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Analyses on GHG Mitigation Costs and Measures and their Implications

Keigo Akimoto

Group Leader, Systems Analysis Group

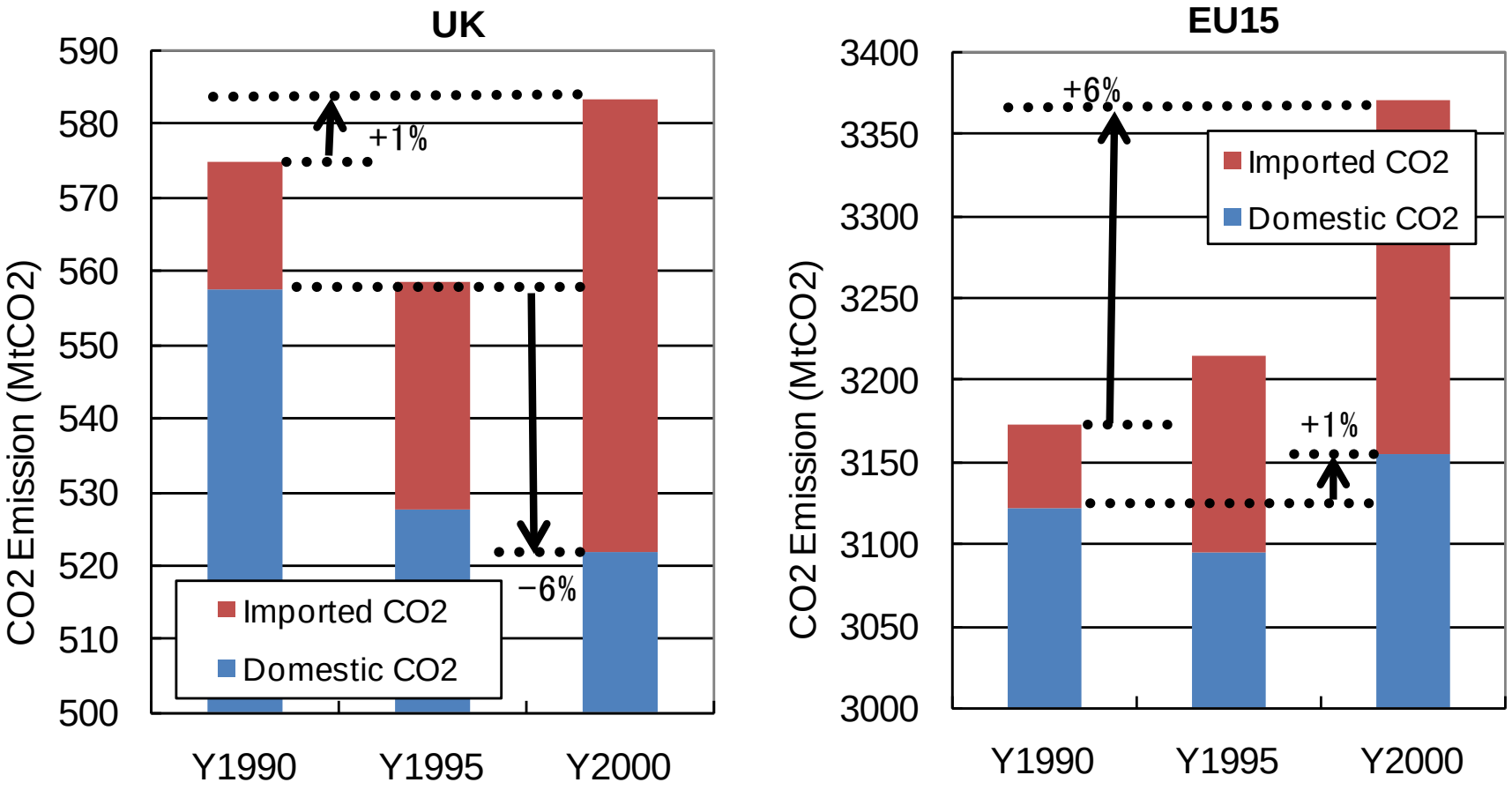
Research Institute of Innovative Technology for the Earth (RITE)

Guest Professor, Graduate School of Art and Science

The University of Tokyo

Introduction:
Analyses on Current World

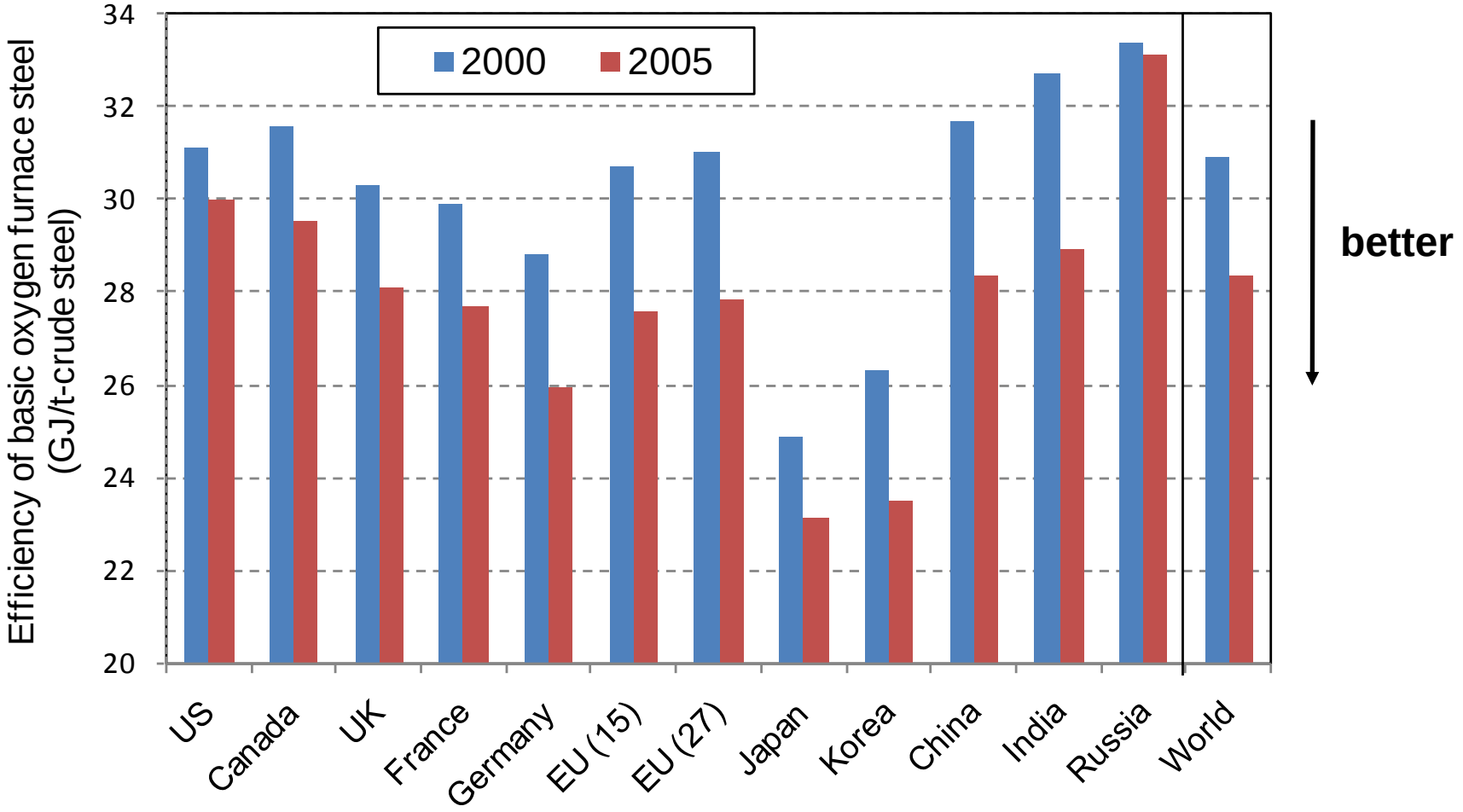
Historical Trends of Industrial Transfer and Carbon Leakage



Source: Homma et al. (RITE), 2008

- **Industries transfer among countries easily under a globalized world.**
- **Global emission reductions cannot be achieved without global industrial structure change, that means consumption structure changes are required.**

Comparisons of Energy Efficiency — Iron & Steel Sector (BF/BOF) —



Note: Electricity is converted by using 1MWh=0.086/0.33toe.
Source: Estimates by RITE based on IEA statistics, IISI (WSA) etc.

Analyses on Emission Reduction Targets Proposed to Copenhagen Accord

Overview of the Model
(2 Models and 1 Scenario)

1. DNE 21+ Model

- Assessment model for **energy-related CO_2** emissions
- **54 regions** in the world
- **Bottom-up** modeling (**200-300 specific technologies** are modeled)

Non-Energy CO_2 Emissions Scenario

- Projection module for **non-energy CO_2** emissions
- **54 regions** in the world
- **Estimations of sectoral** non-energy CO_2 emissions to be consistent with GDP and production activities

2. Non-CO_2 GHG Assessment Model

- Assessment model for the **5 non-CO_2 GHG** emissions (CH_4, N_2O, HFCs, PFC, SF_6)
- **18 regions** in the world (allocated to the 54 regions, based on the **historical data**)
- The methodology is **similar to the USEPA** assessment

Estimates of the 6 GHG emissions, emission reduction costs and potentials, and specific cost-effective measures for emission reductions

Note: LULUCF is excluded for the estimates.

Energy Assessment Model: DNE21+

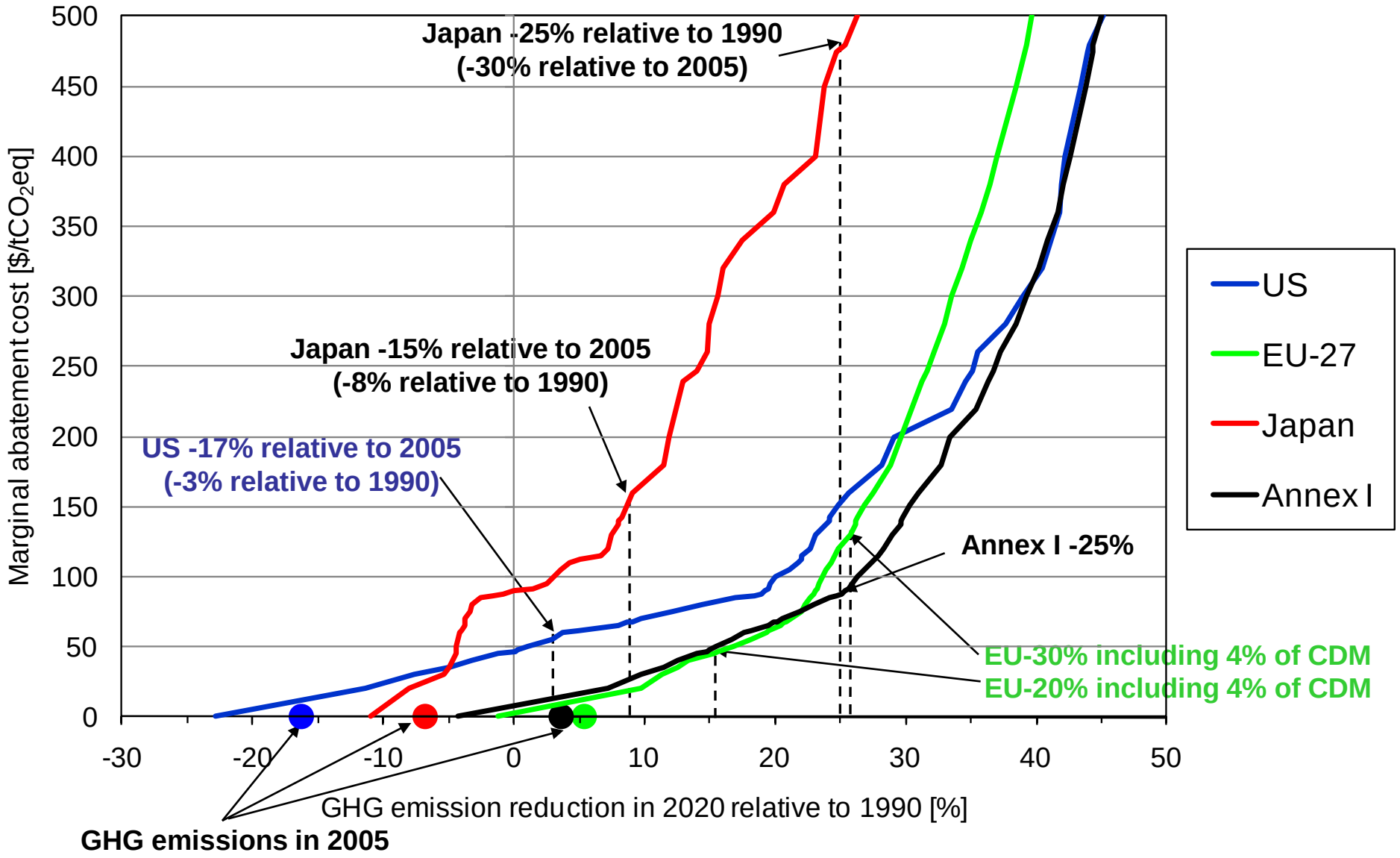
- Linear programming model (minimizing world energy system cost)
- Evaluation time period: 2000-2030 (or -2050)
  Representative time points: 2000, 2005, 2010, 2015, 2020, 2025, 2030, 2040, 2050
- World divided into 54 regions
  Large area countries are further divided into 3-8 regions, and the world is divided into 77 regions.
- Bottom-up modeling for technologies both in energy supply and demand sides (200-300 specific technologies are modeled.)
- Primary energy: coal, oil, natural gas, hydro&geothermal, wind, photovoltaics, biomass and nuclear power
- Electricity demand and supply are formulated for 4 time periods: instantaneous peak, peak, intermediate and off-peak periods
- Interregional trade: coal, crude oil, natural gas, syn. oil, ethanol, hydrogen, electricity and CO_2
- Existing facility vintages are explicitly modeled.

- The model has detailed information in regions and technologies enough to analyze sectoral approach.
- Consistent analyses among regions and sectors can be conducted.

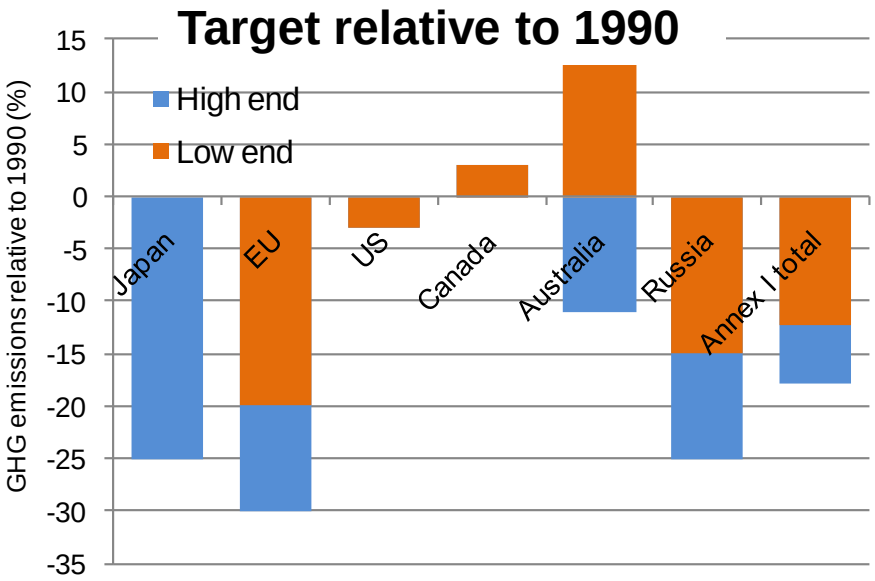
Pledged Mid-term Targets

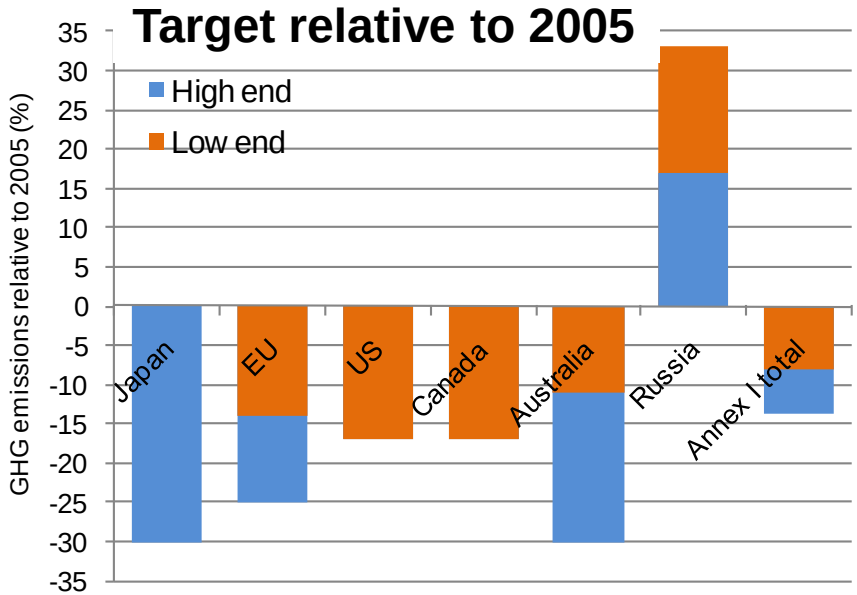
	Emission Reduction Target in 2020
Japan	−25% relative to 1990
EU	−20% - −30% relative to 1990
United States	−17% relative to 2005
Canada	−17% relative to 2005
Australia	−5% - −25% relative to 2000
Russia	−15% - −25% relative to 1990
Korea	−30% relative to Baseline (−4% relative to 2005)
China	−40% - −45% for per-GDP emission relative to 2005
India	−20% - −25% for per-GDP emission relative to 2005

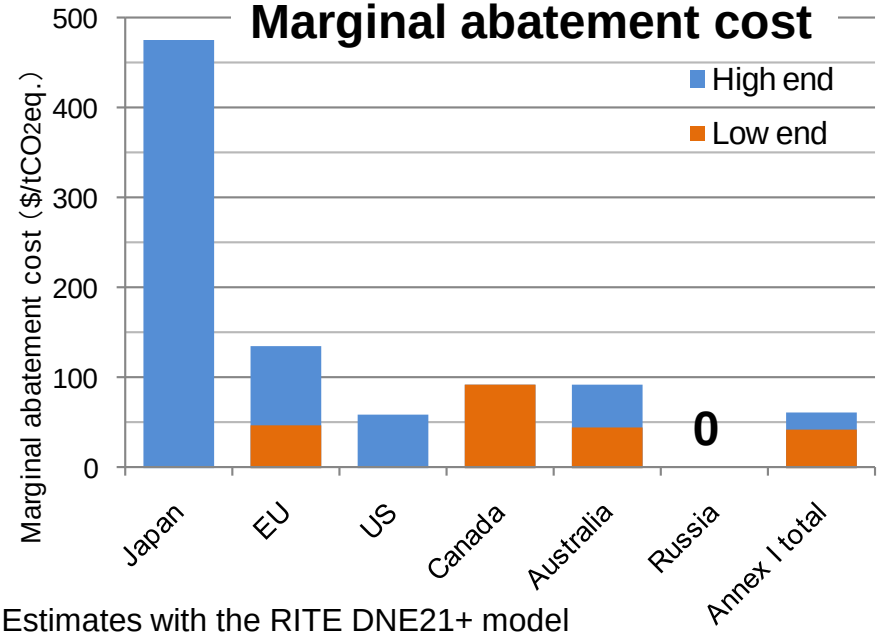
Marginal Abatement Cost Curves in 2020

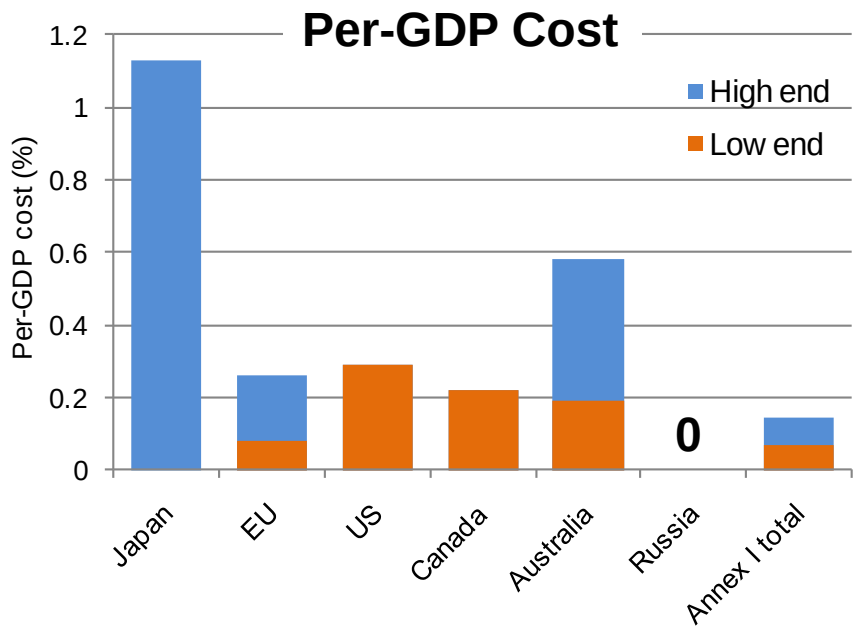


Mid-term Emission Reduction Target of Major Annex I Countries (Y2020)



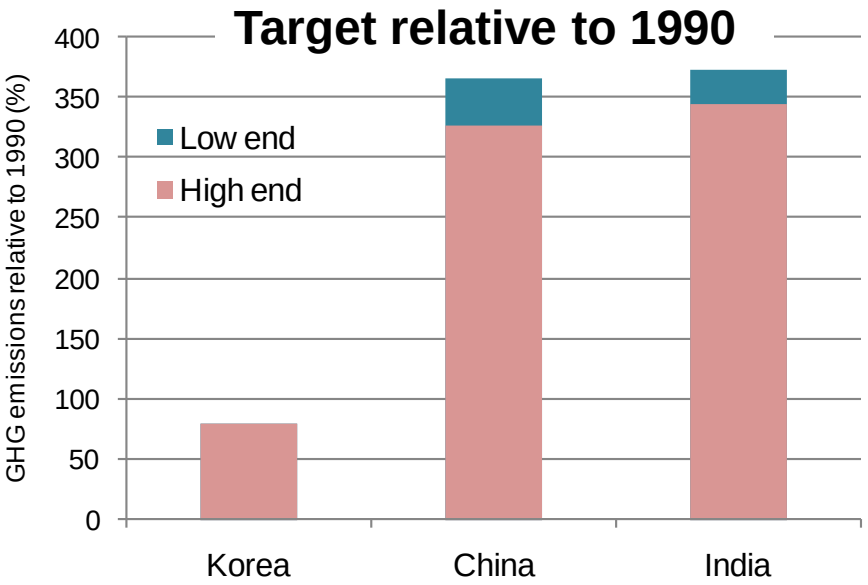


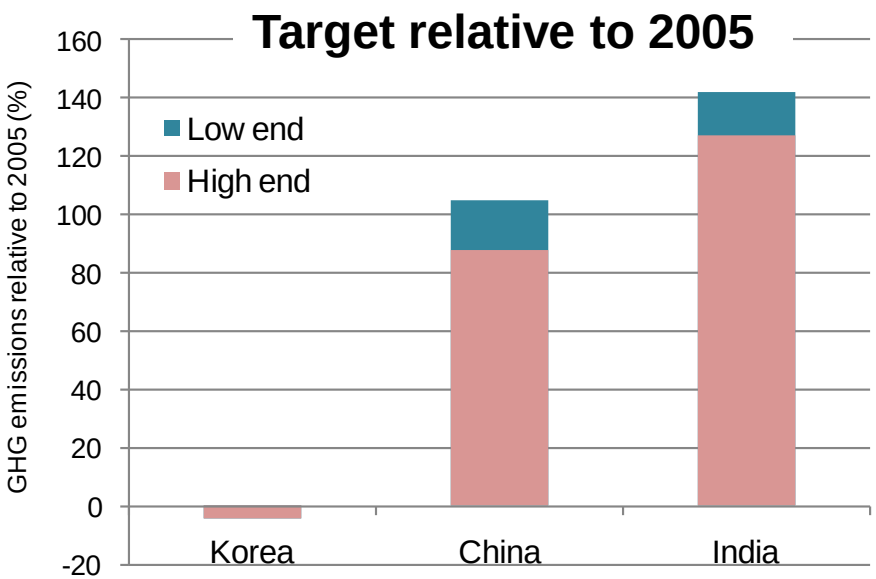


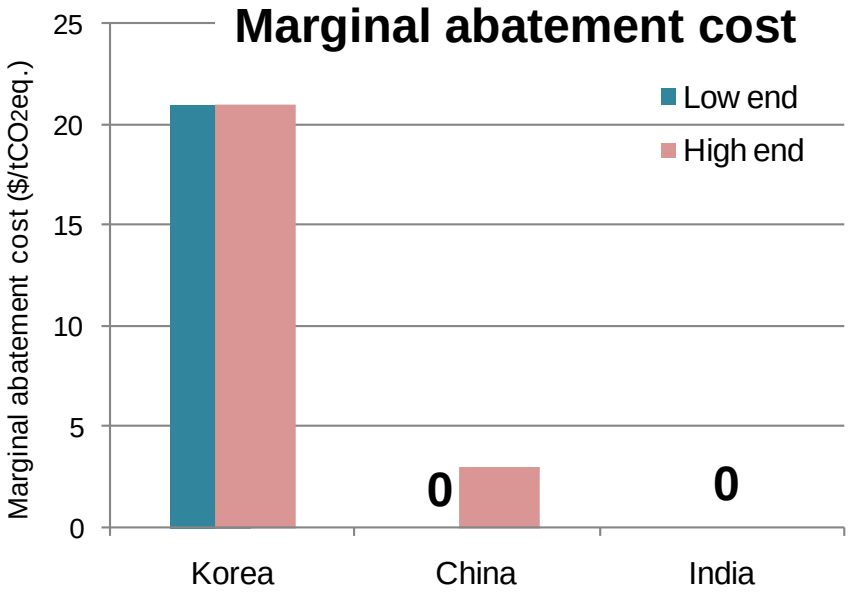


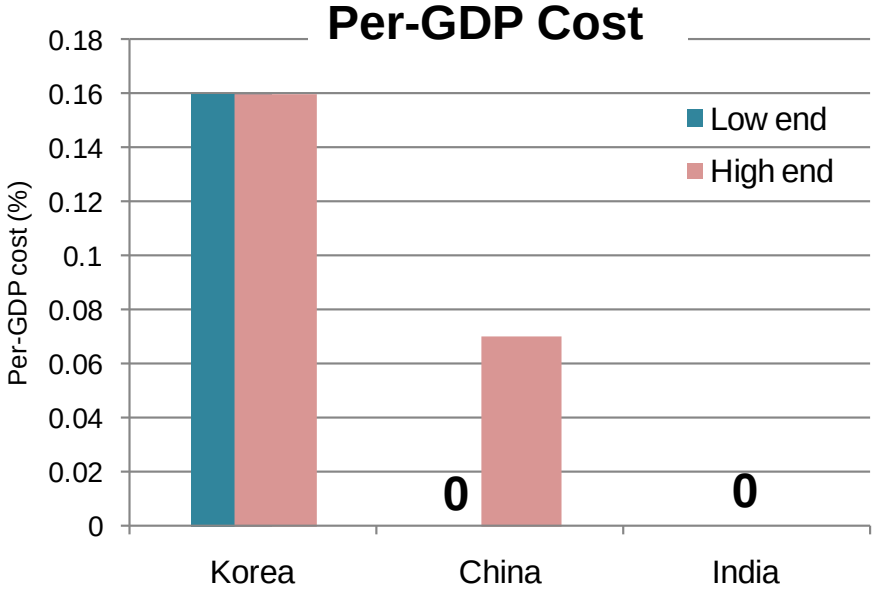
Estimates with the RITE DNE21+ model

Mid-term Emission Reduction Target of Major Non-Annex I Countries (Y2020)





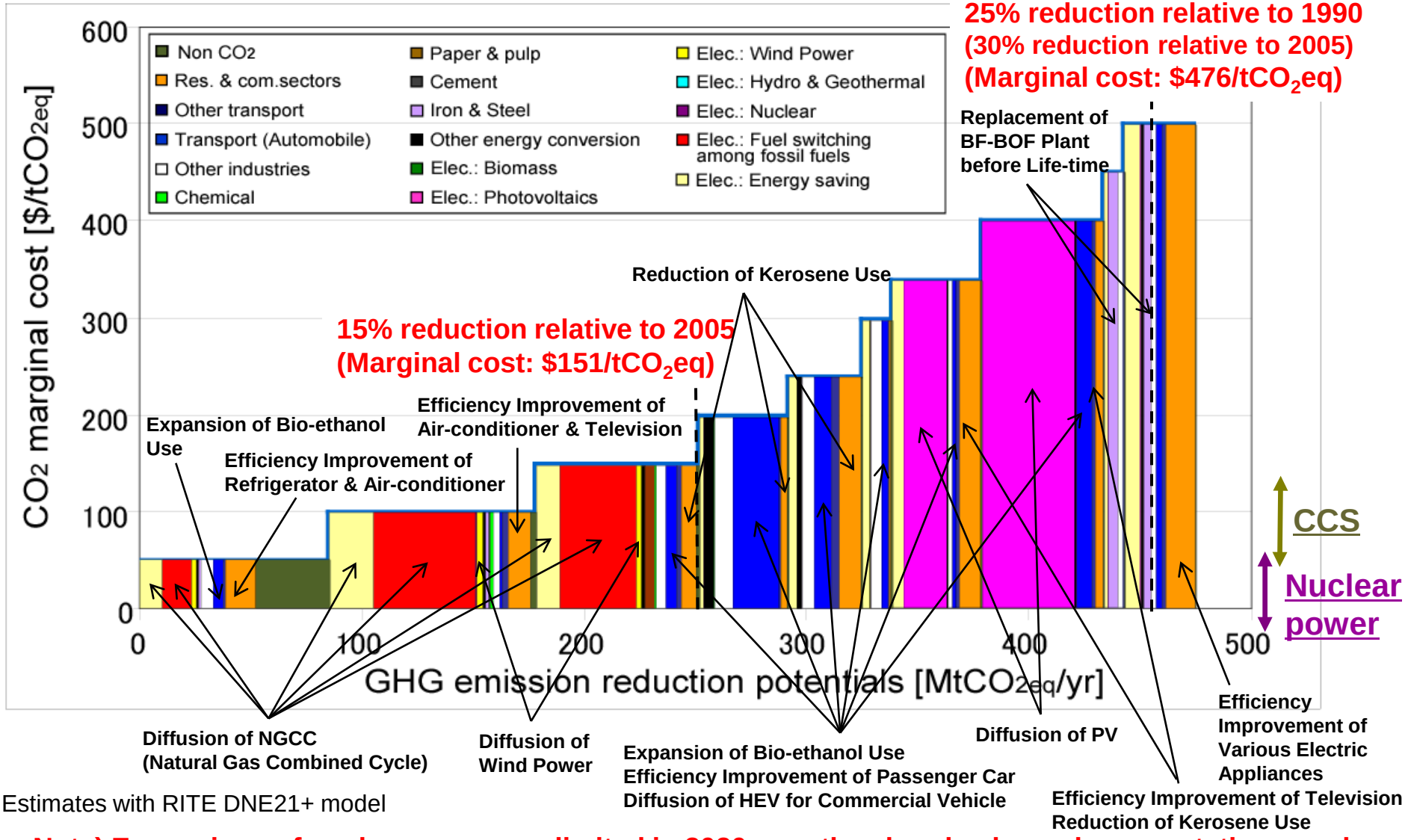




Estimates with the RITE DNE21+ model

Impacts on Japanese Economics

GHG Emission Reduction Potentials and Costs in 2020 in Japan



Estimates with RITE DNE21+ model

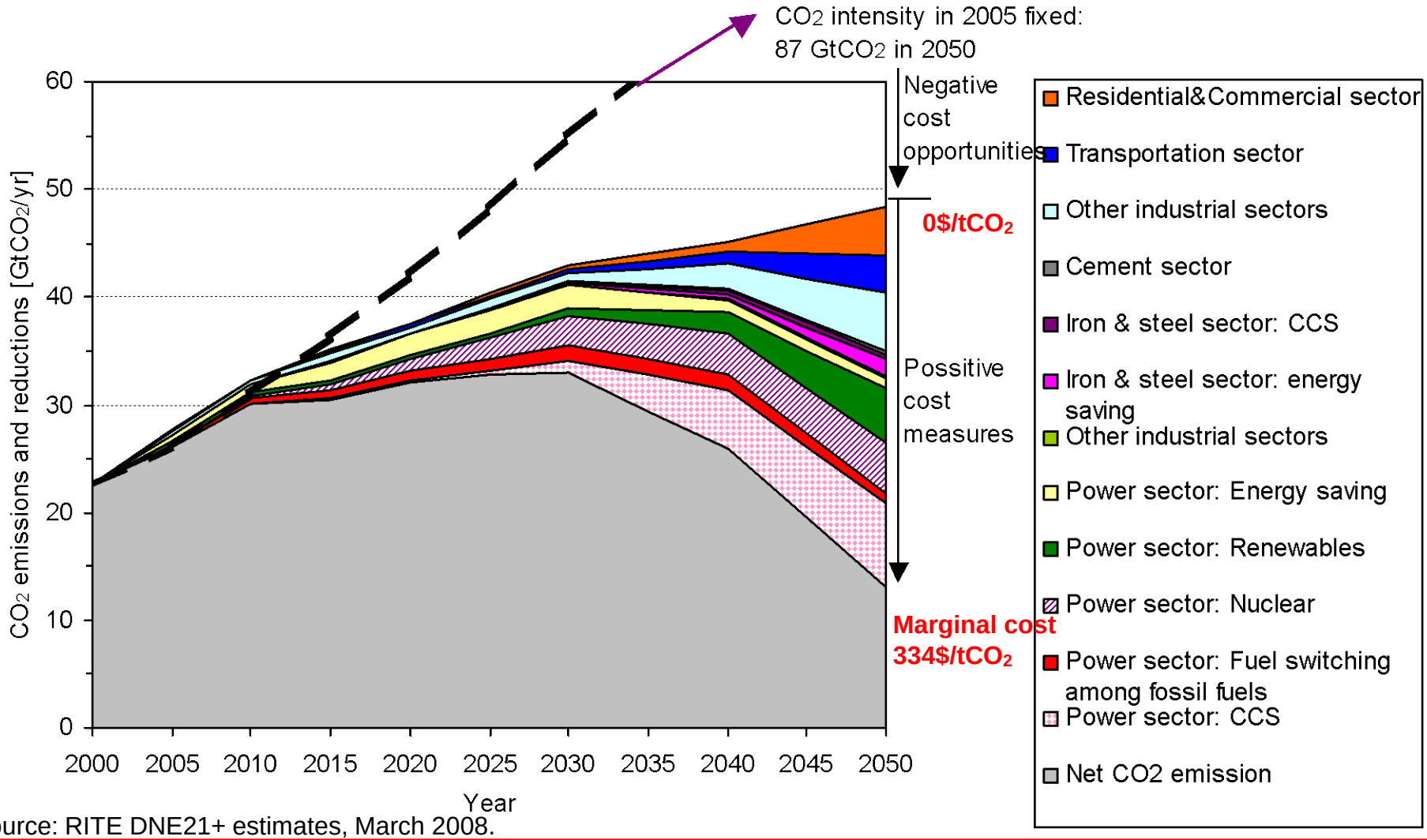
Note) Expansions of nuclear power are limited in 2020 over the already planned power stations, and therefore, the reduction potentials of nuclear power are excluded above.

Economic Impacts by Mid-term Targets in Japan

		Keio Univ.	Nikkei Center		NIES
		KEO	CGE	Macro-economic	AIM/CGE
Alternative 1: +4% relative to 1990(-4% relative to 2005) , Baseline (The Alternative 1 is assumed to be 0% of GDP loss)					
Alternative 3 ▲7% relative to 1990 (▲14% relative to 2005)	GDP (real)	▲0.5%	▲0.6%	▲0.9%	▲0.5%
	Private Fixed Invest.	+3.4%	+0.1%	+2.2%	▲0.8%
	Disposal Income (per household)	▲3.1% ▲15,000 JPY	▲0.8% ▲40,000 JPY	▲0.7%	▲1.1% ▲50,000 JPY
	Cost of fuel and light (per household)	+19.7% +30,000 JPY	+17.6% +30,000 JPY	—	+13.2% +20,000 JPY
	Gasoline price	+40JPY/L	+30JPY/L	+40JPY/L	+20JPY/L
Alternative 5 ▲15% relative to 1990 (▲21% relative to 2005)	GDP (real)	▲2.1%	▲1.4%	▲2.6%	▲0.8%
	Private Fixed Invest.	+7.9%	+0.0%	+5.3%	▲0.2%
	Disposal Income (per household)	▲8.2% ▲390,000 JPY	▲1.9% ▲90,000 JPY	▲2.1%	▲2.3% ▲100,000 JPY
	Cost of fuel and light (per household)	+44.8% +80,000 JPY	+38.6% +70,000 JPY	—	+34.5% +60,000 JPY
	Gasoline price	+90JPY/L	+70JPY/L	+90JPY/L	+60JPY/L
Alternative 6 ▲25% relative to 1990 (▲30% relative to 2005)	GDP (real)	▲5.6%	▲3.2%	▲6.6%	▲6.0%
	Private Fixed Invest.	+6.6%	▲0.4%	+12.5%	▲11.9%
	Disposal Income (per household)	▲15.9% ▲770,000 JPY	▲4.5% ▲220,000 JPY	▲5.6%	▲9.1% ▲440,000 JPY
	Cost of fuel and light (per household)	+76.6% +130,000 JPY	+81.0% +140,000 JPY	—	+65.7% +110,000 JPY
	Gasoline price	+190JPY/L	+170JPY/L	+220JPY/L	+130JPY/L

Long-term Emission Reduction Perspective

CO_2 Emission Reductions by Sector For Halving Global Emission in 2050



Source: RITE DNE21+ estimates, March 2008.

There are no silver bullet technologies, and the best mix of the effective technologies are needed.

For Sustainable GHG Mitigation Actions

For Sustainable Mitigation Actions

- **Balanced mitigation efforts among countries will be needed (Mitigation cost is one of the important indicators particularly among developed countries.).**
- **For reducing the economic losses, the following efforts will be needed.**

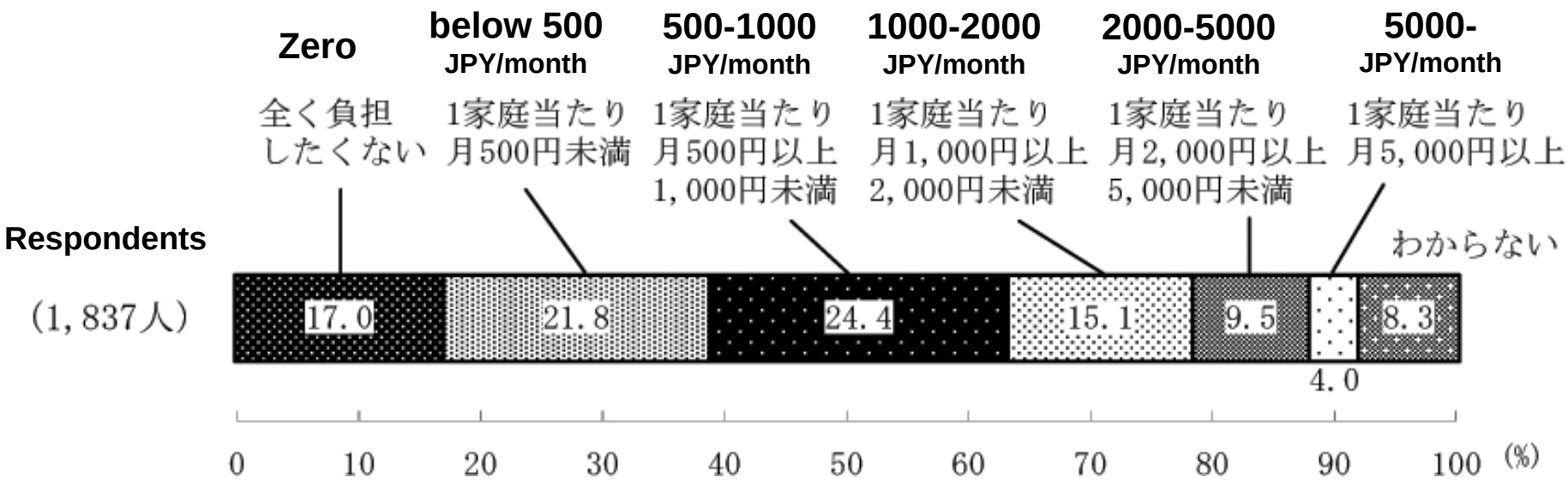
  1) Cost reductions of mitigation technologies through development of innovative technologies,

  2) Removing social barriers for deployment of energy efficiency technologies,

  3) Deployment of co-benefit measures with system considerations (e.g., energy security, environment compatible city with high quality), and

  4) Increase in environment consciousness (to be discussed in the following slides)

Willingness to Pay (WTP) for Preventing Global Warming in Japan

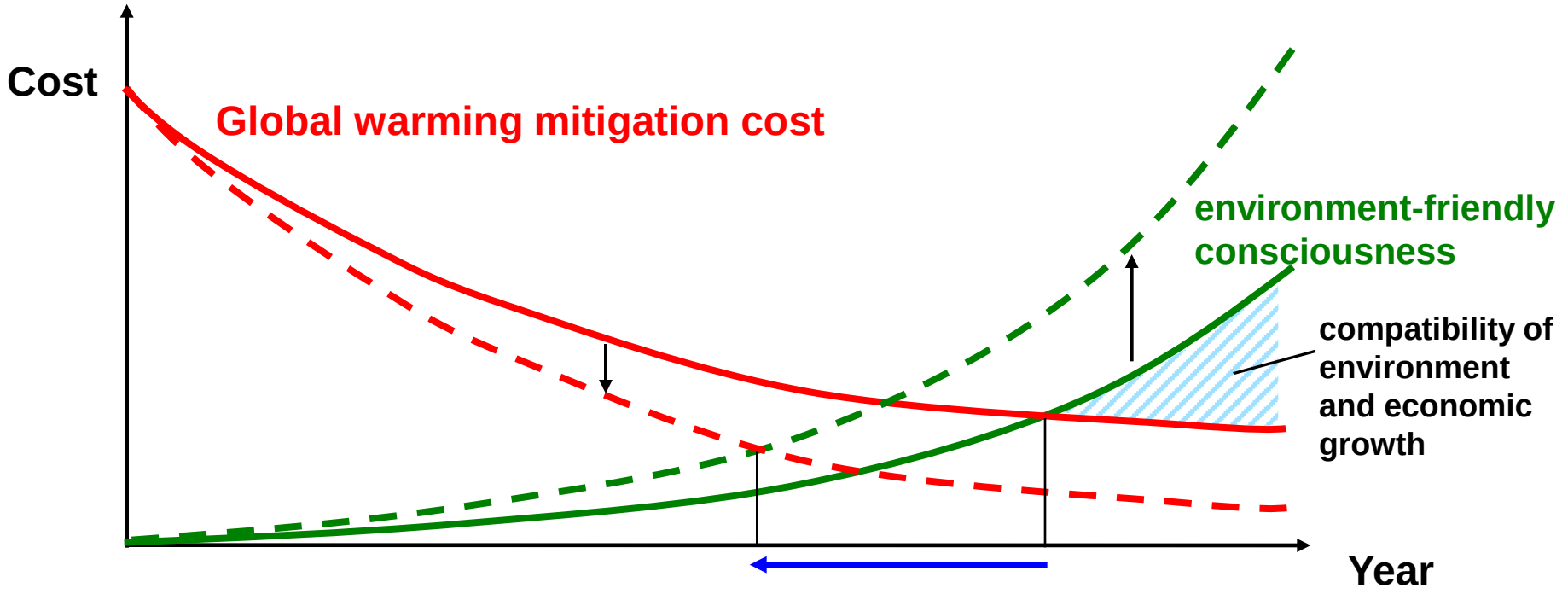


Source: Japanese government, from May 22 to June 1, 2008

・Only 4% of Japanese public accepts more than 5,000 JPY per month per household (60,000 JPY/yr) for preventing global warming. However, estimates imply that 220,000-770,000 JPY/yr per household are required for achieving 25% reduction in 2020 relative to 1990 level.

- Need to explore compatibility of environment and economic growth in a well balanced manner

Toward Compatibility of Environment and Economic Growth



Both developments of innovative technologies and deployments of mitigation technologies with low cost and increase in environment conscious behavior are important for compatibility of environment and economic growth.

Increase in environment consciousness will induce changes in consumption structures.

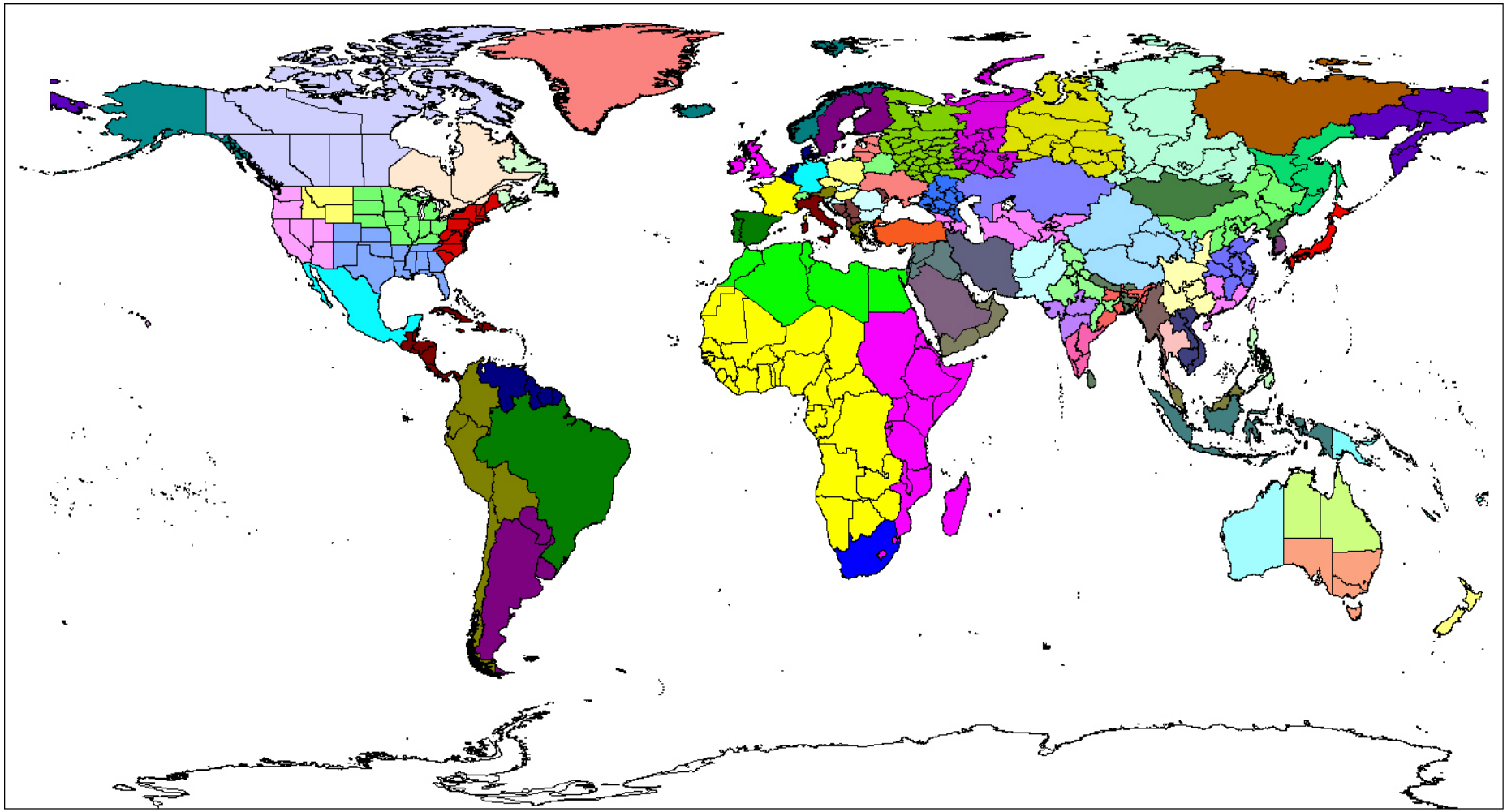
Basic economic growth is also important for increase in environment-friendly consciousness.

Conclusion

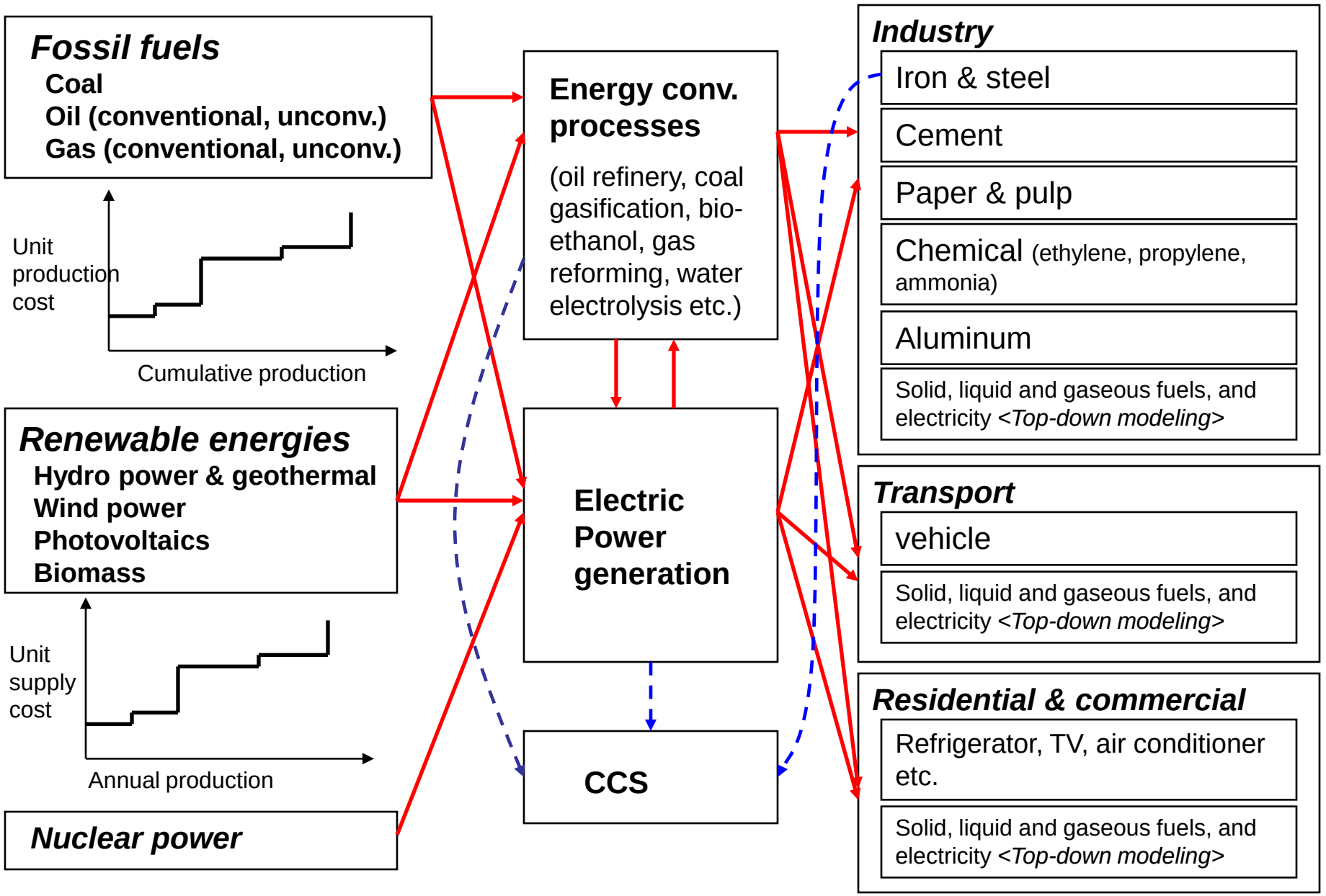
- Global cooperation is a key for preventing global warming and toward sustainable development, and fair emission reduction targets among countries are significant for achieving emission reductions.
- There are large differences among countries. Many international frameworks, different types of emission reduction targets, and different types of policies will be needed for really effective emission reductions.
- Both of improvements of global warming mitigation technologies and increase in environment conscious behavior are important for compatibility of environment and economic growth.
- Models are powerful tools, but not prediction tools. Well understanding them is important for policy making.

Appendix

Region divisions of DNE21+

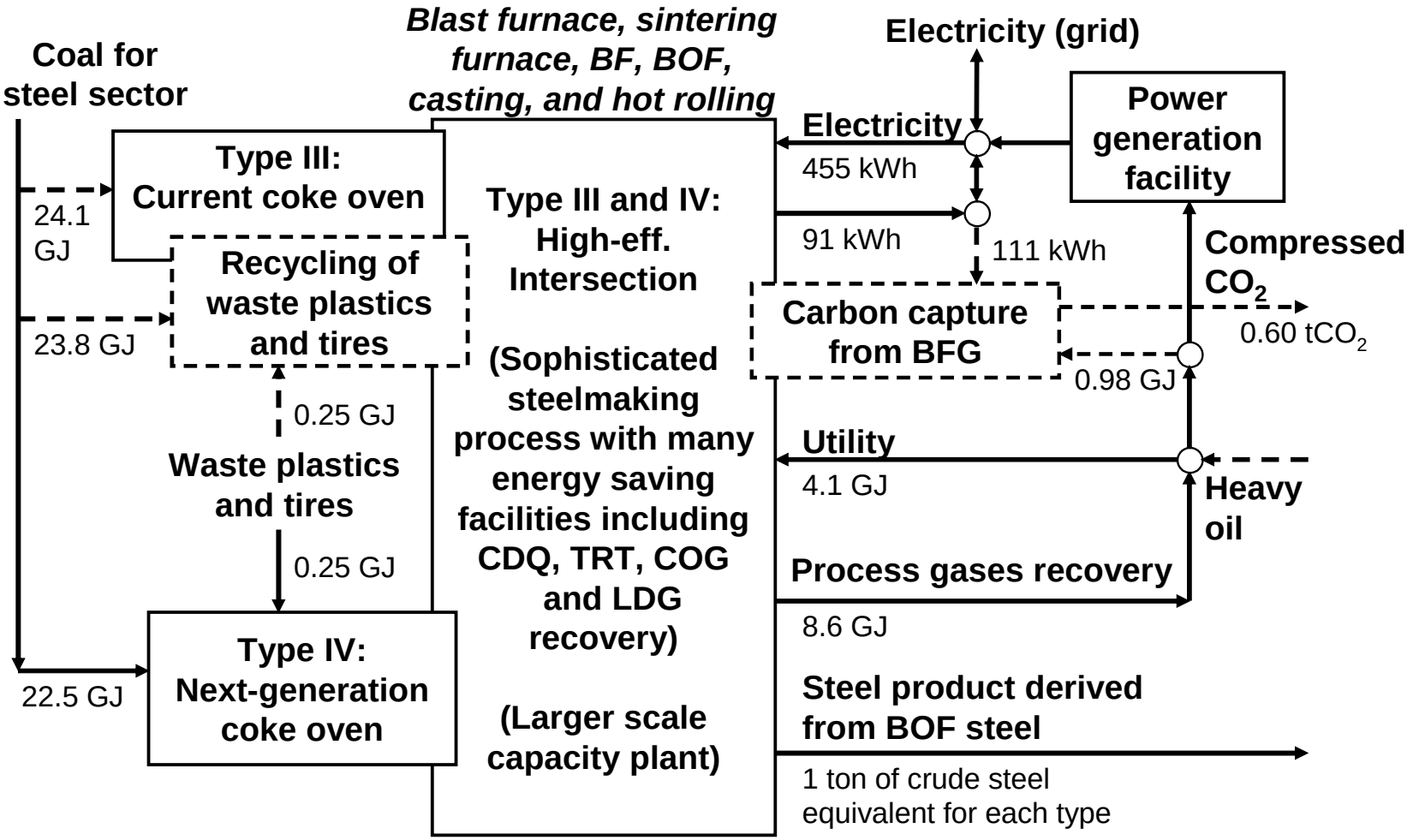


Technology Descriptions in DNE21+ (1/2)



Technology Descriptions in DNE21+ (2/2)

–An Example for High Energy Efficiency Process in Iron & Steel Sector–



BF: blast furnace, BOF: basic oxygen furnace, CDQ: Coke dry quenching, TRT: top-pressure recovery turbine, COG: coke oven gas, LDG: oxygen furnace gas