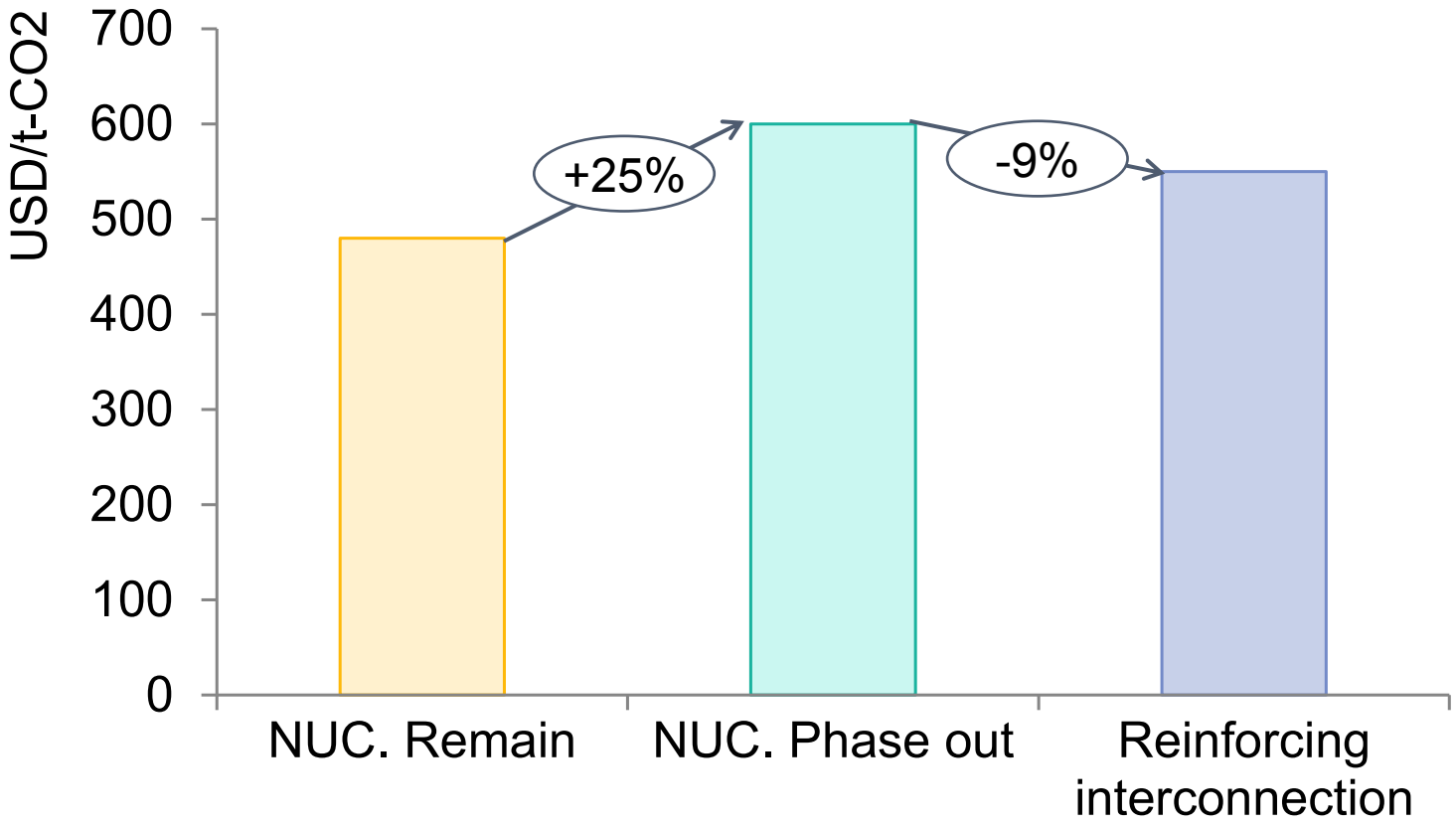
<80% reduction scenario>
(Reinforcing interconnection scenario)



Carbon price

- Without nuclear power, carbon price to reduce GHG by 80% is about 600 USD/t-CO2 (increasing 25% from Nuclear remain scenario)
- In Reinforcing interconnection scenario, carbon price is reduced by 9%

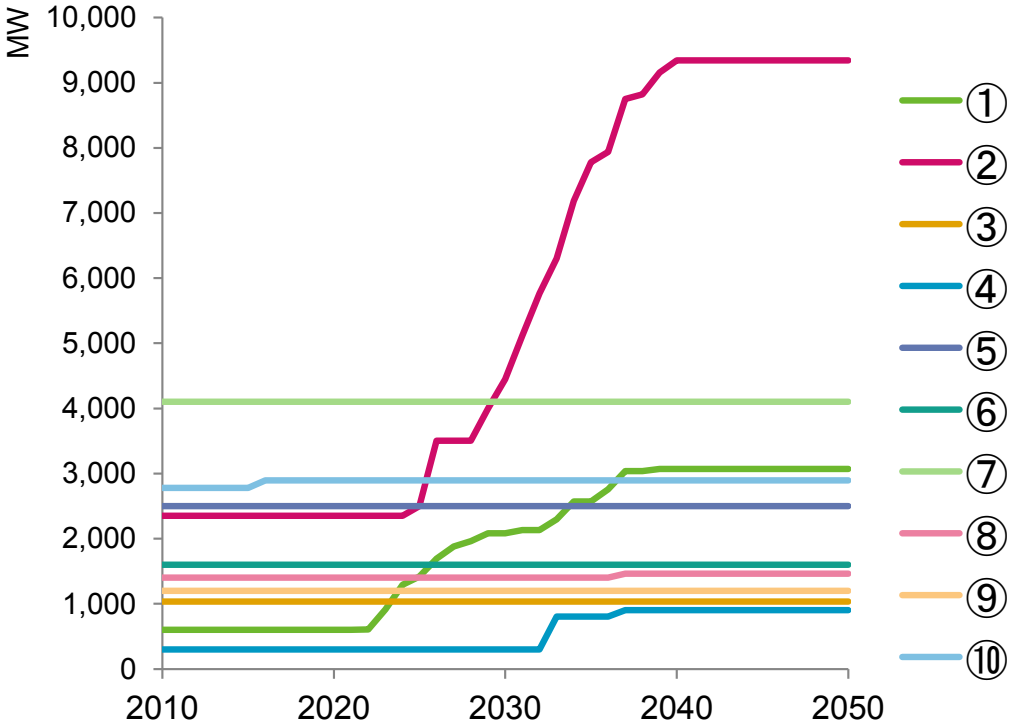
<Carbon price to reduce GHG by 80% by scenario in 2050>

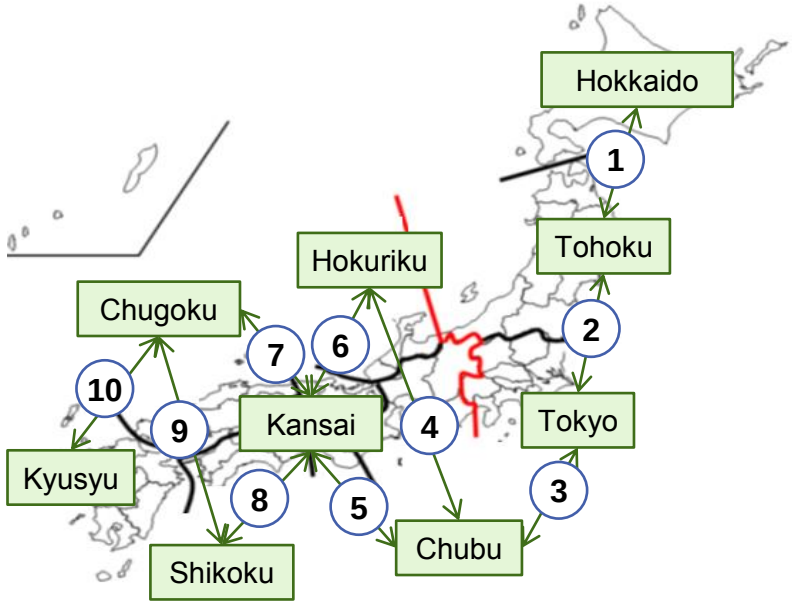


Electricity interconnection capacity

- Tohoku-Tokyo line and Hokkaido-Tohoku line are reinforced in reinforcing interconnection scenario

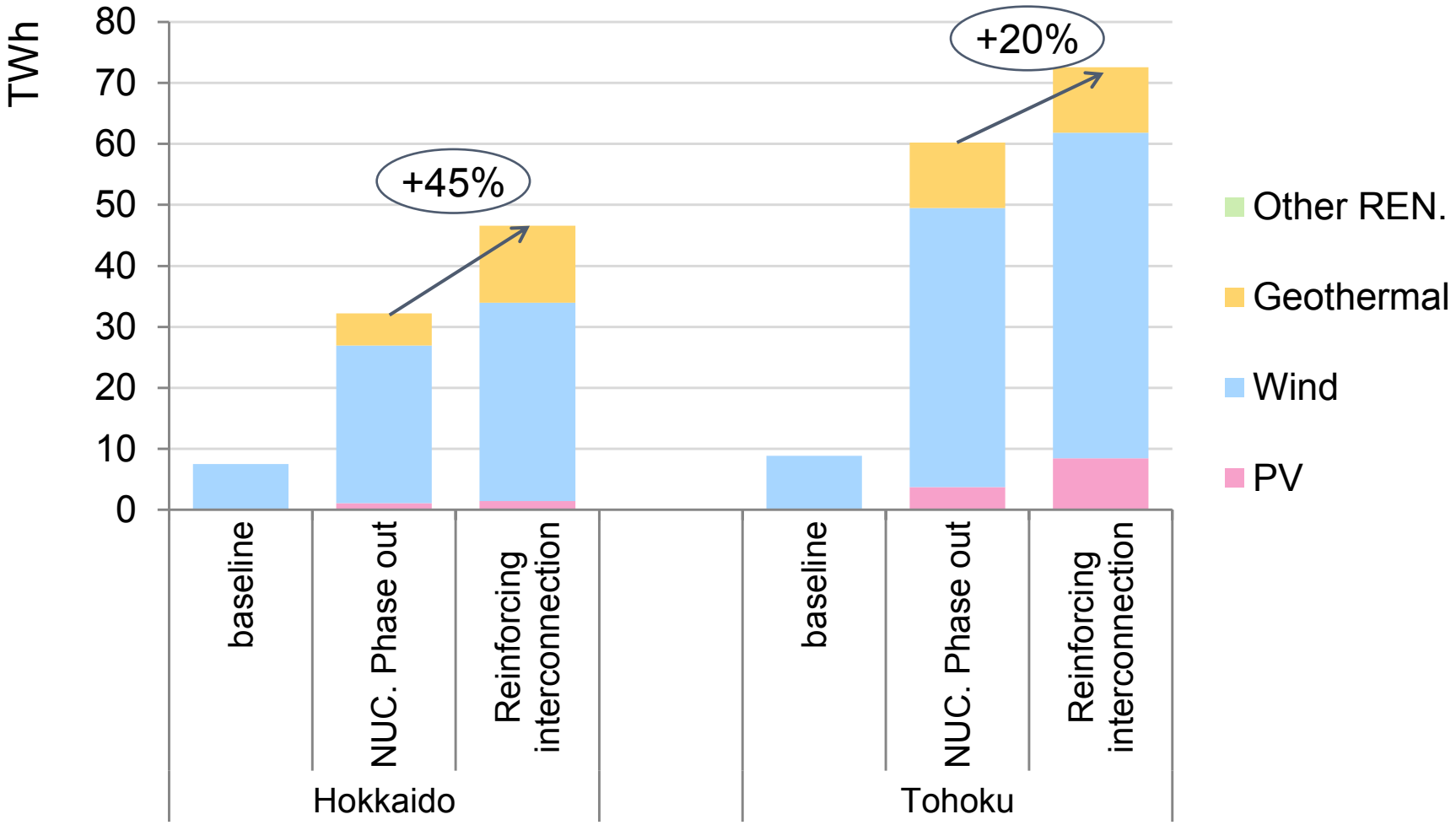
<Interconnection capacity (upper limit)>
(Reinforcing interconnection scenario)





Power generation from renewable

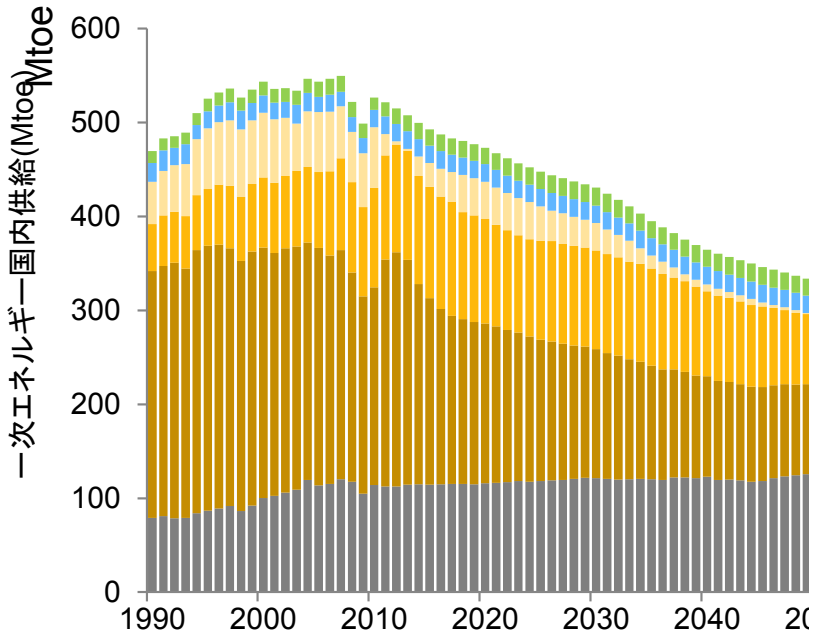
- In reinforcing interconnection scenario, power generation from renewable in Hokkaido and Tohoku aria increases by 20%~45%



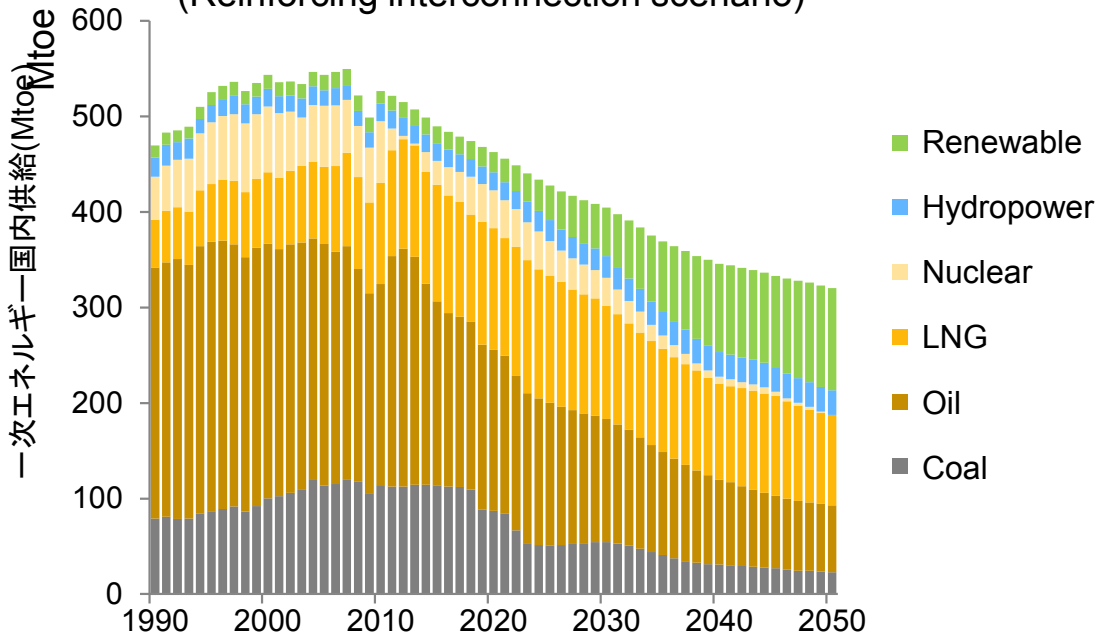
Primary energy supply

- In 80% reduction scenario, renewable energy occupies over 40% of total supply

<Baseline scenario>



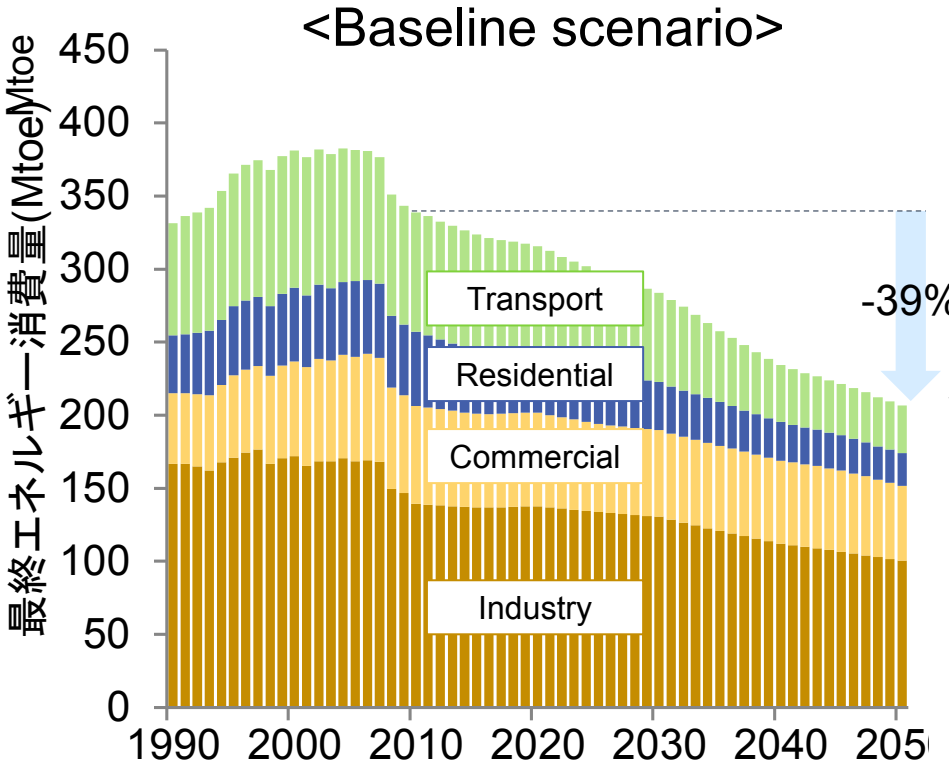
<80% reduction scenario>
(Reinforcing interconnection scenario)

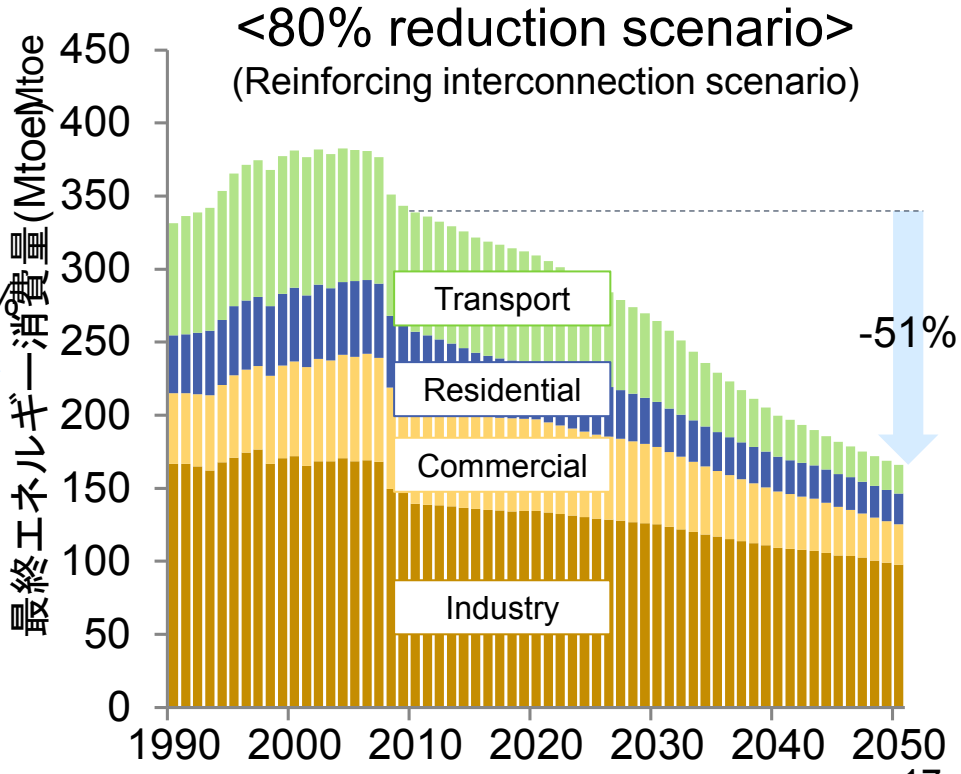


* Including non-energy use

Final energy consumption

- In 80% reduction scenario, energy consumption in 2050 is almost reduced by half compared to 2010

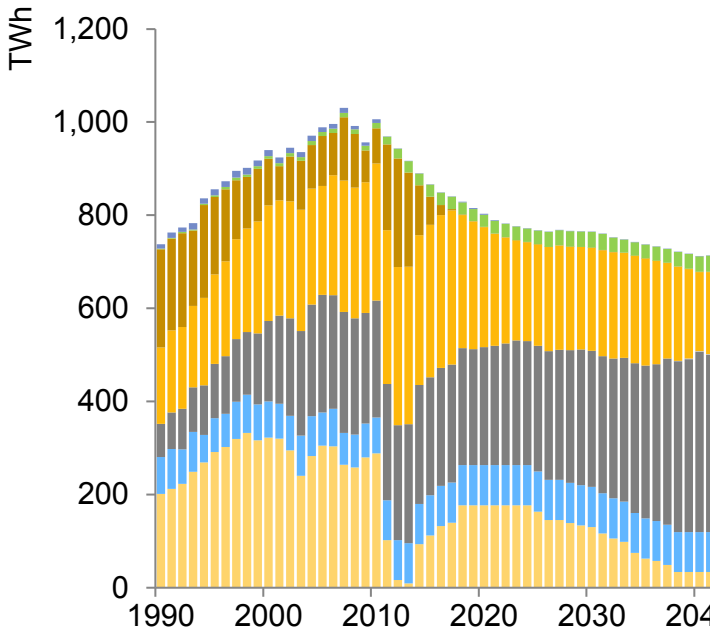




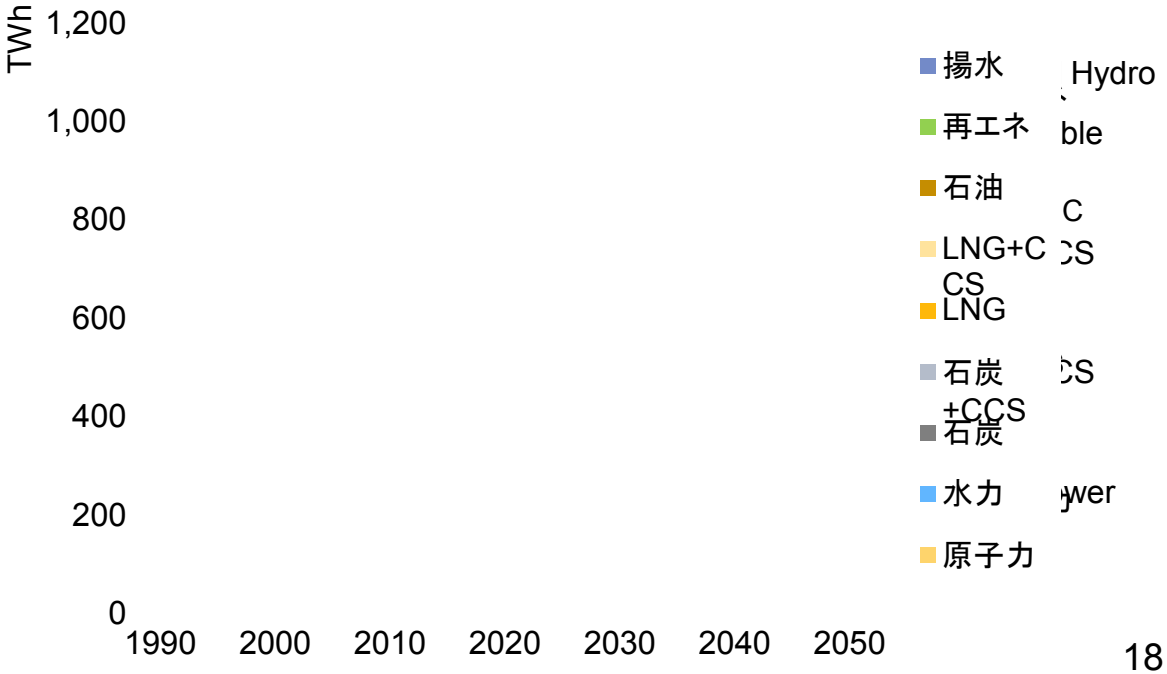
Power generation

- In baseline scenario, share of coal increases in place of nuclear power.
- In 80% reduction scenario, share of LNG with CCS increases. And renewable exceed 40% of total generation

<Baseline scenario>



<80% reduction scenario>
(Reinforcing interconnection scenario)

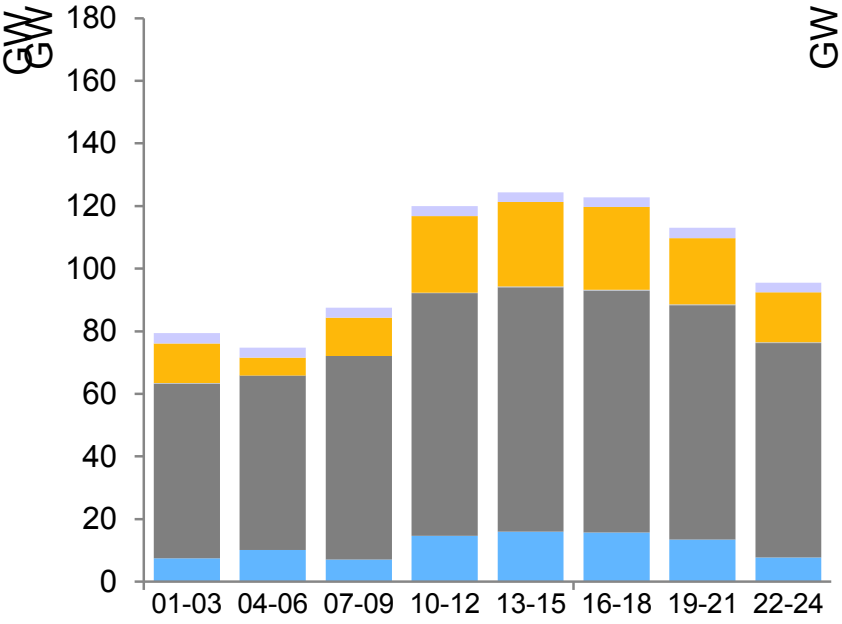


Power generation (detail)

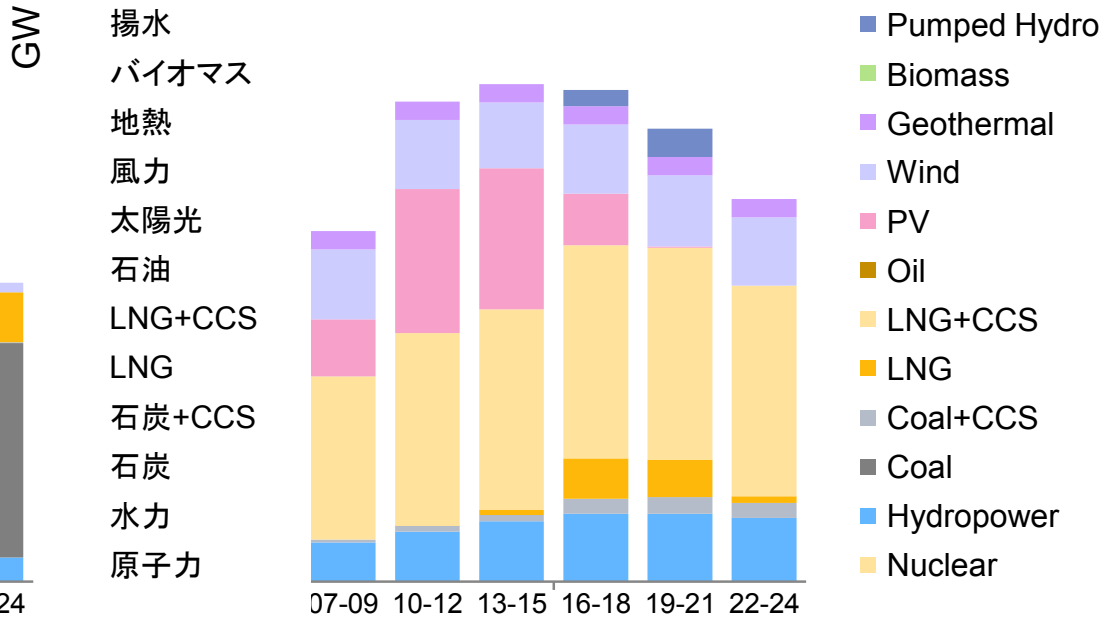
- In 80% reduction scenario, PV increases significantly so pumped hydro plant operates not in the daytime but in the evening

Power generation in the summer of 2050

<Baseline scenario>

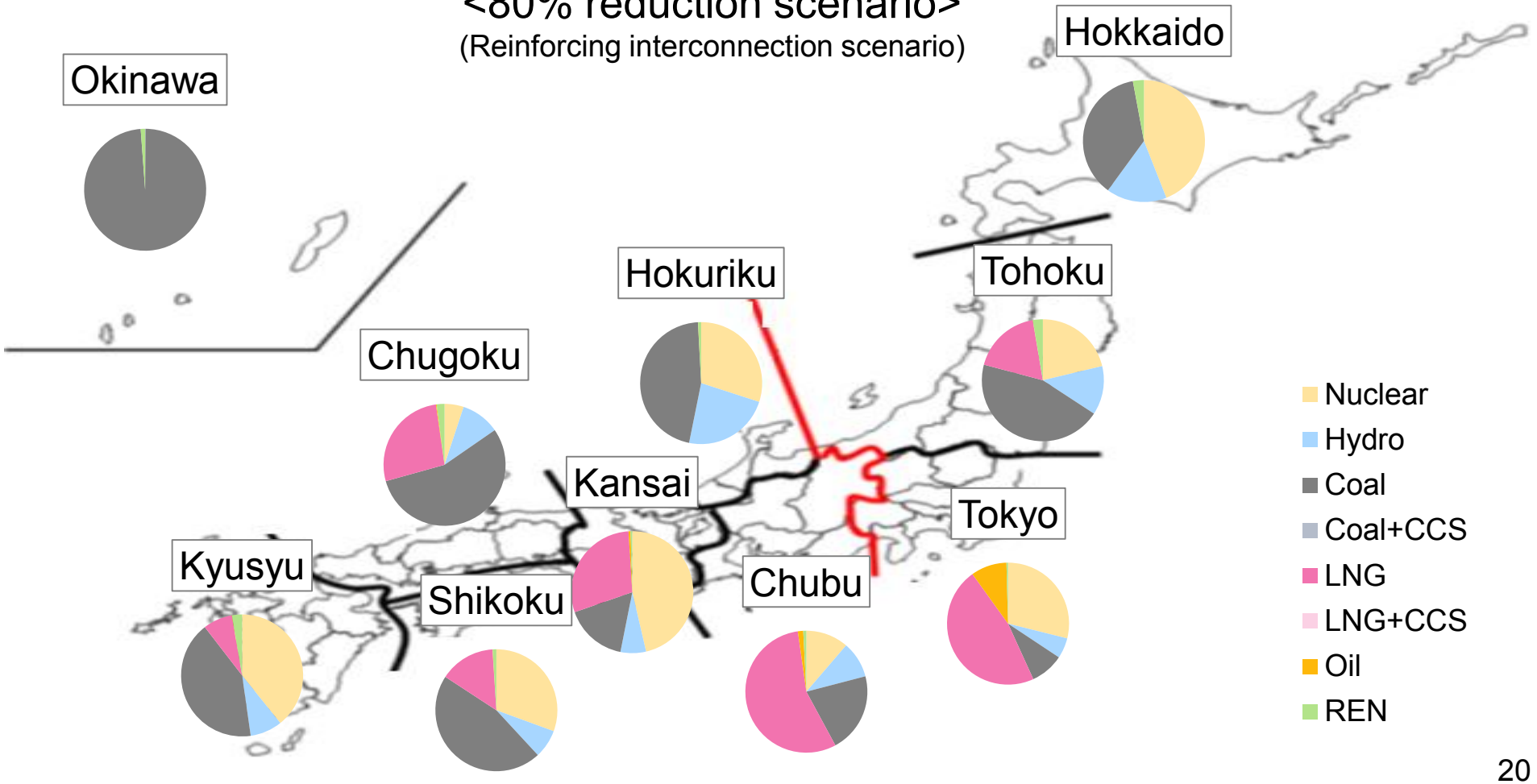


<80% reduction scenario>
(Reinforcing interconnection scenario)



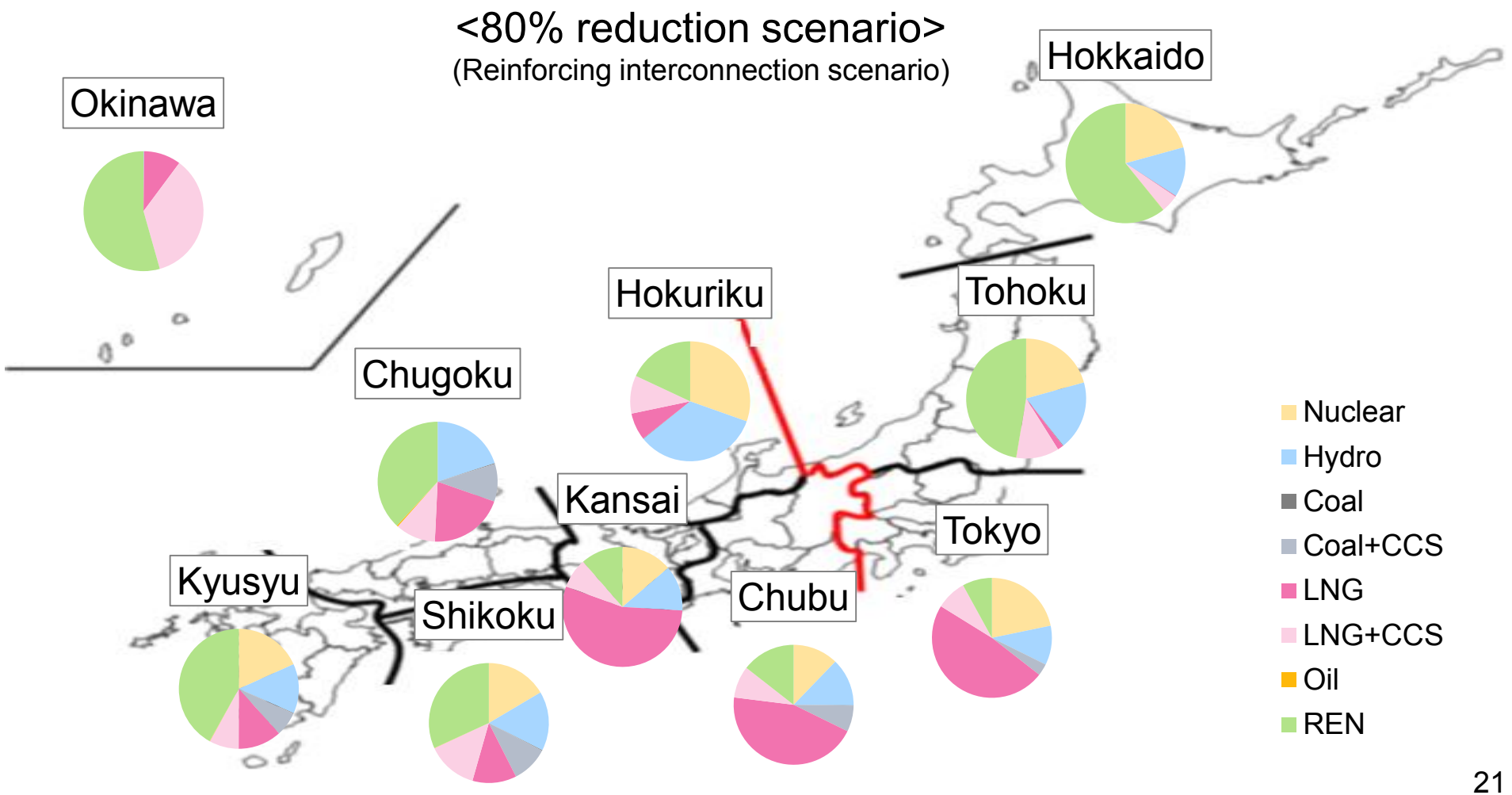
Power generation by region in 2010

<80% reduction scenario>
(Reinforcing interconnection scenario)



Power generation by region in 2030

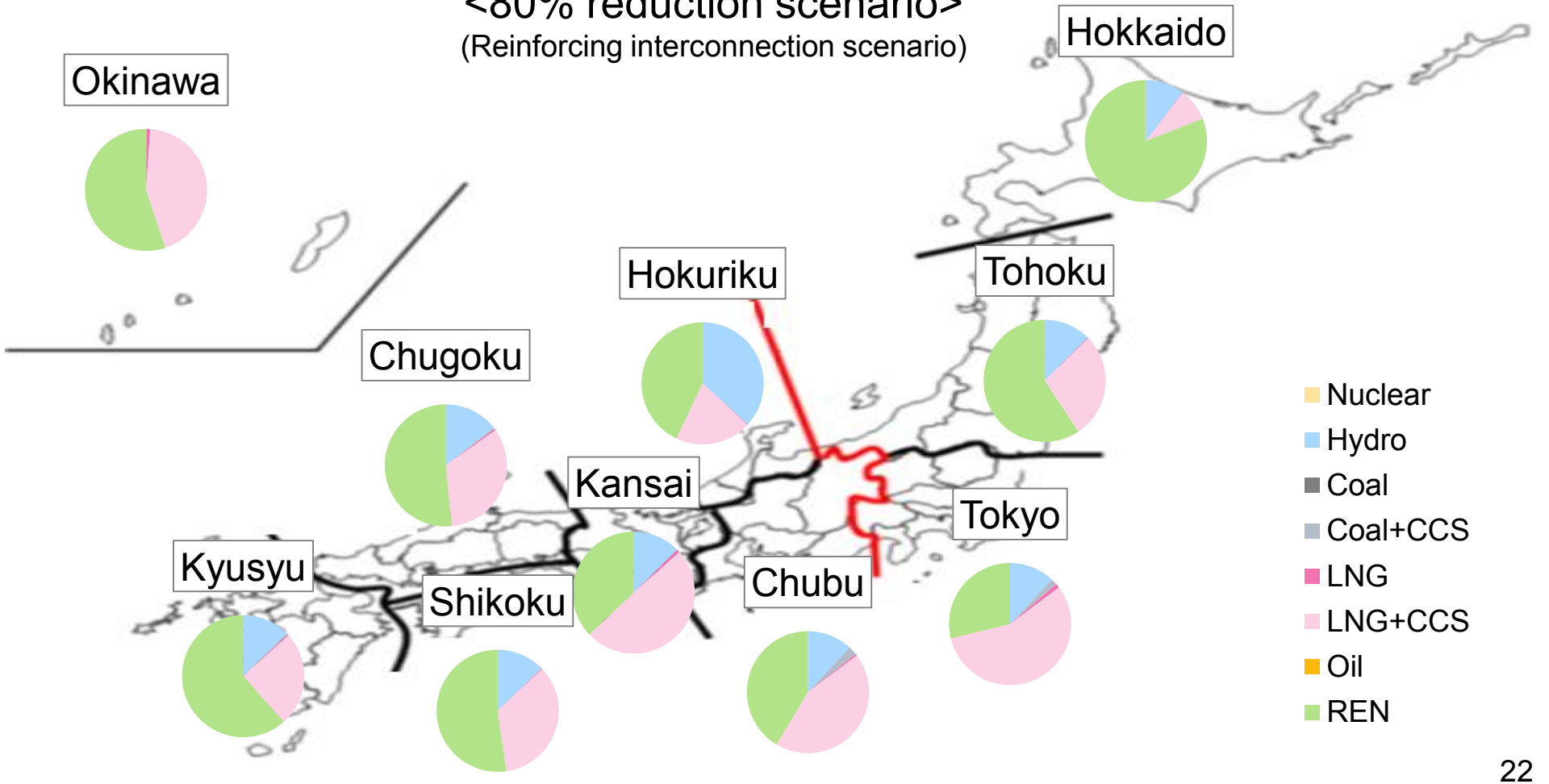
- Generation from LNG and renewable is growing rapidly



Power generation by region in 2050

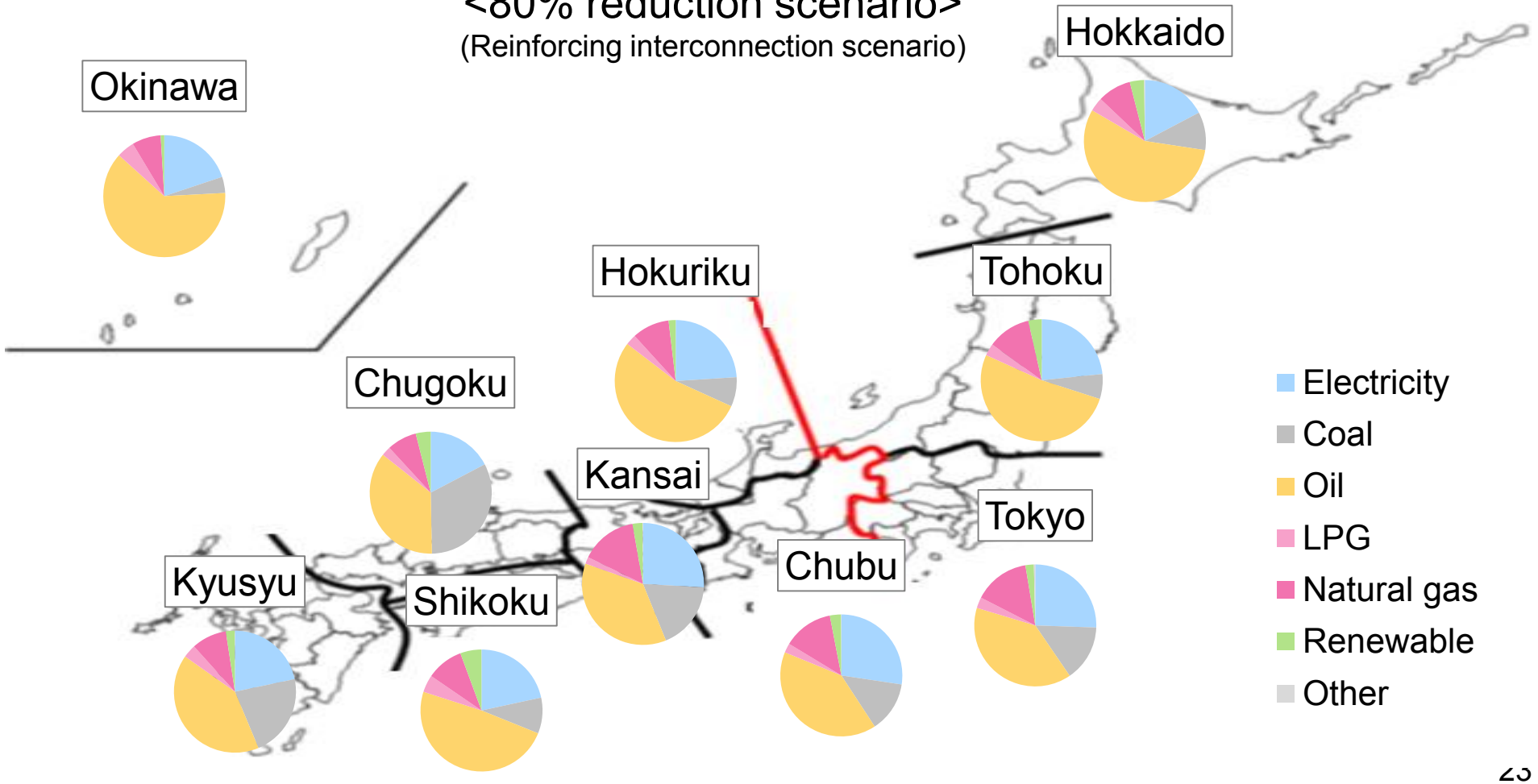
- Generation from renewable is growing more, and the rest is occupied by LNG equipped with CCS.

<80% reduction scenario>
(Reinforcing interconnection scenario)



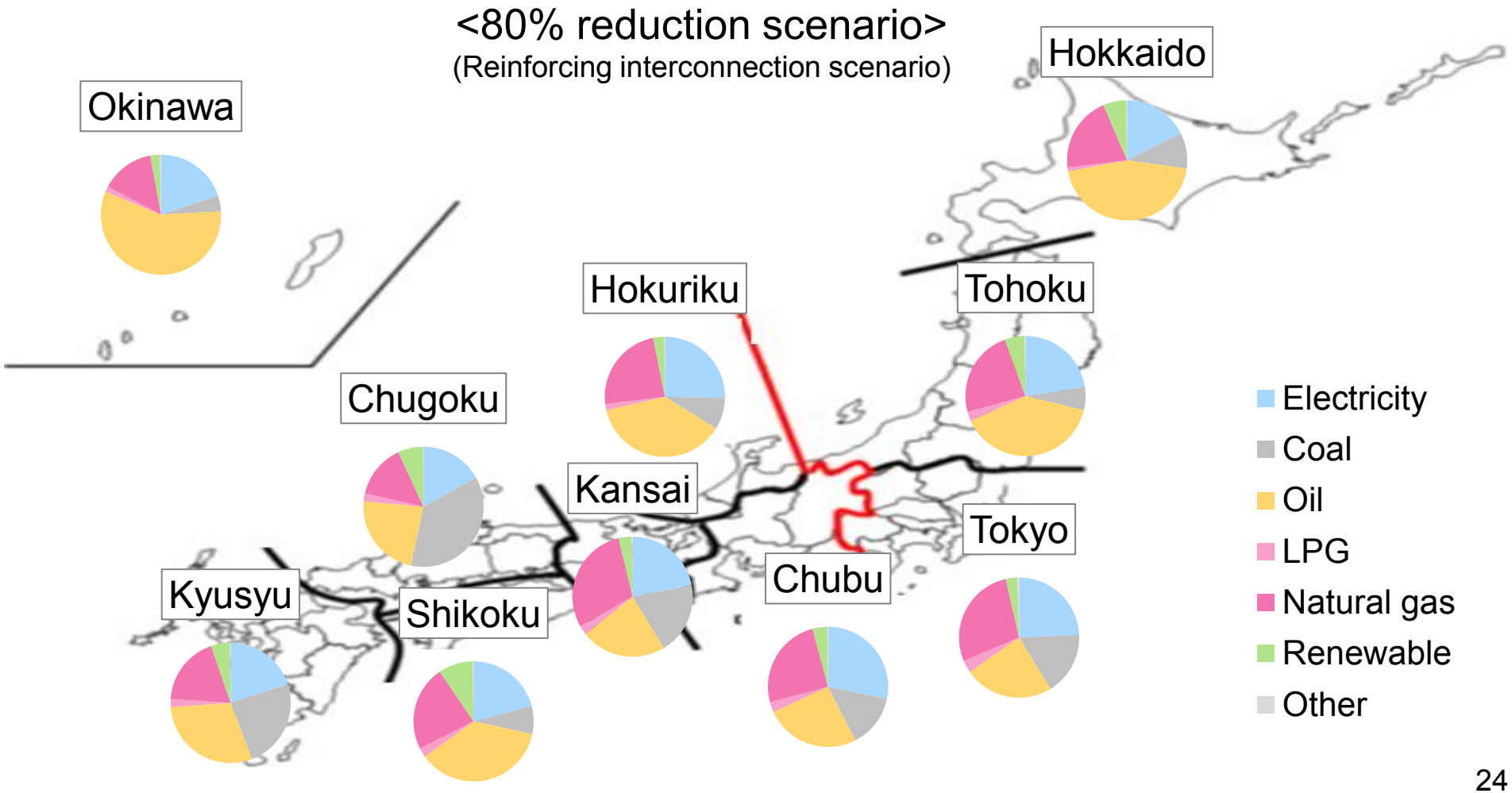
Final energy consumption by region in 2010

<80% reduction scenario>
(Reinforcing interconnection scenario)



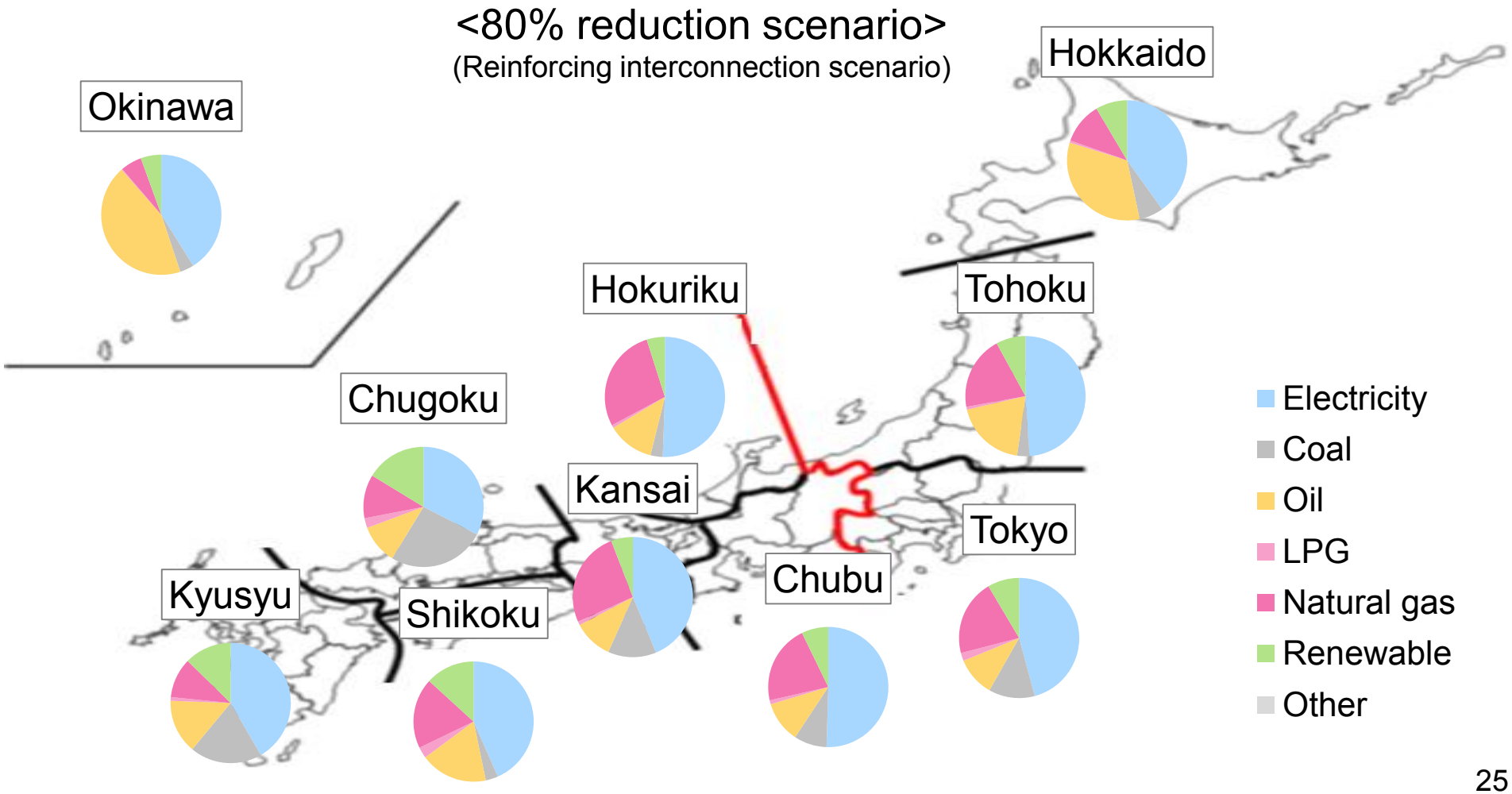
Final energy consumption by region in 2030

- Natural gas increases mainly in place of oil



Final energy consumption by region in 2050

- Electricity and renewable is growing



Summary

- without nuclear power, carbon price to achieve 80% reduction by 2050 is very high
- To reduce economic impact, not only energy efficiency or renewable technology but system technology such as reinforcing electricity interconnection is important
- If reinforcing electricity interconnection is available, Hokkaido and Tohoku region will take a important role because of their rich renewable energy potential

Thank you for your attention !