Workshop on mitigation potentials, comparability of efforts and sectoral approaches

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The Sectoral Approach to Analyze Global Mitigation Potentials

Miyuki Nagashima

Systems Analysis Group
Research Institute of Innovative Technology for the Earth (RITE)

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- Case studies considering differentiated responsibilities and capabilities for developed countries, major developing countries and other developing countries
- Conclusion
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Assessment Framework: DNE21+ Model

- Linear programming model (minimizing world energy system cost)
- Evaluation time period: 2000-2050

  Representative time points: 2000, 2005, 2010, 2015, 2020, 2025, 2030, 2040, 2050
- World divided into 54 regions

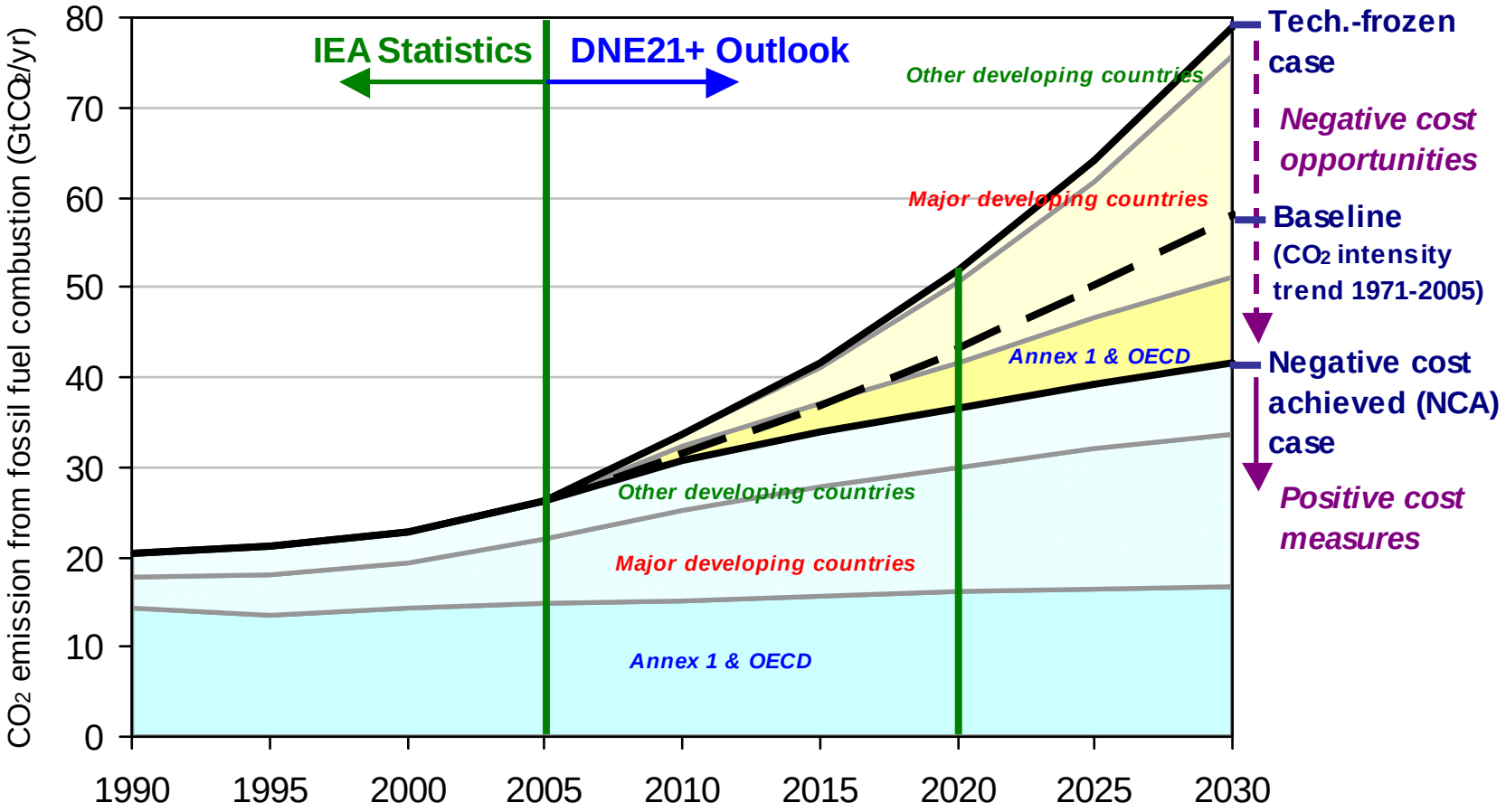
  Large area countries are further divided into 3-8 regions, and the world is divided into 77 regions.
- Bottom-up modeling for technologies both in energy supply and demand sides (Technology improvements and innovative technologies are also considered.)
- Primary energy: coal, oil, natural gas, hydro&geothermal, 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 CO2
- Existing facility vintages are explicitly modeled.

-The model has high resolutions in regions and technologies to analyze sectoral approach.
- Consistent analysis among regions and sectors can be conducted.

Scenario Definition

Case	Definition
Negative-Cost-Achieved (NCA) Case	● Emissions Scenario where **all the emission reduction measures below 0 $/tCO2** are achieved.
Technology-frozen Case	● **CO_2 intensity** (CO_2 per GDP): Fixed at the level of 2005 ● Regional GDP growth rate: Set based on the prospects by World Bank ● Industrial structure: Constant after 2005 ● This case is a hypothetical scenario to understand emission reduction potential from current technology level.

CO_2 Emissions in Baseline and Tech.-frozen Case

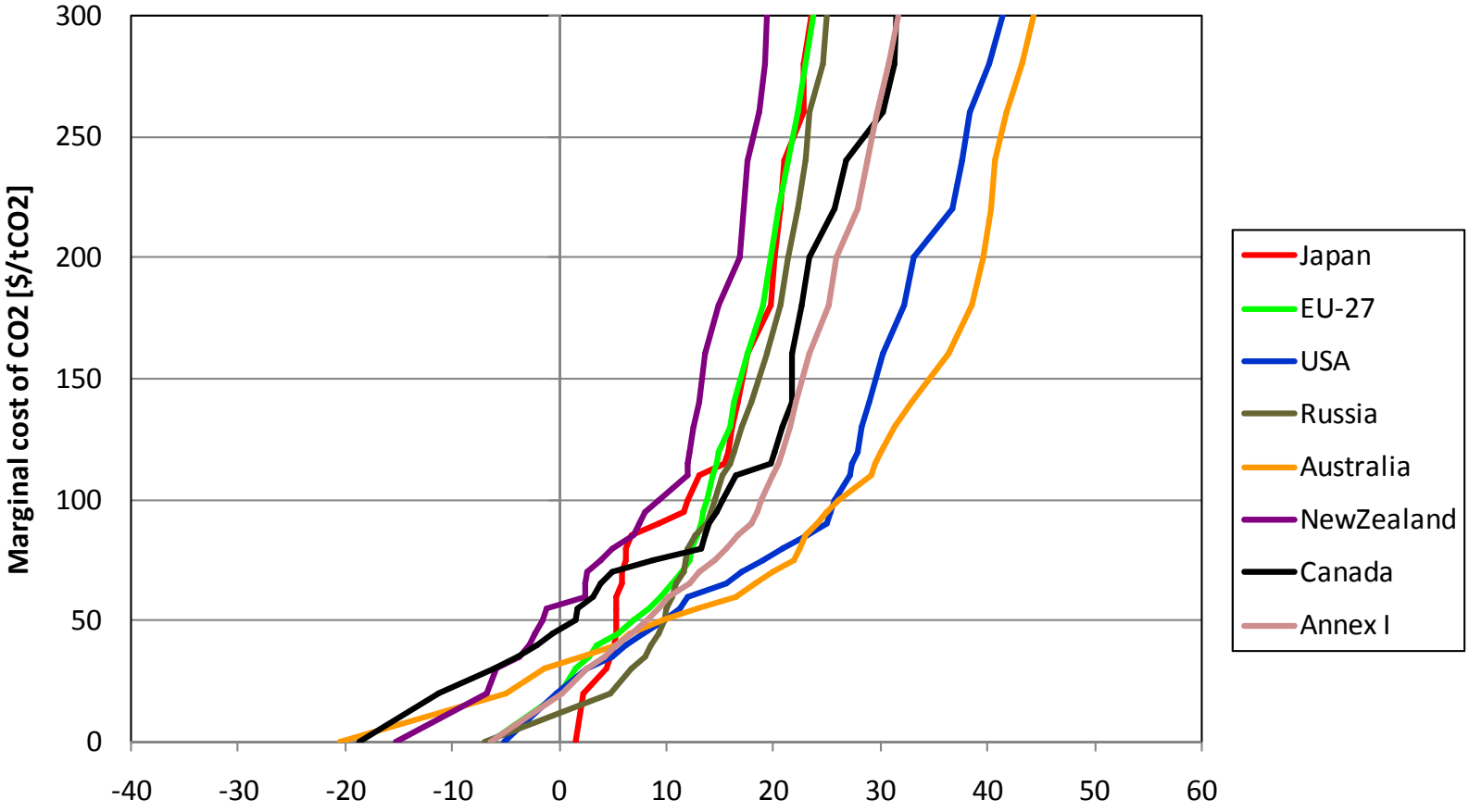


Major developing countries (MEM): Brazil, China, India, Indonesia and South Africa

- The global CO2 emission in 2020 would almost double from the current level if intensity levels were fixed at the current level even in the future.
- Large efforts are required even for achieving the emissions in NCA Case (There are large opportunities for emission reductions of negative costs.).
- High emission growth in Non-annex I countries is estimated for the future.

Marginal costs for Annex I countries in 2020

Only energy-related CO2 emission reduction

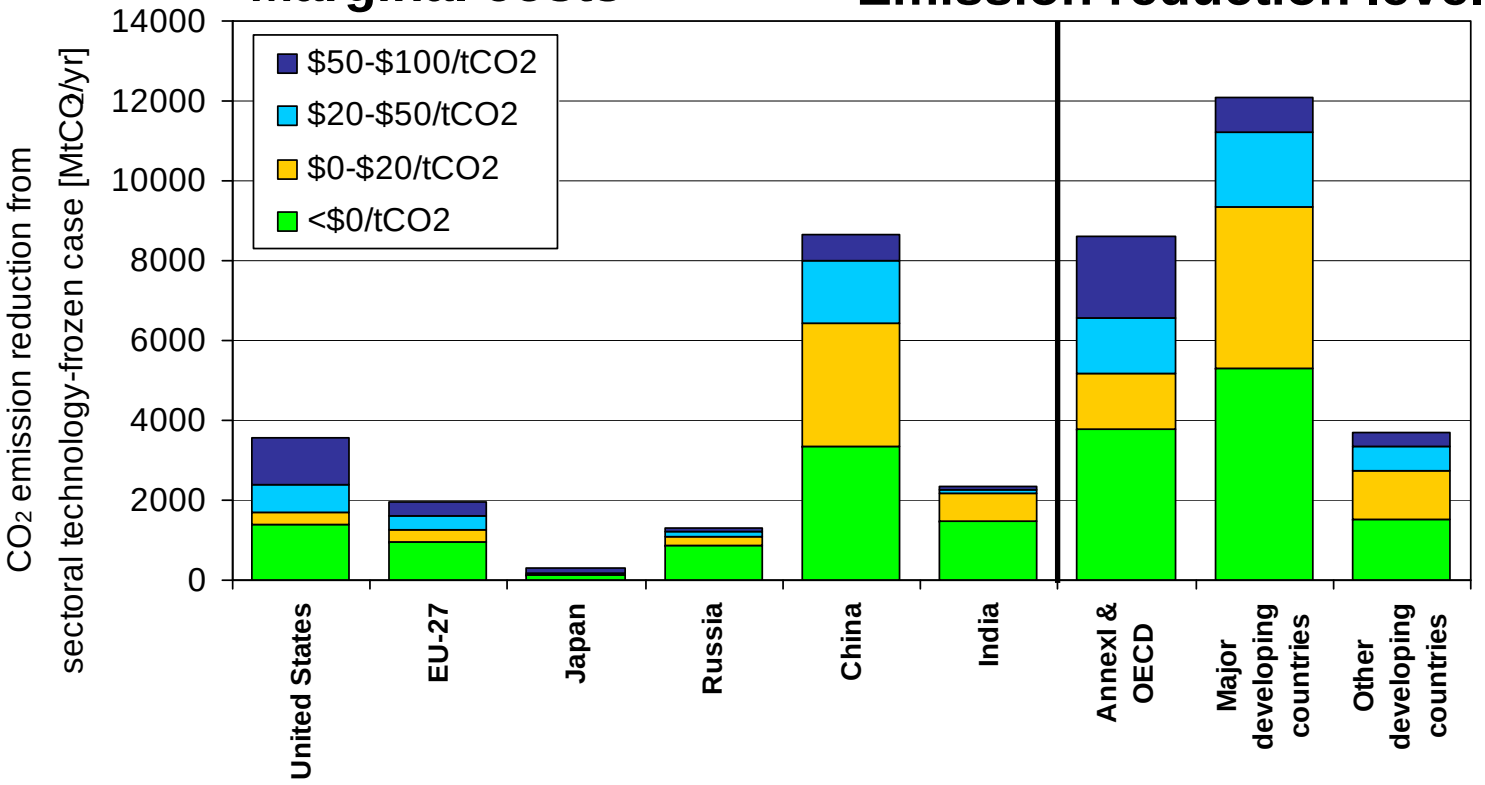


- Marginal abatement cost (MAC) curves are different in each country.
- MAC for Japan is relatively high particularly at the cost below 100 $/tCO2 due to high energy efficiencies of coal power plants and in most of the energy intensive sectors.

Regional Emission Reduction Potentials in 2020

Reduction Potentials from Sectoral Technology-frozen Case

Marginal costs ⟶ Emission reduction levels

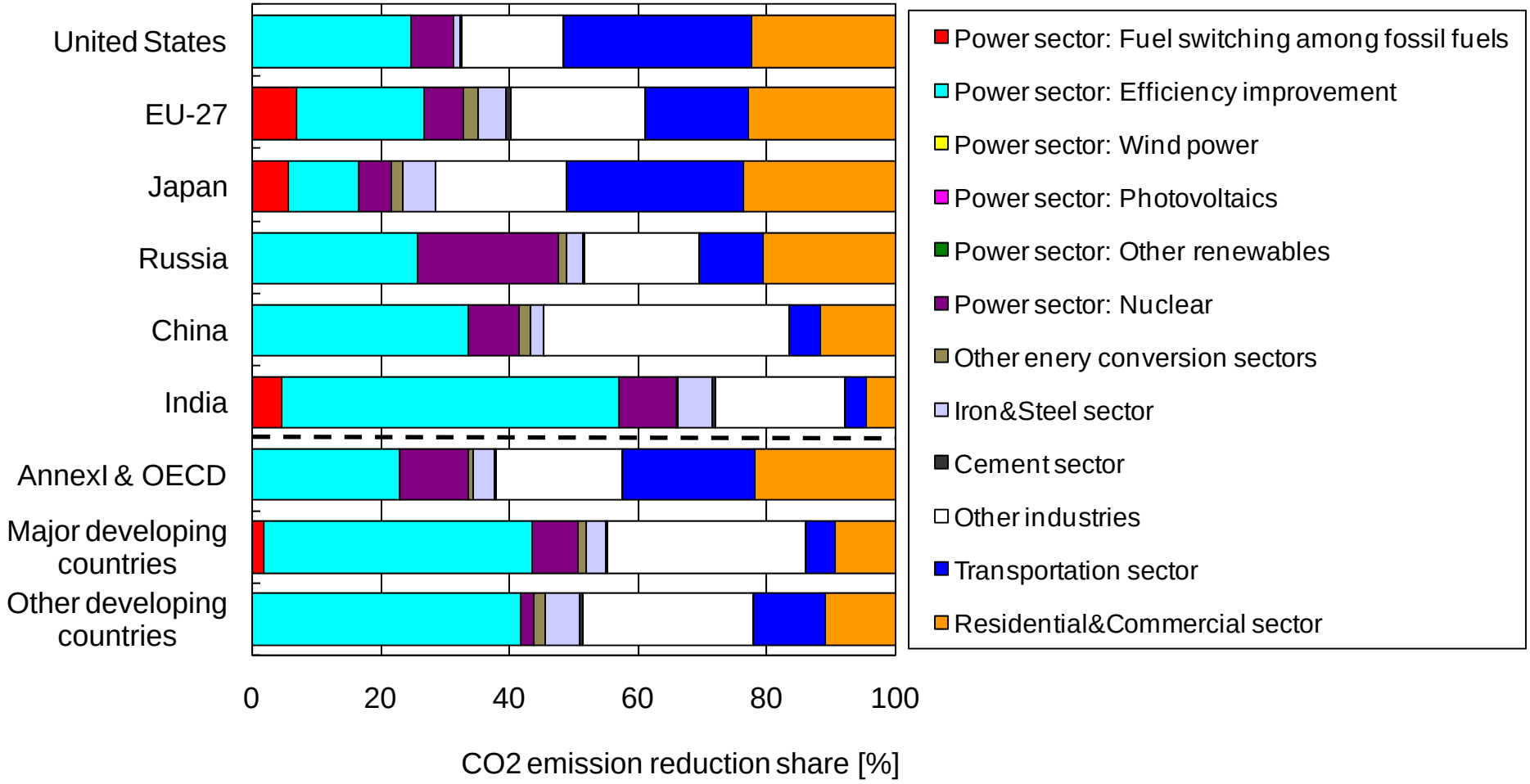


Note: emission reduction potentials of CCS excluded

- There are large potentials for emission reductions at negative costs and relatively low-costs (<20$/tCO2) in the world regions.
- Reduction potentials of United States at marginal costs of below 20$/tCO2 account for a large share (33%) of those in Annex I & OECD.
- Reduction potentials of China and India at marginal costs of below 20$/tCO2 account for a large share (92%) in those of Major developing countries.

Sectoral Emission Reduction Potentials in 2020

≤0$/tCO2 (from Sectoral Technology-frozen Case)



Note: nuclear power scenarios are exogenously assumed for all the scenarios above 0$/tCO2. Emission reduction potentials of CCS are excluded.

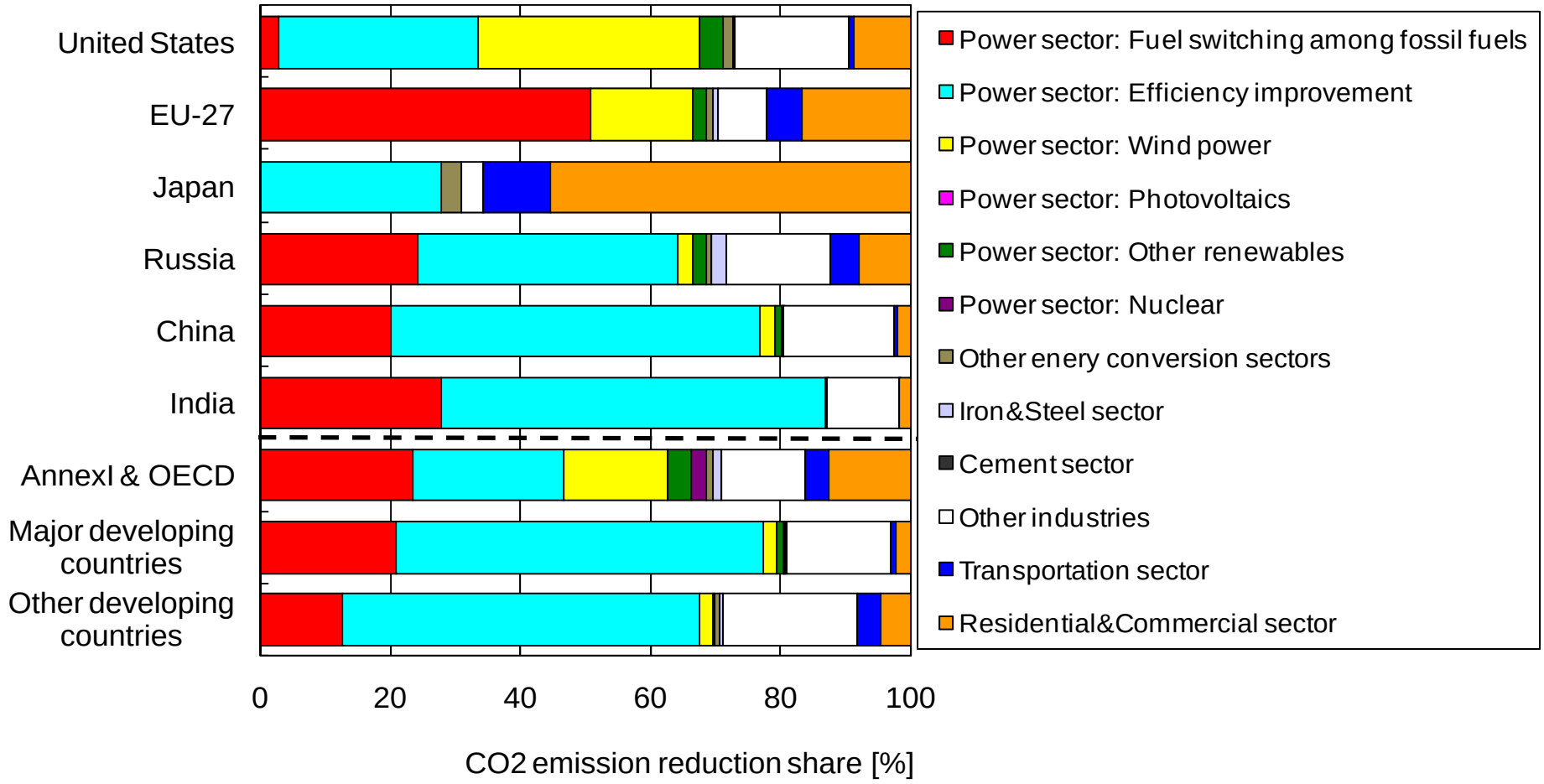
Key Emission Reduction Measures in 2020

≤0$/tCO2

- Power sector of Major developing countries:
  - Efficiency improvement of coal power plants
- Iron & Steel sector of all regions
  - Diffusion of energy saving equipment (CDQ; Coke Dry Quenching, TRT: Top pressure Recovery Turbine)
  - Diffusions of high-efficiency BF-BOF including next generation coke oven
- Transportation sector of all regions
  - Improvement of road infrastructure
  - Diffusion of ecodriving
  - Efficiency improvement of light-duty vehicle
- Residential & Commercial sector of all regions
  - Efficiency improvement of various appliances (space heating, lighting, etc)

Sectoral Emission Reduction Potentials in 2020

0–20$/tCO2

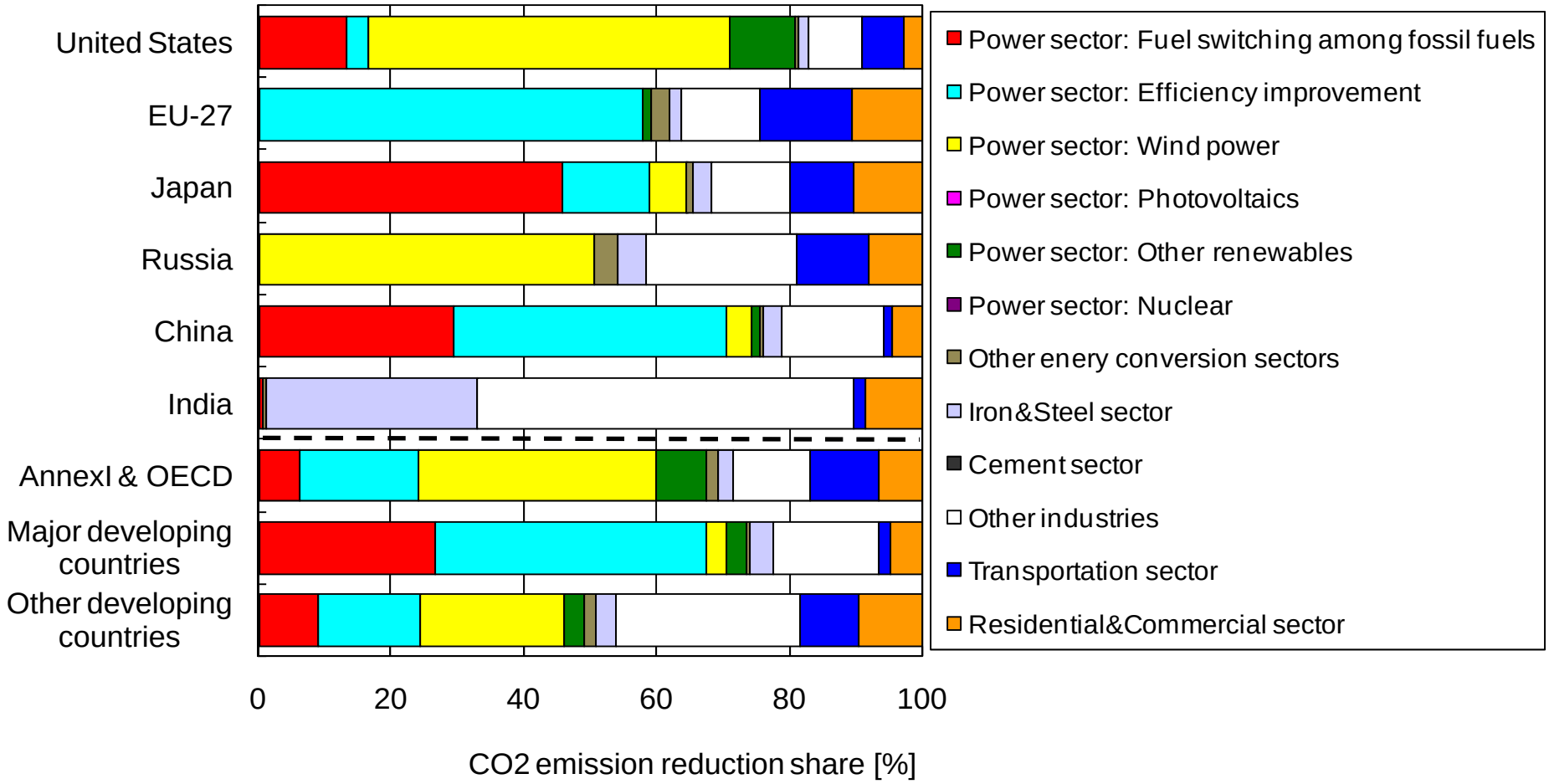


Note: nuclear power scenarios are exogenously assumed for all the scenarios above 0$/tCO2. Emission reduction potentials of CCS are excluded.

- There are large potentials of more introduction of high-efficiency gas power plants in major developing countries, and some potentials of wind power in Annex 1 & OECD.

Sectoral Emission Reduction Potentials in 2020

20–50$/tCO2



Note: nuclear power scenarios are exogenously assumed for all the scenarios above 0$/tCO2. Emission reduction potentials of CCS are excluded.

- **There are some potentials of more introduction of high-efficiency gas power plants and renewables (wind power) in power sector.**

Case Studies (for year 2020)

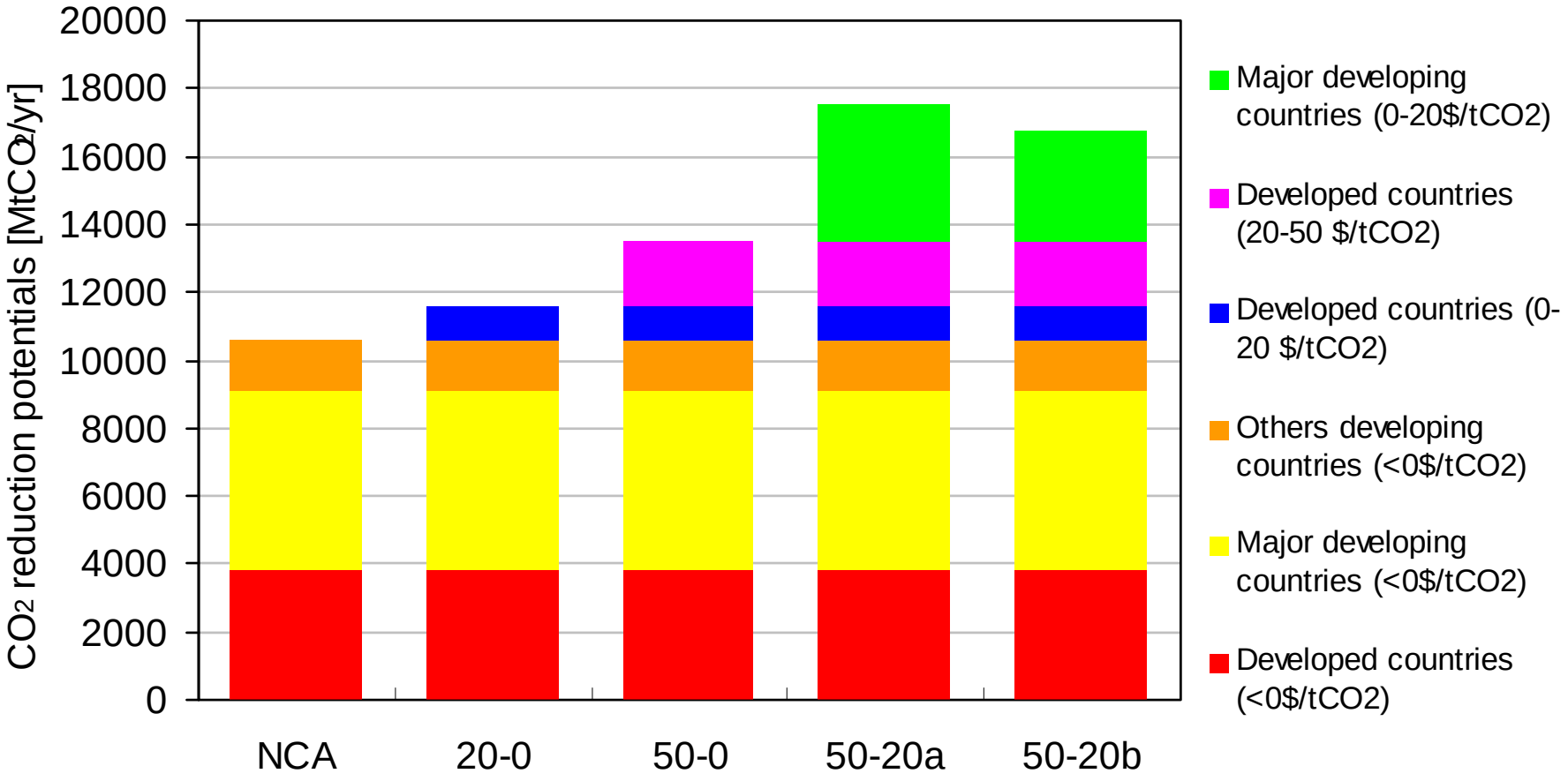
Case	Developed countries (Annex I & OECD)	Major developing countries (MEM)	Other developing countries
NCA Case	0 $/tCO2	0 $/tCO2	0 $/tCO2
20-0	20 $/tCO2	0 $/tCO2	
50-0	50 $/tCO2	0 $/tCO2	
50-20a	50 $/tCO2	**Macro CO2 intensity target** corresponding to 20 $/tCO2	
50-20b	50 $/tCO2	**CO2/energy intensity target for selected sectors** corresponding to 20 $/tCO2	

Major developing countries (MEM): Brazil, China, India, Indonesia and South Africa

Selected sectors: power, iron&steel, cement, aluminum and transportation sectors

Expected CO_2 Emission Reduction

Global Reduction Potentials from Sectoral Technology-frozen Case



- **The reduction potential at 0–20 $/tCO2 in developed countries is about 1.0 GtCO2, and that at 20–50 $/tCO2 is about 1.8 GtCO2.**
- **The reduction potential at 0–20 $/tCO2 in major developing countries is about 4.1 GtCO2.**
- **Large-scale emission reductions of 3.3 GtCO2 could be achieved even if CO2 intensity targets for major sectors are assumed in major developing countries.**

Conclusion (1/2)

- By introducing the two Cases, **Negative-Cost-Achieved Case** and **Tech.-Frozen Case**, the emission reduction potentials of negative costs were estimated besides those of positive costs.

- The global CO2 emission in 2020 would almost double from the current level if intensity levels were fixed at the current level even in the future.

- Reduction potential below 0$/tCO2 is large.
  - ✓ Global potential in 2020 is **10.6 GtCO2**, **3.8 Gt** in developed countries, **5.3 Gt** in major developing countries, and **1.5 Gt** in other developing countries.
  - ✓ Potentials are mainly in the **Power Sector**, **Transportation Sector** and **Iron & Steel Sector**.

- Countries which made **continuous energy saving efforts**, such as Japan, have relatively small reduction potentials of negative costs.

Conclusion (2/2)

- The **cooperative measures** between developed and developing countries are key to large emission reductions at low cost.
  - ✓ The emission reduction potential at the cost of 0–20 $/tCO2 in developed countries is about **1.0 GtCO2**, but that at the cost of 20–50 $/tCO2 is about **1.8 GtCO2**.
  - ✓ On the other hand, the emission reduction potential at the cost of 0–20 $/tCO2 in major developing countries is about **4.1 GtCO2**.
- Large-scale emission reductions of **3.3 GtCO2** could be achieved even if **CO2 intensity targets for major sectors** are assumed in major developing countries.
- This result is one example of the projections of emission path ways. The effort levels, e.g. marginal cost of $ 20/tCO2 etc., should be considered in further discussions.

Caveats

- Models are much simpler than real societies.
- There are large uncertainties of several assumptions, e.g., population, GDP, technology perspectives, in the model.

- The emission reduction potentials of CCS were excluded in this analysis due to large uncertainties. However, the potential will be large.

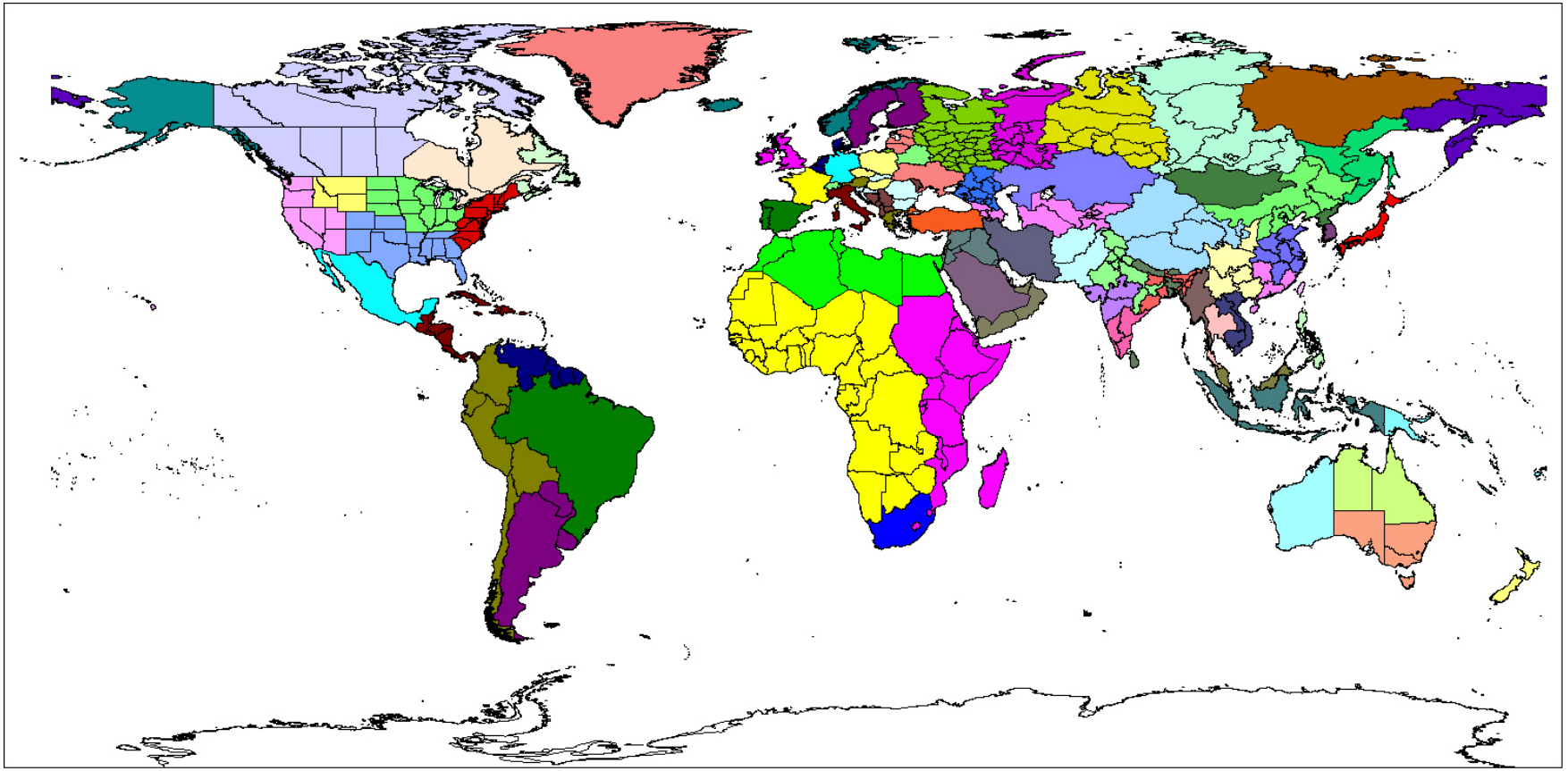
- Marginal cost of emission reductions is NOT the sole indicator of fair and reasonable emission reduction targets.

Thank you for your attention.

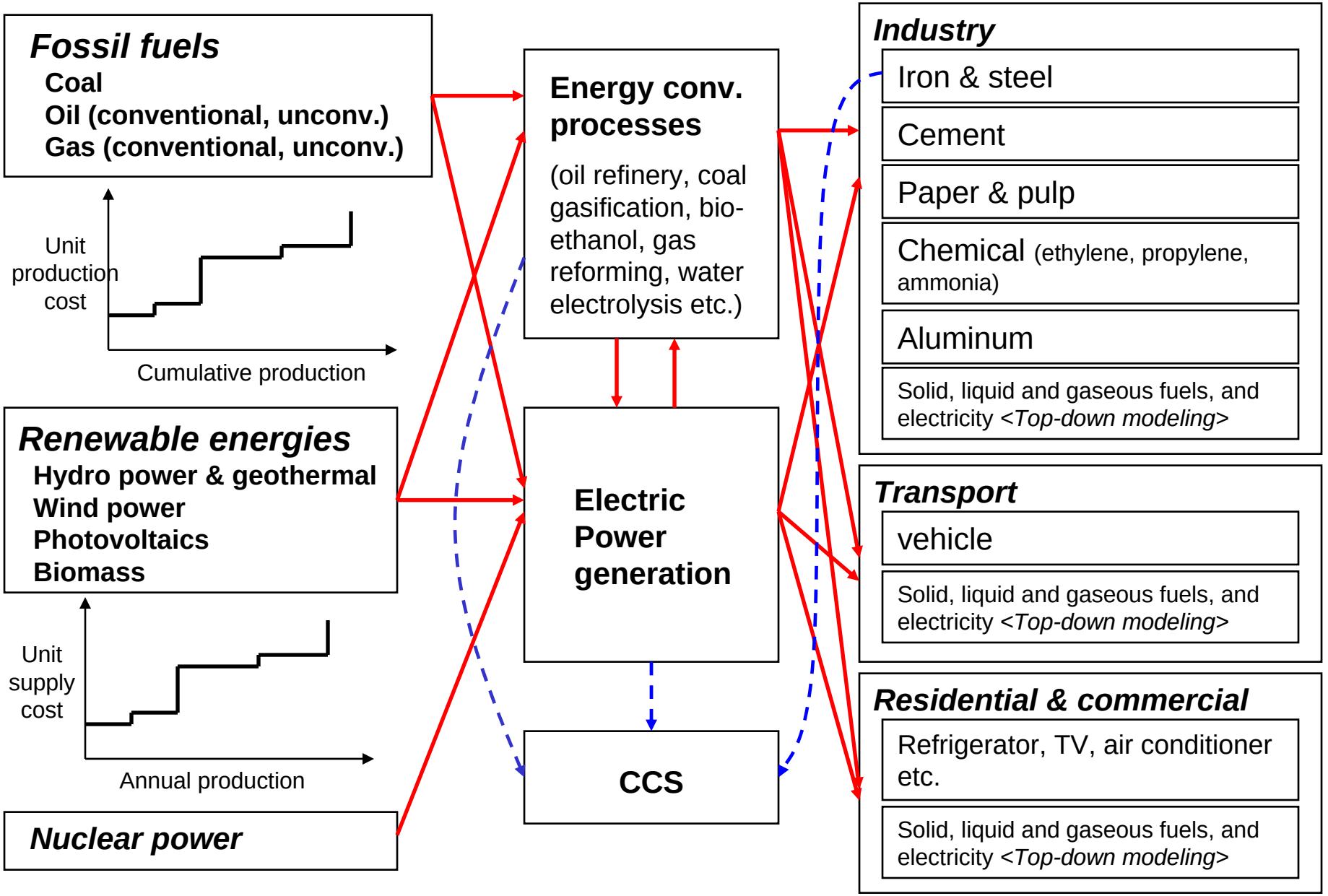
Appendix

Region Divisions of DNE21+

World divided into 54 regions

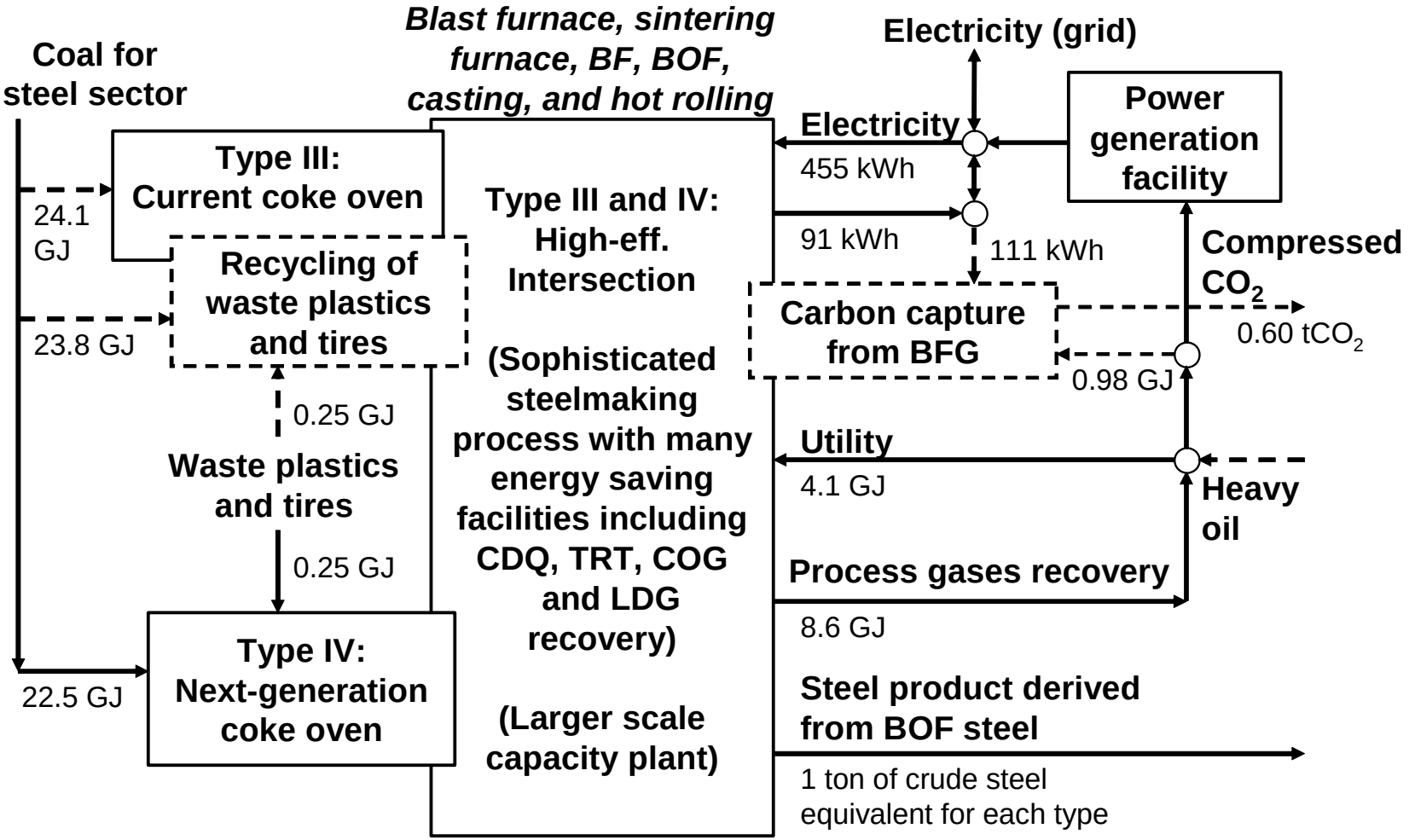


Technology Descriptions in DNE21+ (1/2)



Technology Descriptions in DNE21+ (2/2)

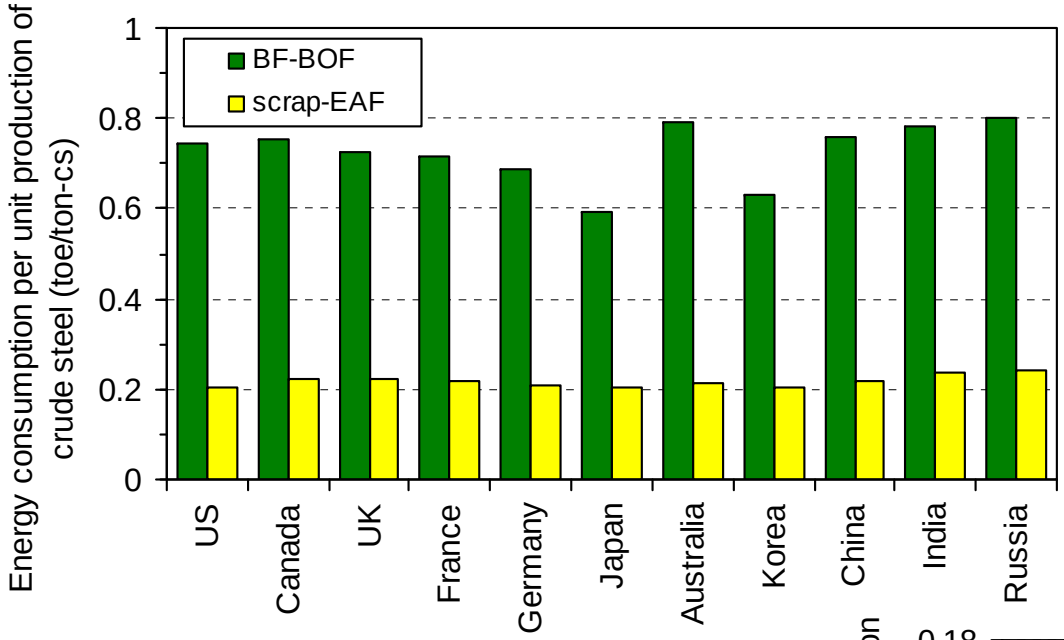
–An Example for High Energy Efficiency Process in Iron & Steel Sector–



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

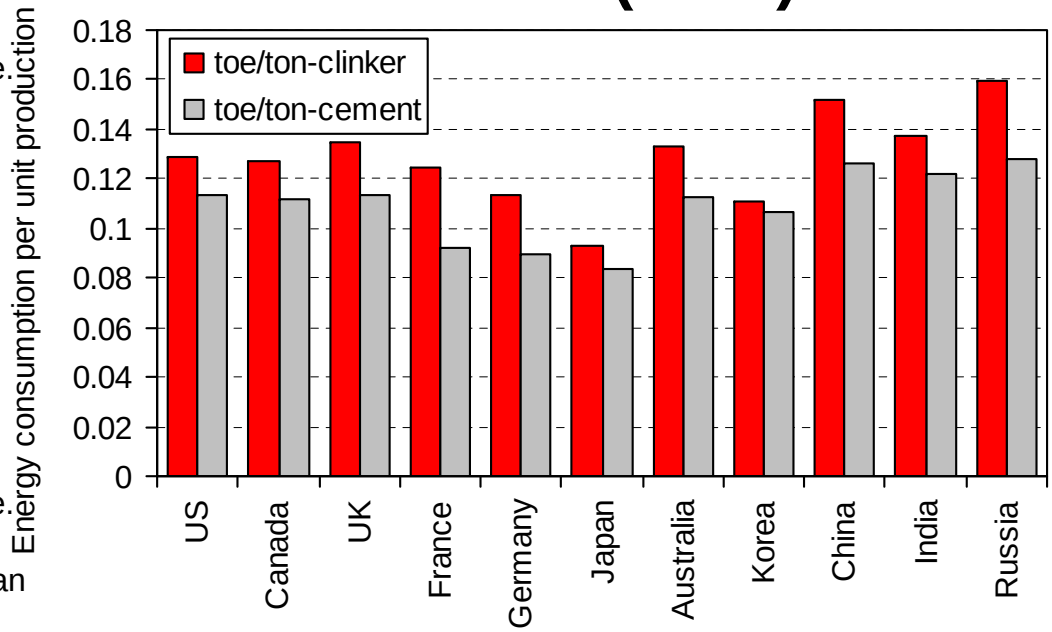
Comparisons of Energy Efficiency (1/2)

Iron & steel (2000)



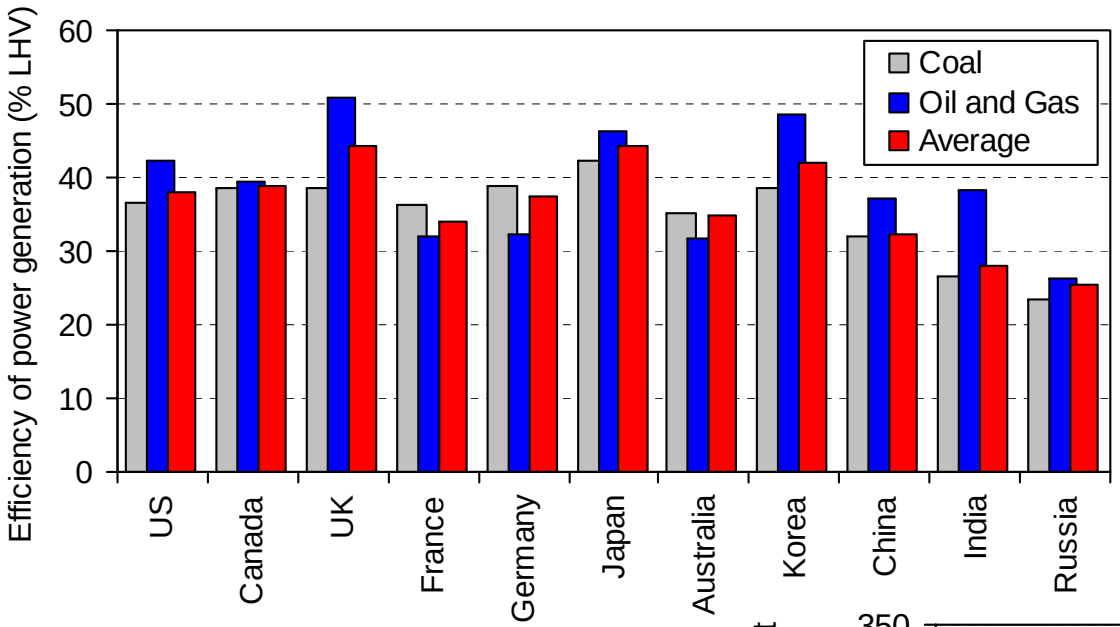
Note: Electricity is converted by using 1MWh=0.086/0.33toe.
Source: Estimates by RITE from IEA (2006), IISI (2005) etc.

Cement (2000)



Note: Electricity is converted by using 1MWh=0.086/0.33toe.
Waste biomass use is excluded in the energy efficiency.
Source: Estimates by RITE from Humphreys and Mahasenan (2002), IEA (2006) etc.

Comparisons of Energy Efficiency (2/2)

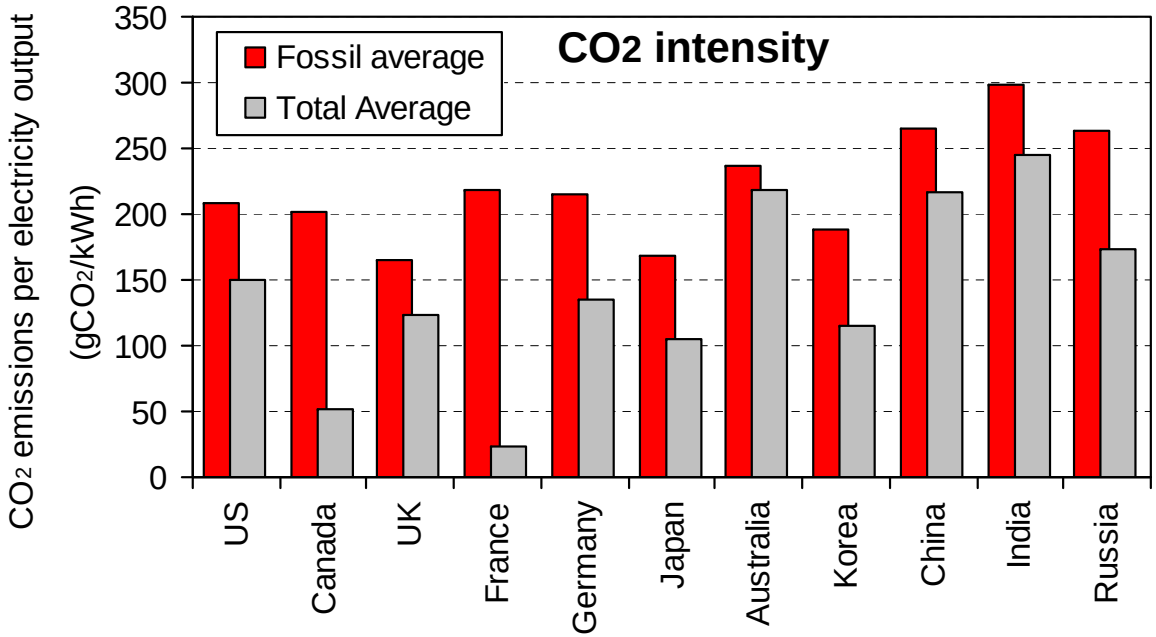


Efficiency

Power sectors (2005)

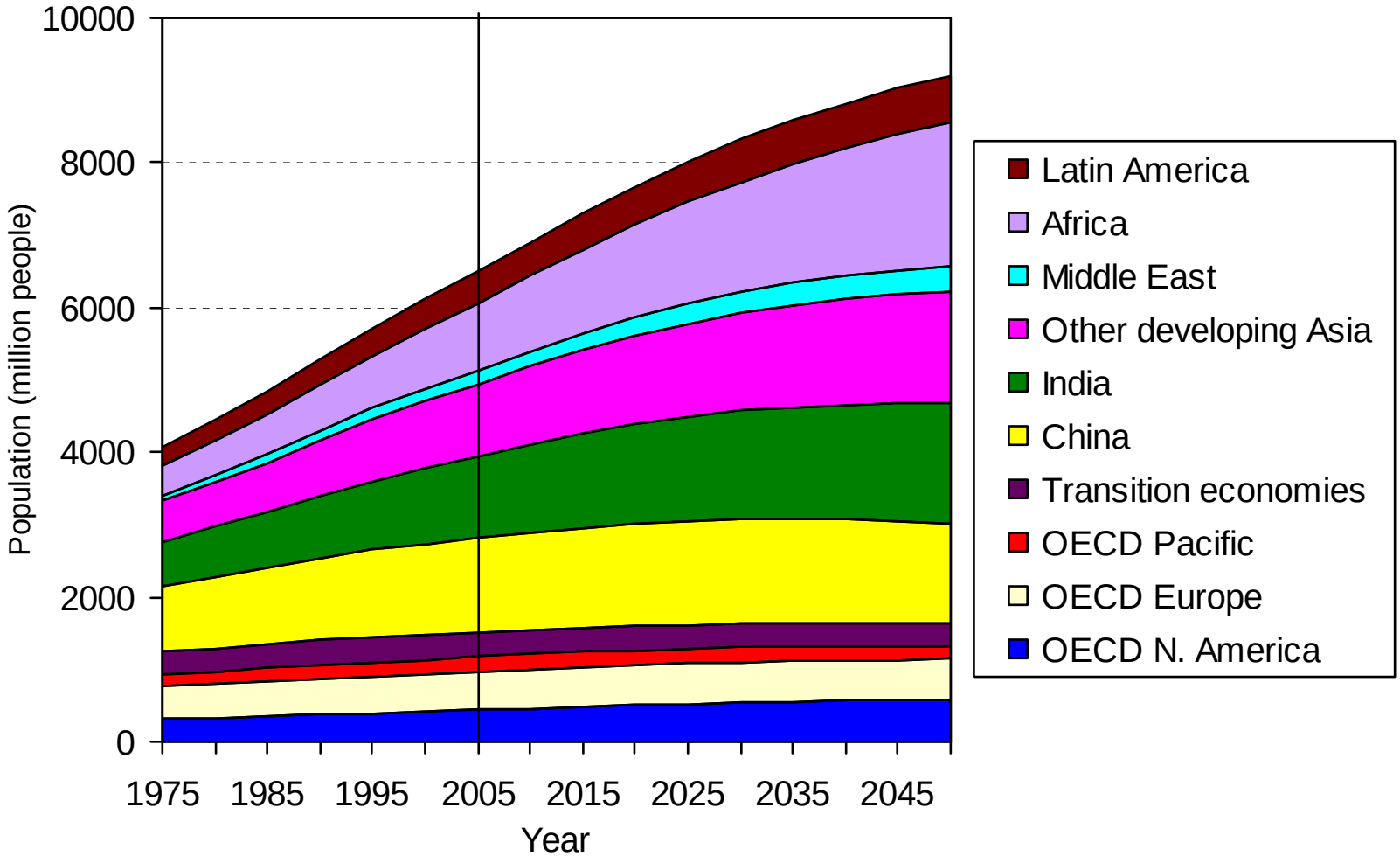
Including CHP

Source: IEA, 2007



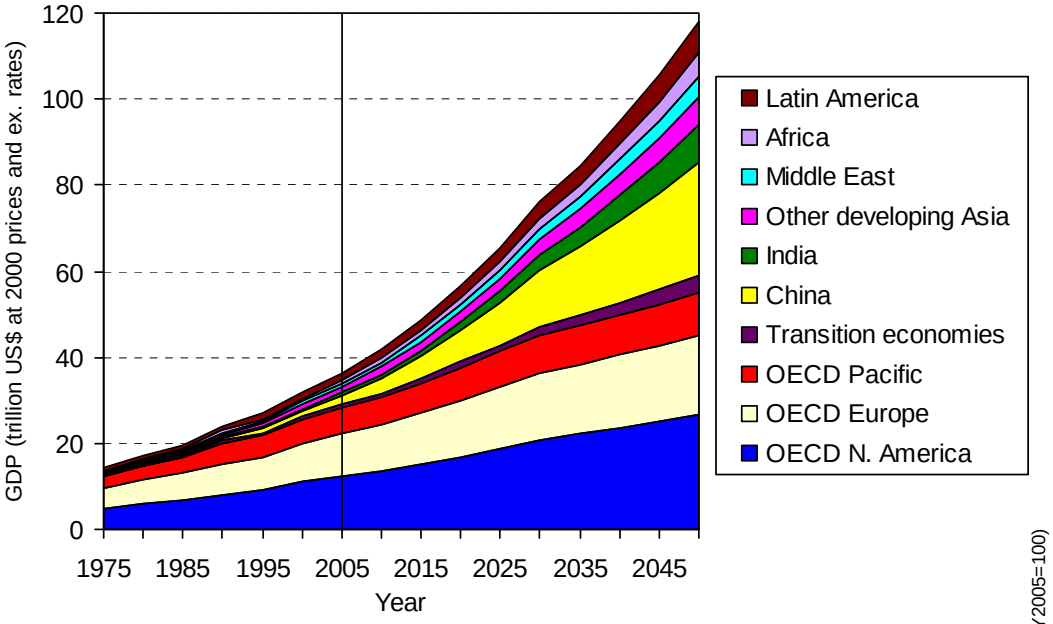
Assumptions of DNE21+ (1/3)

- **Population: UN2006 Medium Scenario**

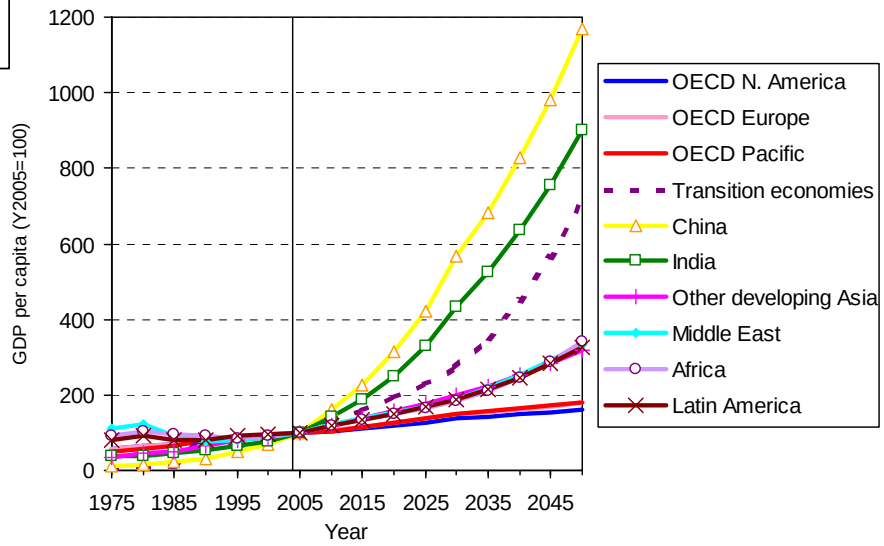


Assumptions of DNE21+ (2/3)

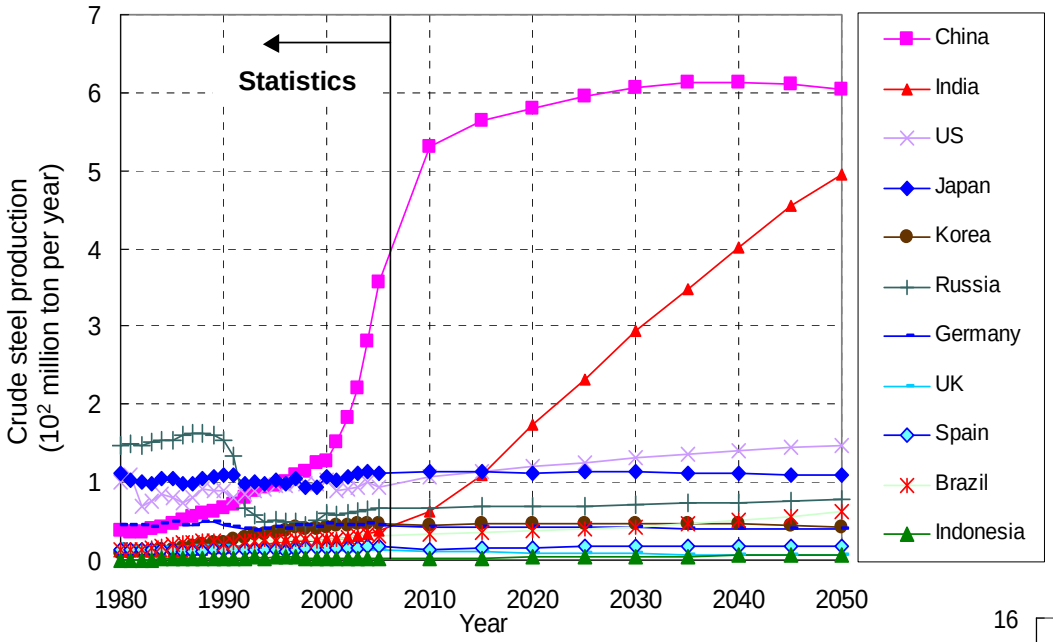
- **GDP**
  - **–Y2030: Projections by Japan Center for Economic Research (provided in December 2008)**
  - **Y2030–2050: Based on IPCC SRES B2 (2000)**



Global average 2005-20: 3.0%/yr



Assumptions of DNE21+ (3/3)



Iron & Steel (Crude steel production)

Cement (Cement production)