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Sectoral Emission Reduction Potential

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Global Emission Reduction Potentials and Scenarios in Energy Supply and End-use Sectors

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Contents

- **Overview of the assessment framework: DNE21+**
  (some model assumptions were modified from the report on May 8th, in order to harmonize the model results with the statistics in 2005.)
- **CO_2 emission outlook for "Technology-frozen Case" and "Negative-Cost-Achieved (NCA) Case"**
- **Regional emission reduction potentials in 2020**
  - **by cost**
  - **by cost and by sector**
- **Case studies considering differentiated responsibilities and capabilities for developed countries, major developing countries and other developing countries**
- **Conclusion**
- **Caveats**

Assessment Framework: DNE21+ Model

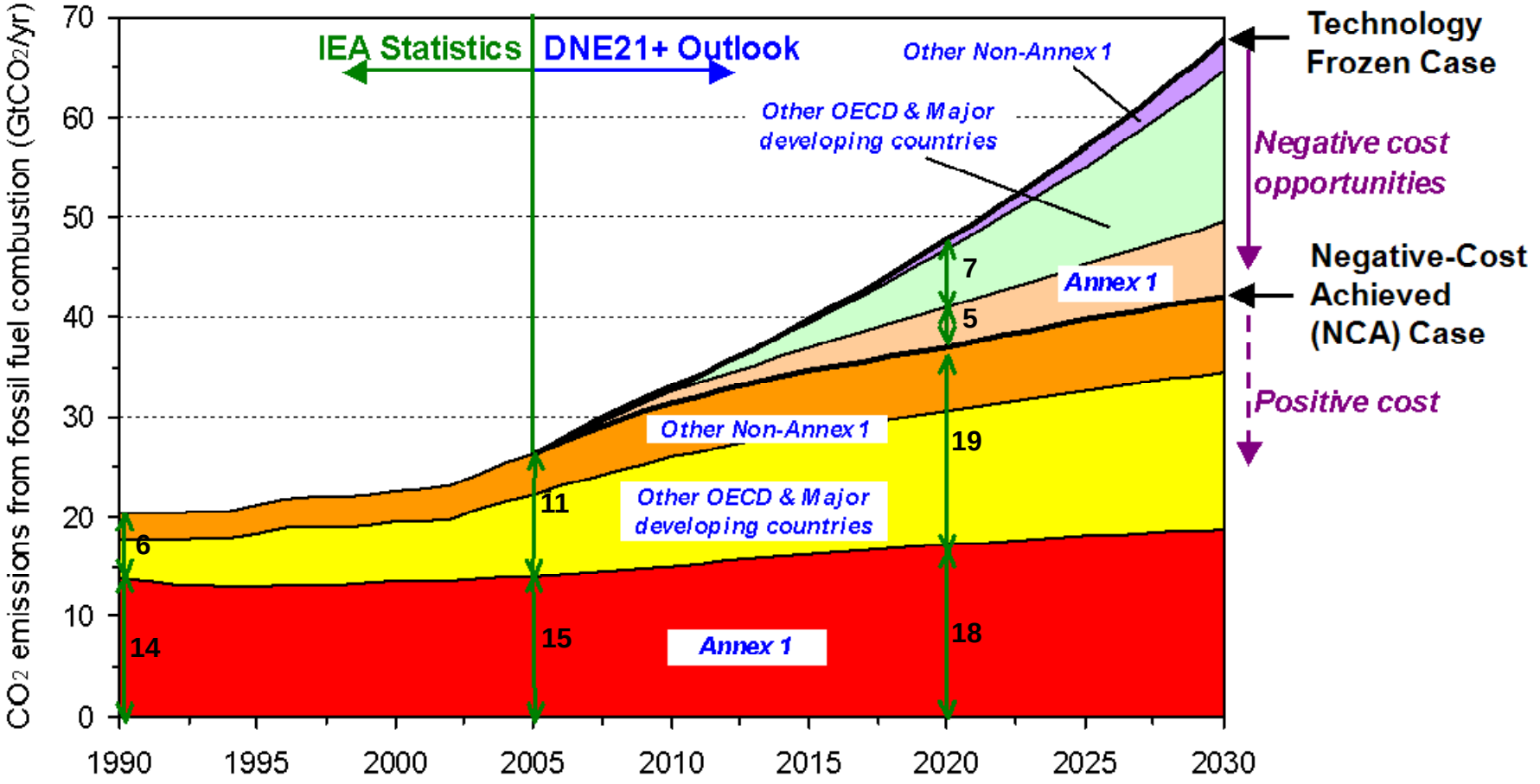
- Linear programming model (minimizing world energy system cost)
- Evaluation time period: 2000-2050
  Representative time points: 2000, 2005, 2010, 2015, 2020, 2025, 2030, 2040, 2050
- World divided into 54 regions
  Large area countries are further divided into 3-8 regions, and the world is divided 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 CO_2
- Existing facility vintages are explicitly modeled.

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

Scenario Definition

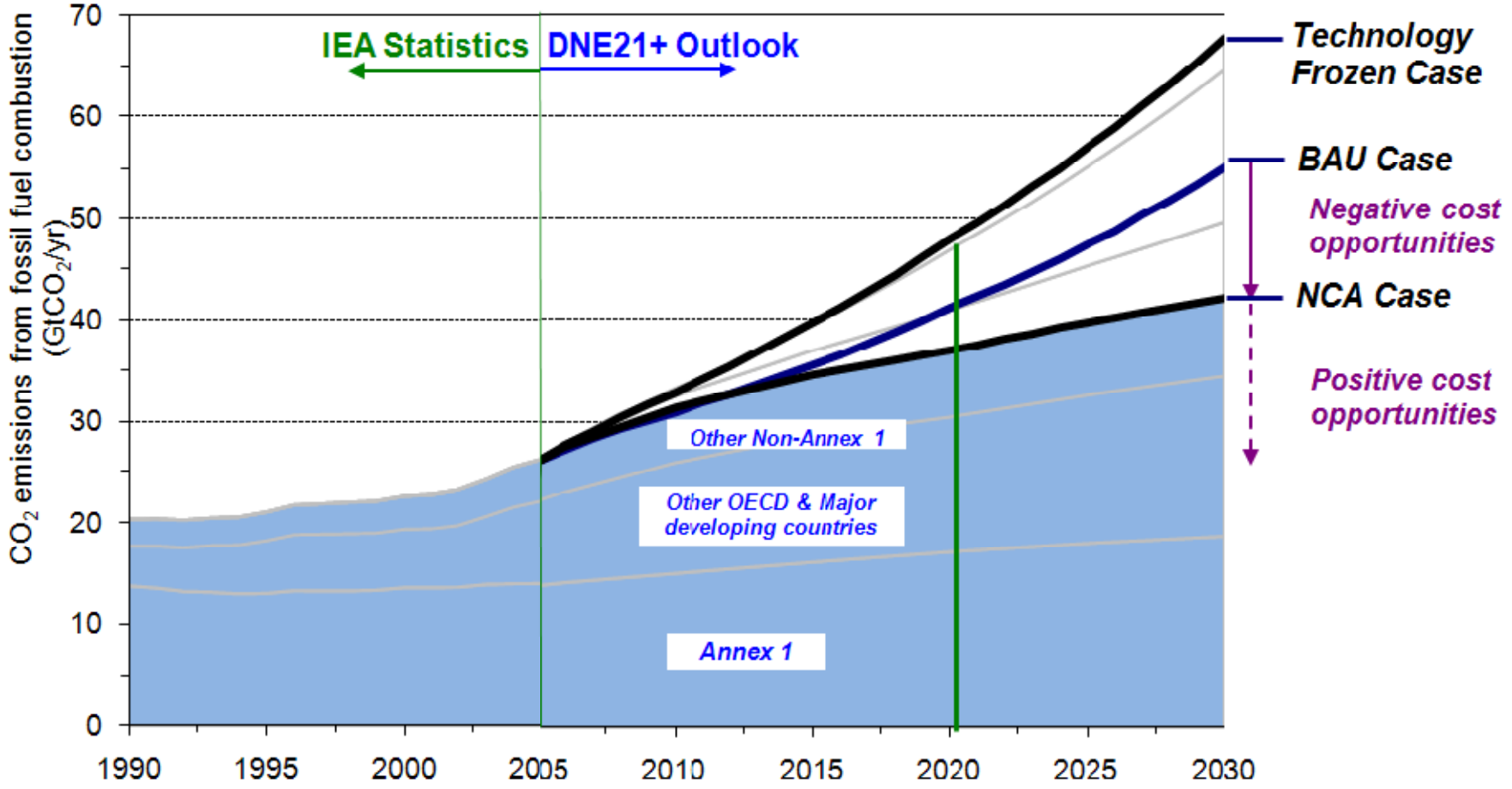
Case	Definition
Negative-Cost-Achieved (NCA) Case	• Emissions Scenario where **all the emission reduction measures below 0 $/tCO2** are achieved.
Technology-frozen Case	• **CO_2 intensity** (CO_2 per GDP): Fixed at the level of 2005 • Regional GDP growth rate: Set based on the prospects by World Bank • 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 (1/2)



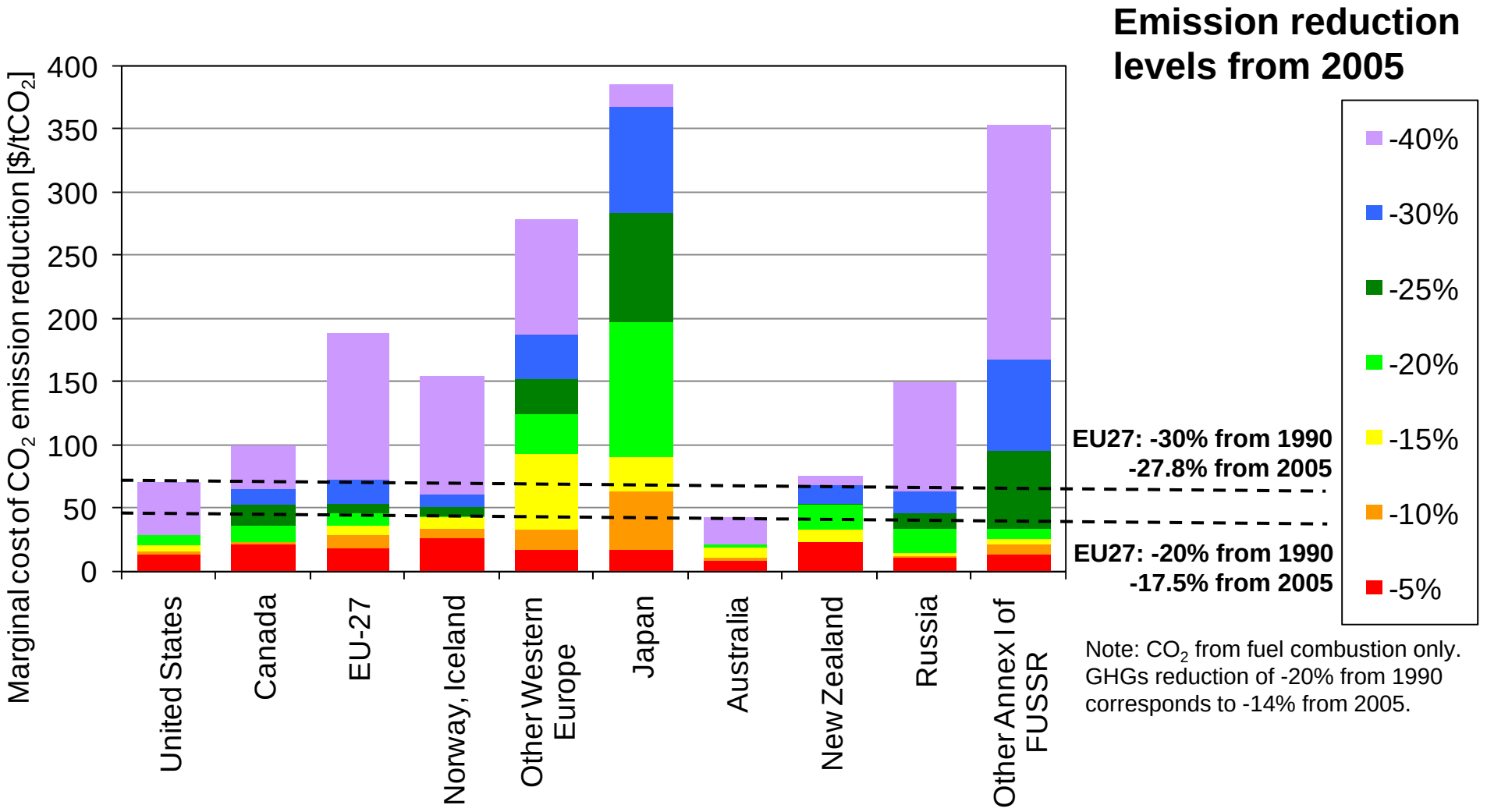
- The global CO2 emission in 2020 would increase by 86% (22.6 Gt: 8.3 Gt in developed countries; 9.0 Gt in major developing countries; 5.4 Gt in other developing countries) above the current level if intensity levels were fixed at the current level even in the future
- Large efforts are required even 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 are estimated for the future.

CO_2 Emissions in Baseline and Tech.-frozen Case (2/2)



- BAU (Business as Usual) Scenario is uncertain and would be b/w Tech.-frozen Case and NCA Case.
- Emission reduction potential from BAU depends on the definition of BAU.

Marginal costs for Annex 1 countries in 2020



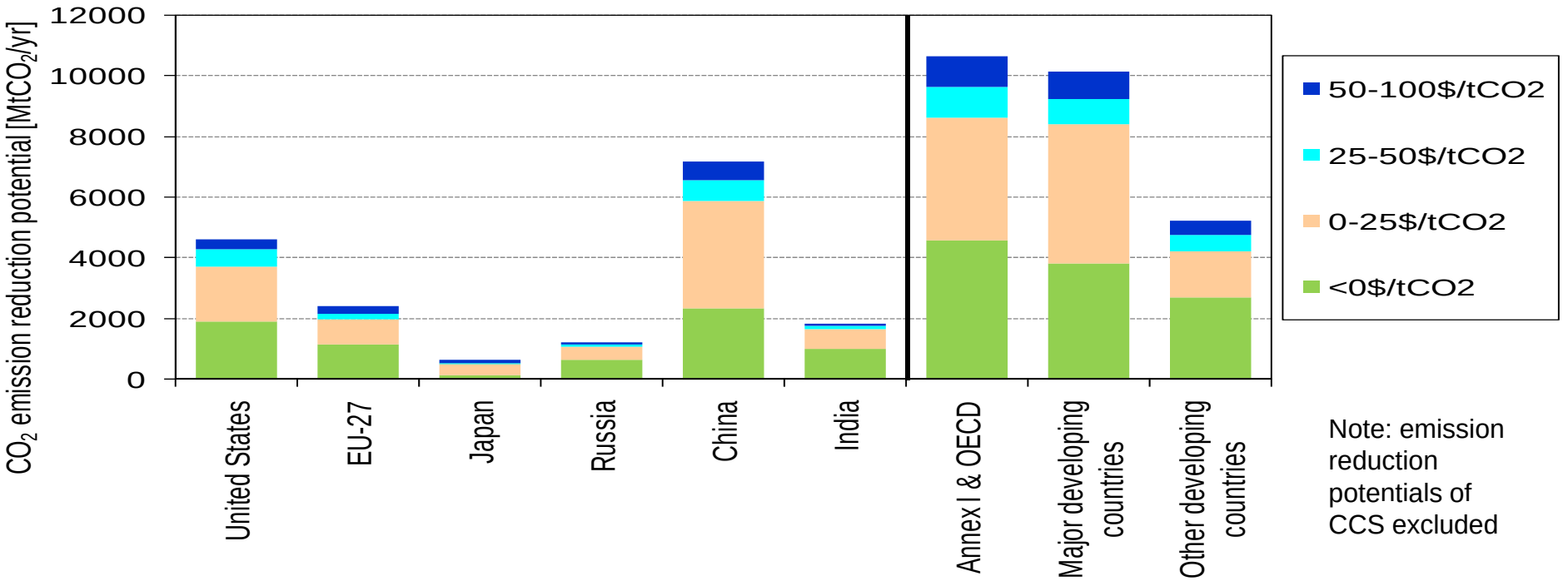
Note: CO_2 from fuel combustion only. GHGs reduction of -20% from 1990 corresponds to -14% from 2005.

- The marginal cost of CO2 emission reduction of –20% and –30% from the 1990 emission level in EU27 (–17.5% and –27.8% from the 2005 emission level) corresponds to around 50 and 75 US$/tCO2.

Regional Emission Reduction Potentials in 2020

Reduction Potentials from Sectoral Technology-frozen Case

Marginal costs ⟶ Emission reduction levels

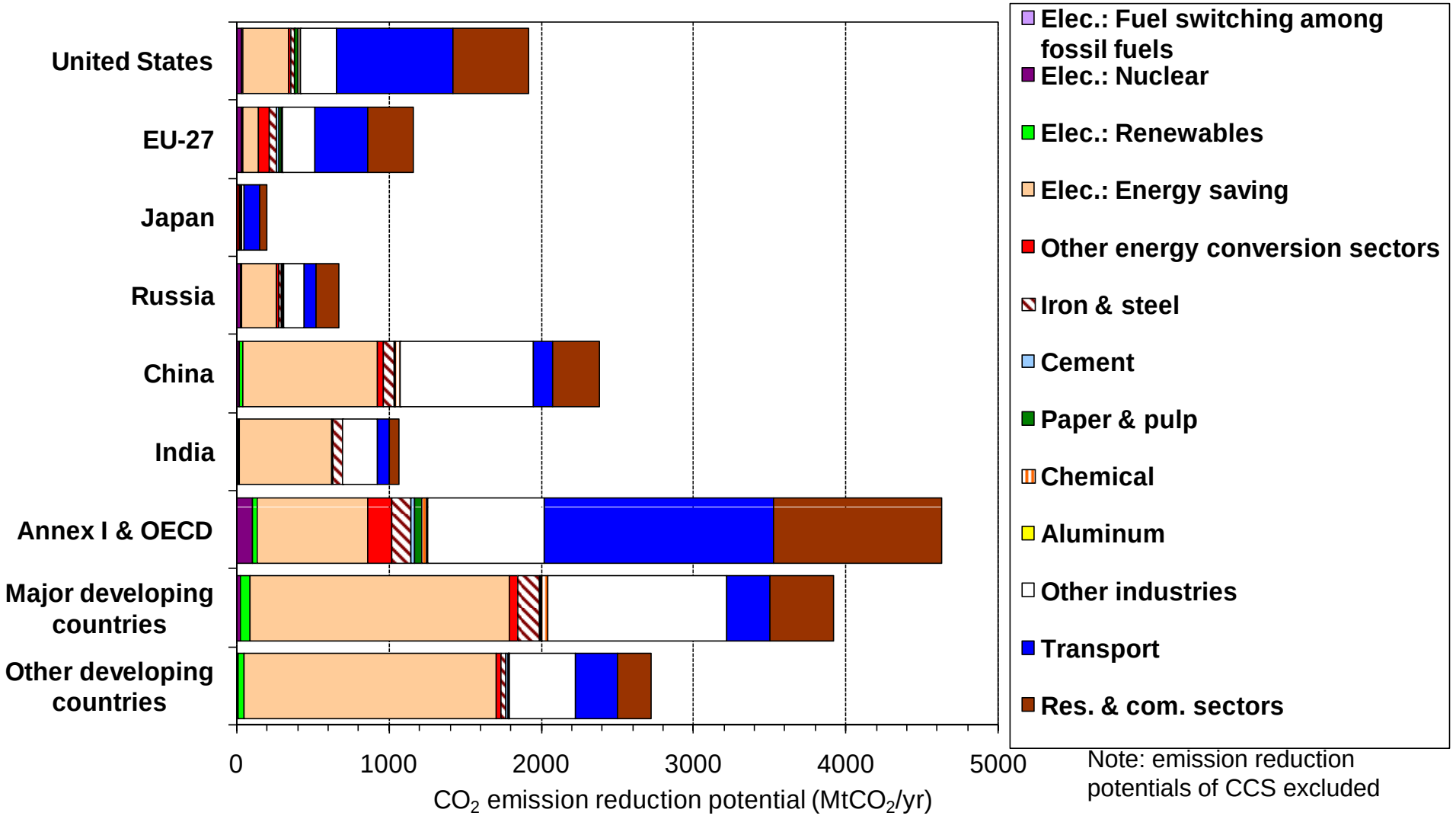


Note: emission reduction potentials of CCS excluded

- There are large potentials for emission reductions of negative costs and relatively low-costs (<25$/tCO2) in the world regions.
- Reduction potentials of United States below 25$/tCO2 have large share (43%) in those of Annex I & OECD.
- Reduction potentials of China and India below 25$/tCO2 have large share (90%) in those of Major developing countries.
- Countries which made continuous energy saving efforts, such as Japan, have relatively small reduction potentials of negative costs.

Sectoral Emission Reduction Potentials in 2020

≤0$/tCO2



Note: emission reduction potentials of CCS excluded

Key Emission Reduction Measures in 2020

≤0$/tCO2

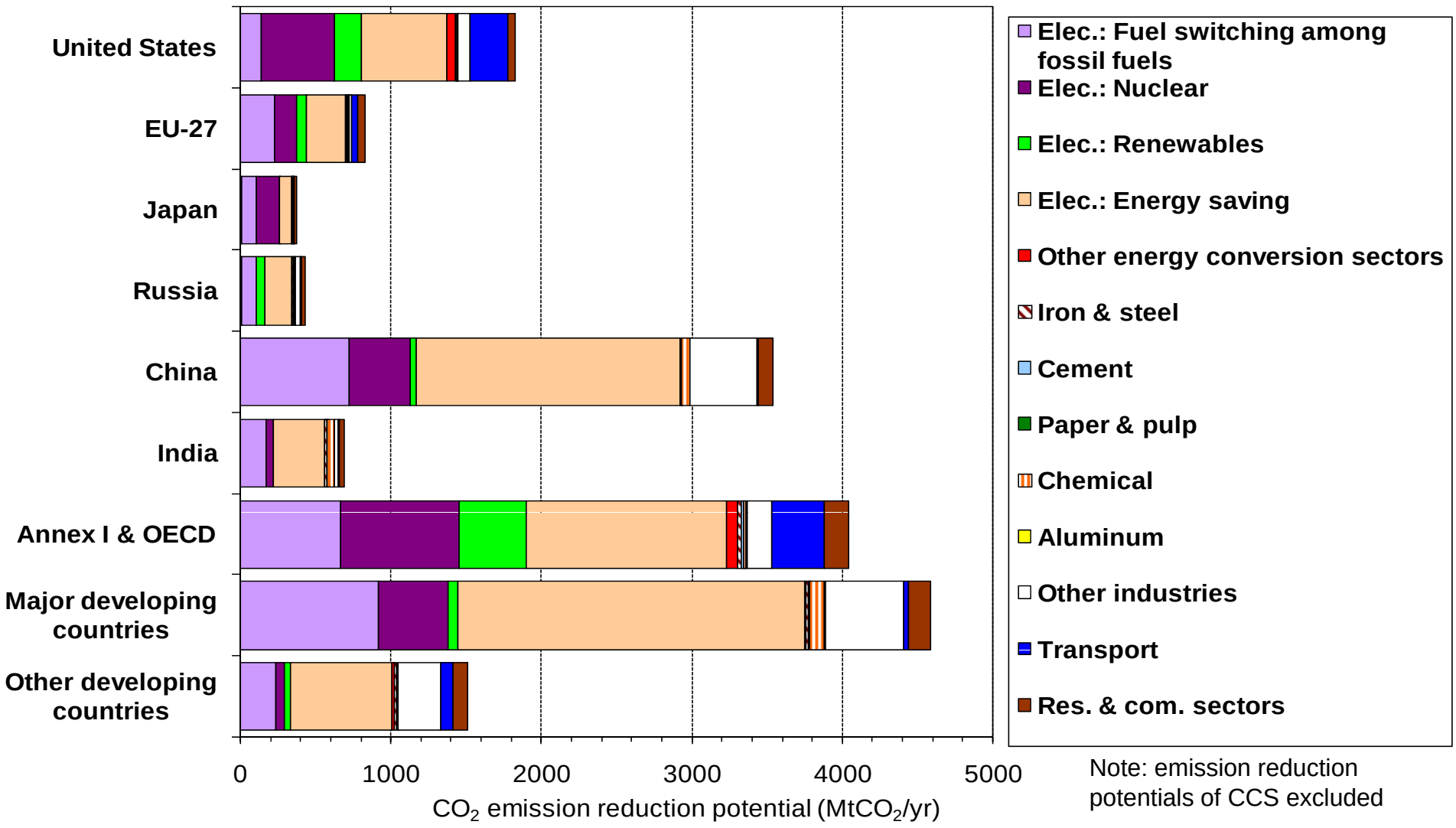
- Power sector of Major developing countries:
  - Efficiency improvement of coal power plants

- 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

- Residential & Commercial sector of all regions
  - Efficiency improvement of various appliances (space heating, lighting, etc)

Sectoral Emission Reduction Potentials in 2020

0–25$/tCO2



Note: emission reduction potentials of CCS excluded

Key Emission Reduction Measures in 2020

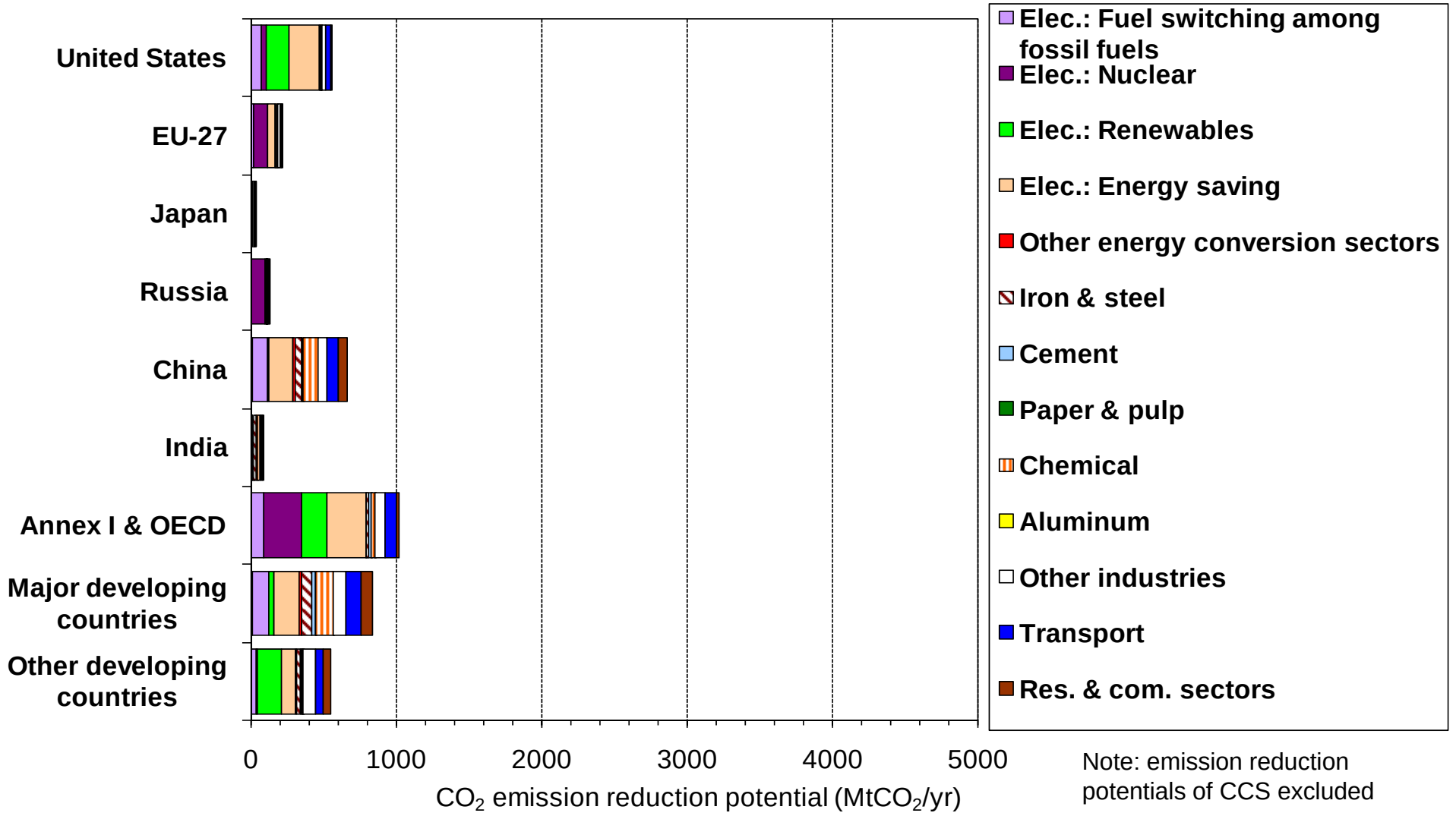
0-25$/tCO2

- Power sector of Major developing countries:
  - More introduction of high-efficiency gas power plants
    (Energy savings and fuel switching among fossil fuels)
  - Nuclear power expansion

- Power sector of Annex I & OECD
  - Nuclear power expansion
  - Diffusion of wind power generation

Sectoral Emission Reduction Potentials in 2020

25–50$/tCO2



Note: emission reduction potentials of CCS excluded

- Reduction potentials at 25-50$/tCO2 are much smaller, compared to those below 25$/tCO2
- There are some potentials of nuclear and renewables (wind power) in power sector.

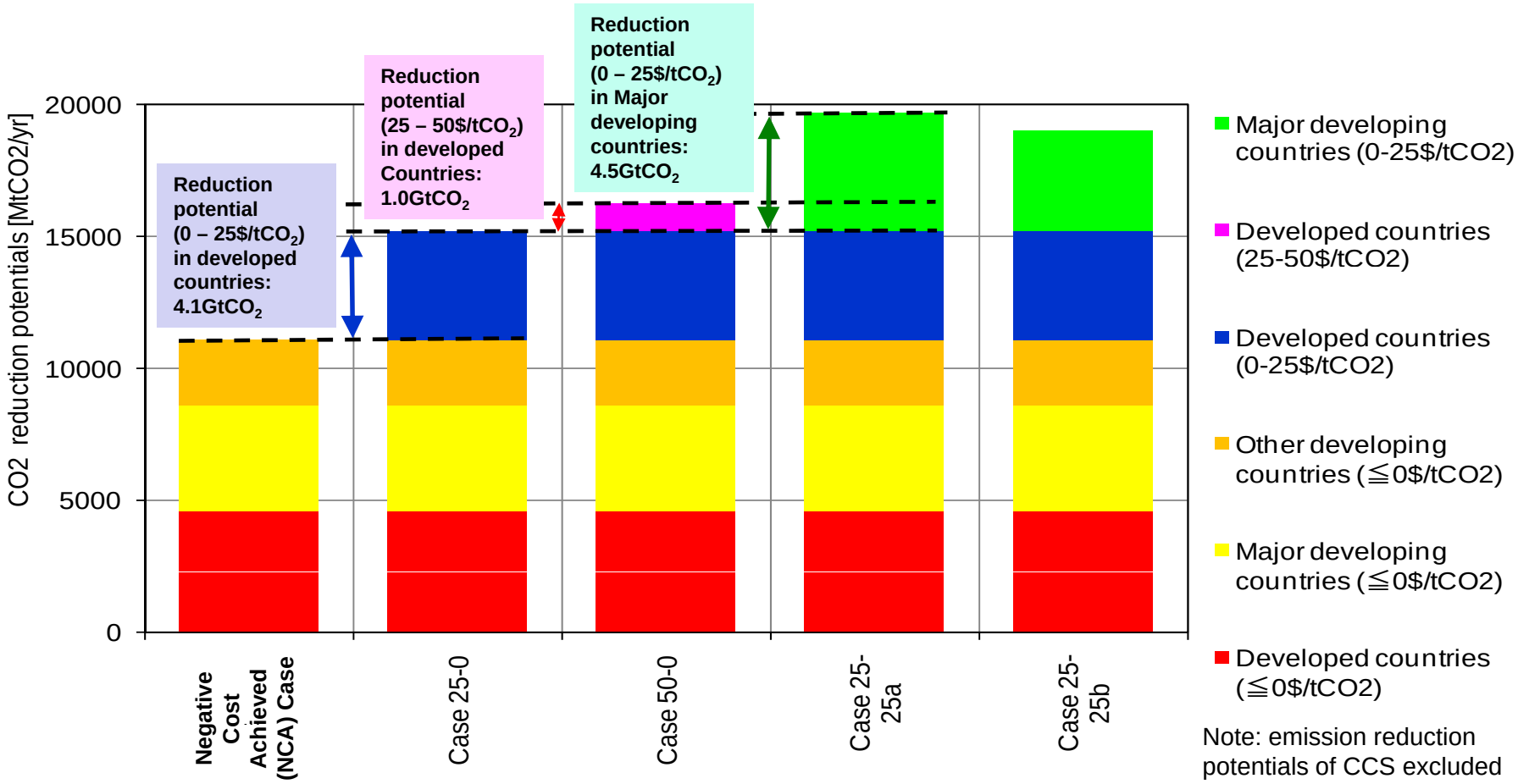
Case Studies (for year 2020)

Case	Developed countries (Annex I & OECD)	Major developing countries (MEM)	Other developing countries
NCA Case	0 $/tCO2	0 $/tCO2	0 $/tCO2
25-0	25 $/tCO2	0 $/tCO2	
50-0	50 $/tCO2	0 $/tCO2	
25-25a	25 $/tCO2	**Macro CO2 intensity target** corresponding to 25 $/tCO2	
25-25b	25 $/tCO2	**CO2/energy intensity target for selected sectors** corresponding to 25 $/tCO2	

Major developing countries (MEM): Brazil, China, India, Indonesia and South Africa
Selected sectors: power, iron&steel, cement, aluminum and transportation sectors

Expected CO2 Emission Reduction

Global Reduction Potentials from Sectoral Technology-frozen Case



Note: emission reduction potentials of CCS excluded

- The reduction potential at 0–25 $/tCO2 in developed countries is about 4.1 GtCO2, but that at 25–50 $/tCO2 is about 1.0 GtCO2.
- The reduction potential at 0–25 $/tCO2 in major developing countries is about 4.5 GtCO2.
- Large-scale emission reductions of 3.8 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 increase by **86%** (**22.6 Gt**: **8.3 Gt** in developed countries; **9.0 Gt** in major developing countries; **5.4 Gt** in other developing countries) above 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 **11.1 GtCO2**, **4.6Gt** in developed countries, **4.0Gt** in major developing countries, and **2.5Gt** 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 0–25 $/tCO2 in developed countries is about **4.1 GtCO2**, but that at the cost of 25–50 $/tCO2 is about **1.0 GtCO2**.
  - ✓ On the other hand, the emission reduction potential at the cost of 0–25 $/tCO2 in major developing countries is about **4.5 GtCO2**.
- Large-scale emission reductions of **3.8 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 $ 25/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.

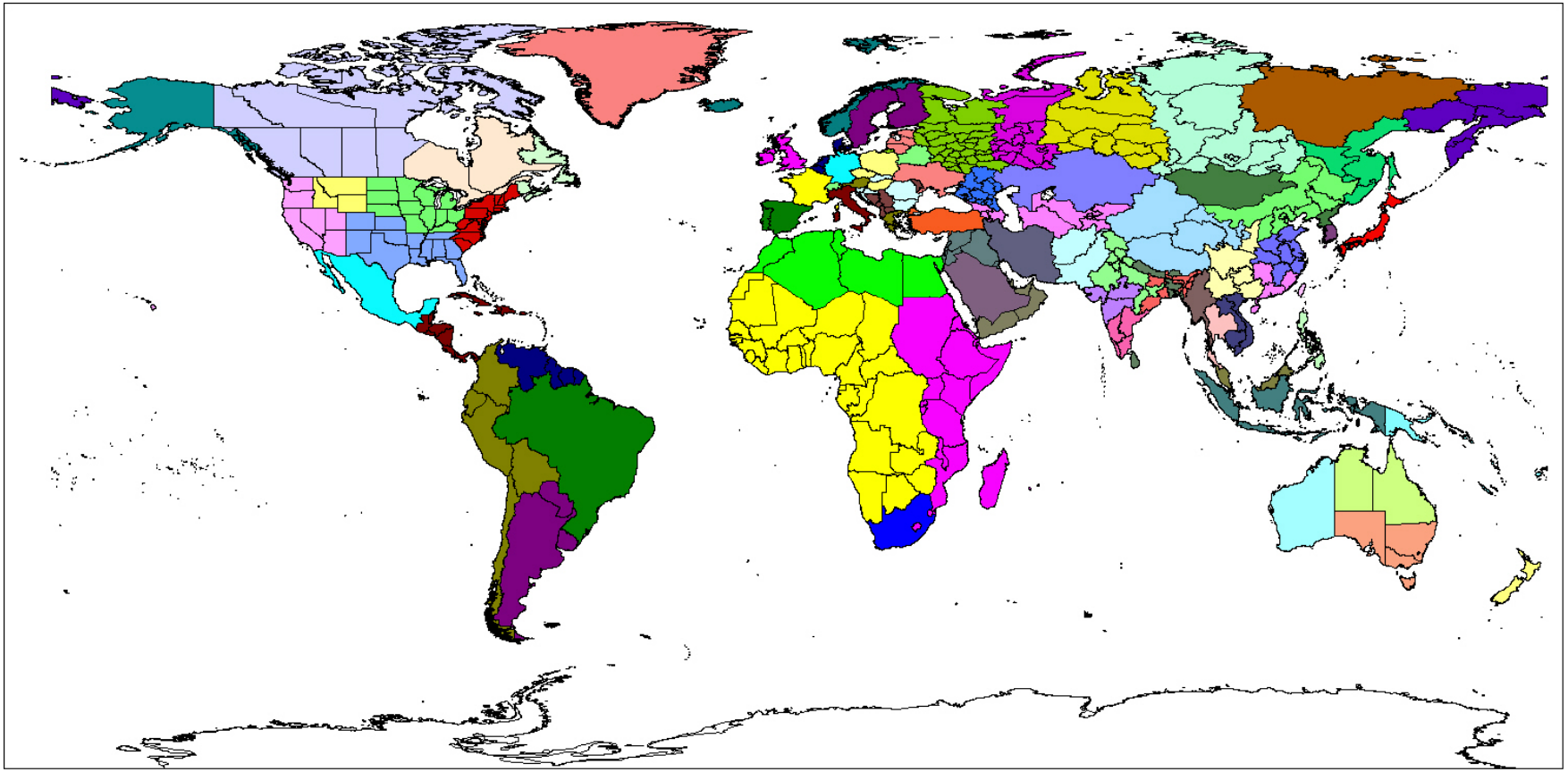
- The emission reduction potentials of CCS were excluded in this analysis due to large uncertainties. However, the potential at the cost below 50 $/tCO2 in the world is about 4.3 GtCO2 in 2020

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

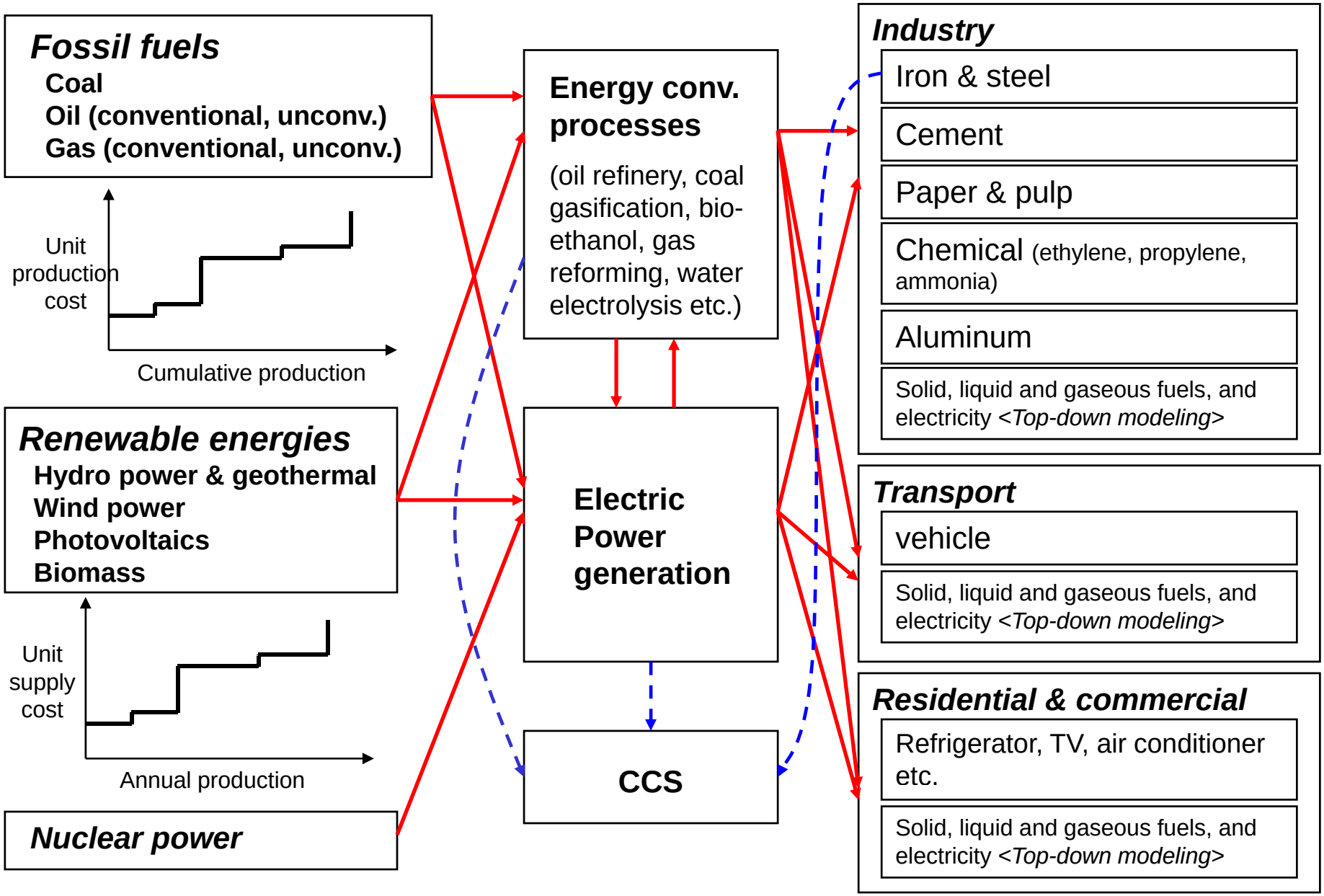
Appendix

Region Divisions of DNE21+

World divided into 54 regions

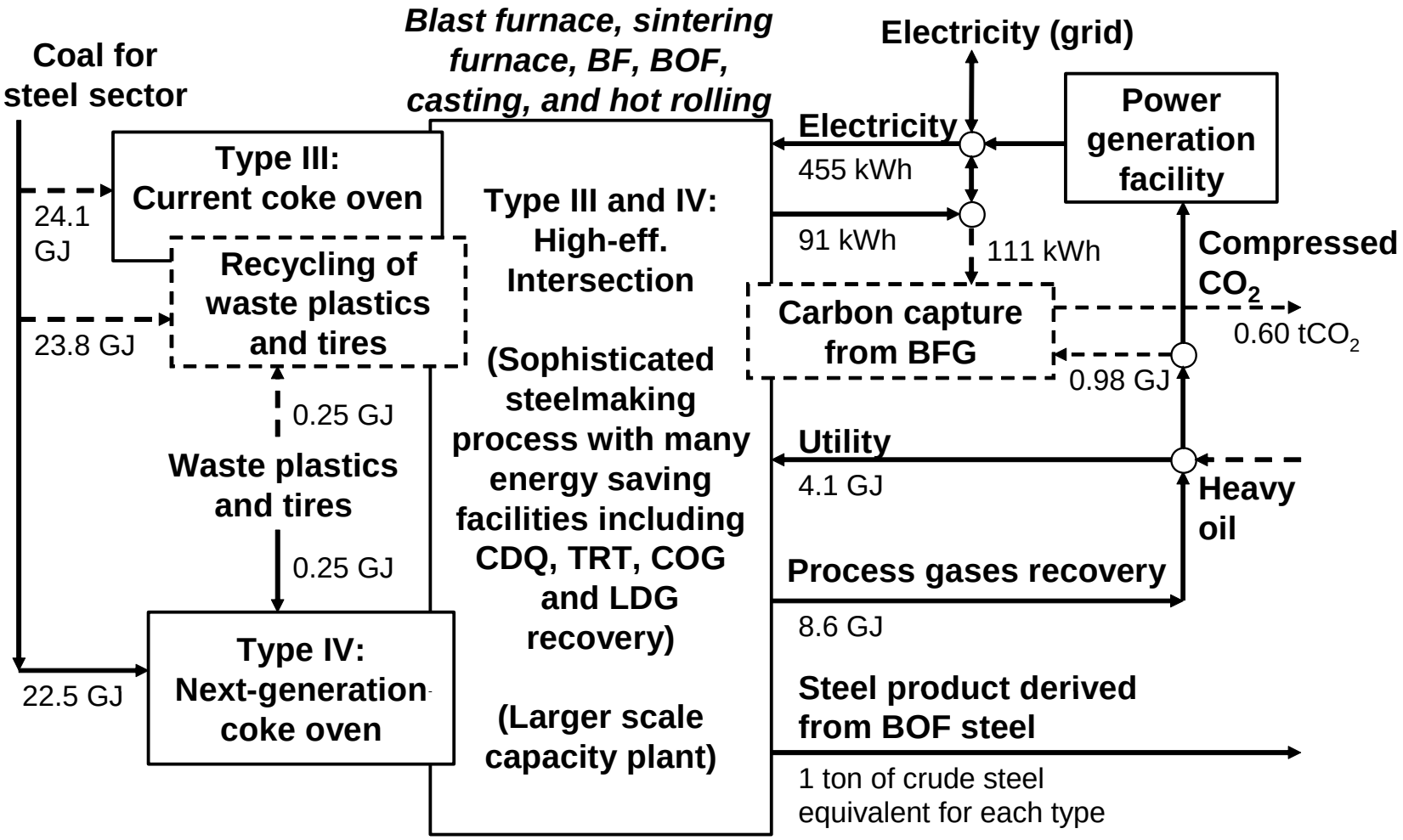


Technology Descriptions in DNE21+ (1/2)



Technology Descriptions in DNE21+ (2/2)

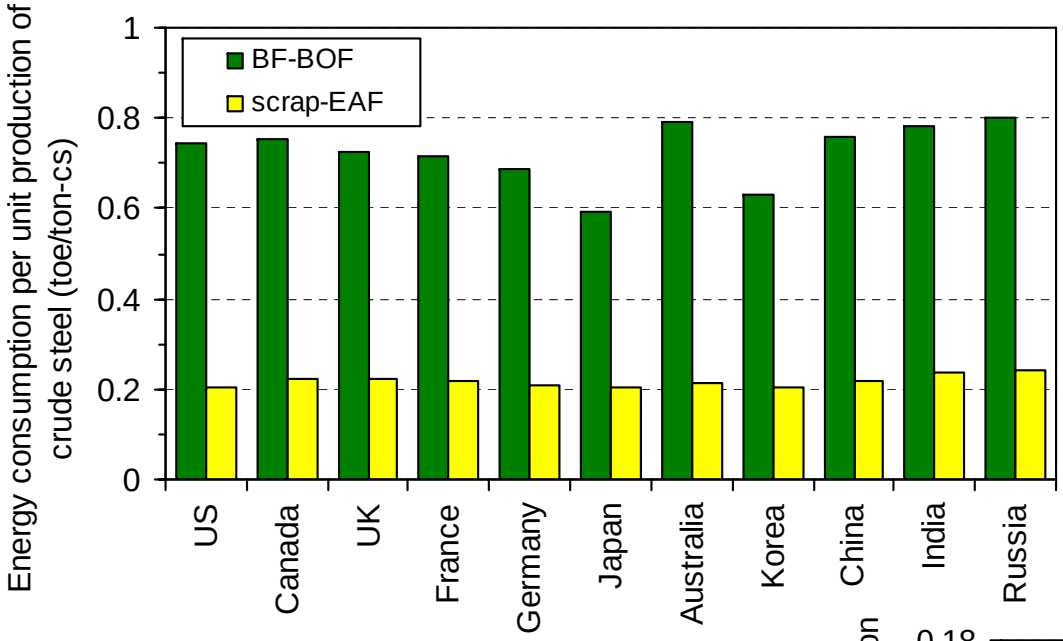
–An Example for High Energy Efficiency Process in Iron & Steel Sector–



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

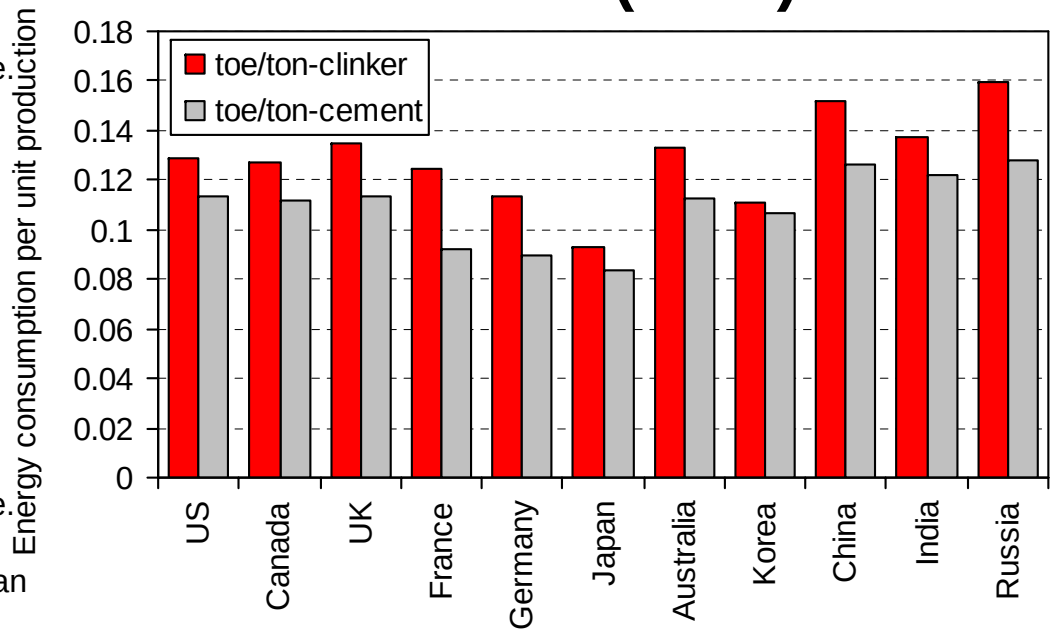
Comparisons of Energy Efficiency (1/2)

Iron & steel (2000)



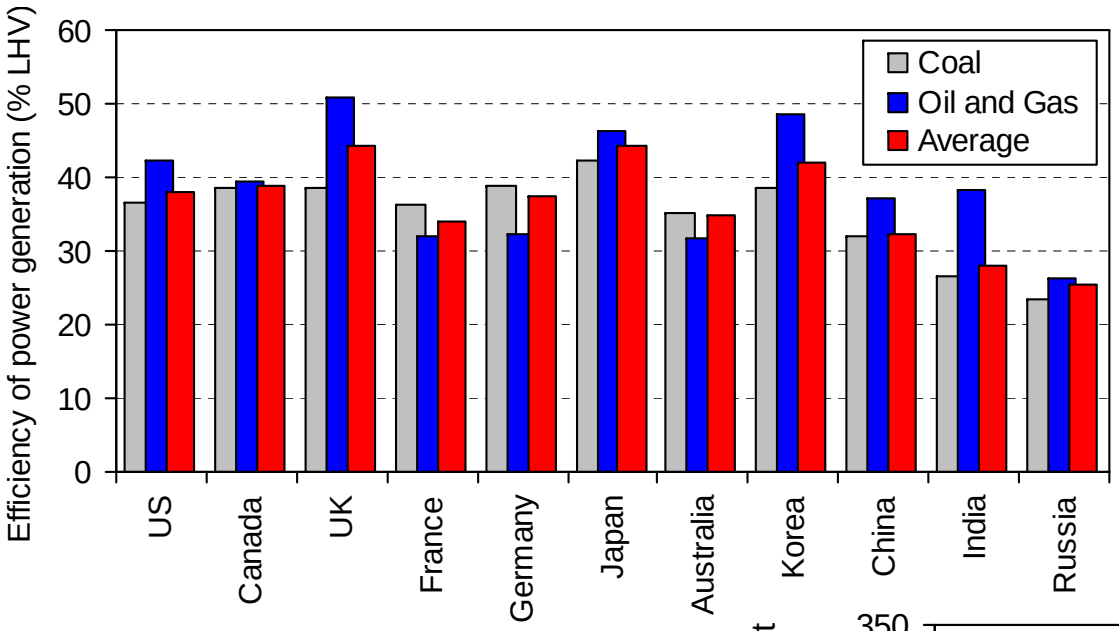
Note: Electricity is converted by using 1MWh=0.086/0.33toe.
Source: Estimates by RITE from IEA (2006), IISI (2005) etc.

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)

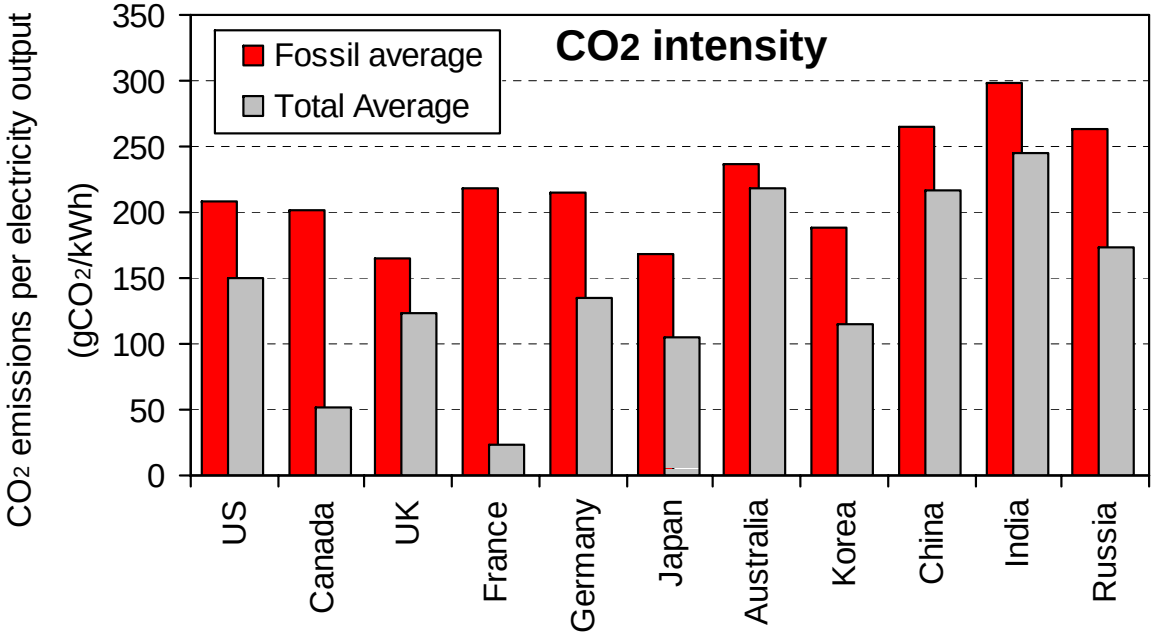


Efficiency

Power sectors (2005)

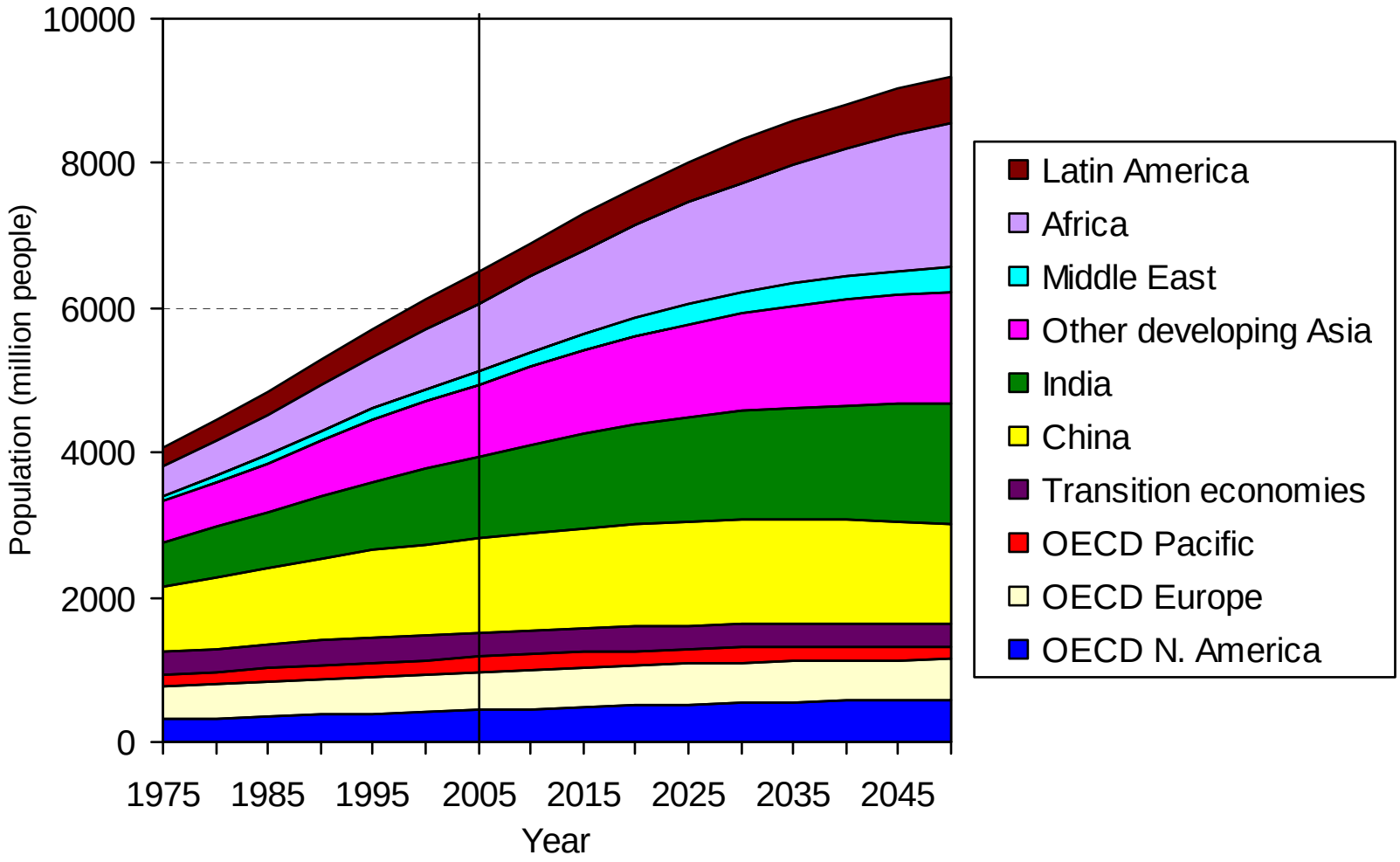
Including CHP

Source: IEA, 2007



Assumptions of DNE21+ (1/3)

- **Population: UN2006 Medium Scenario**

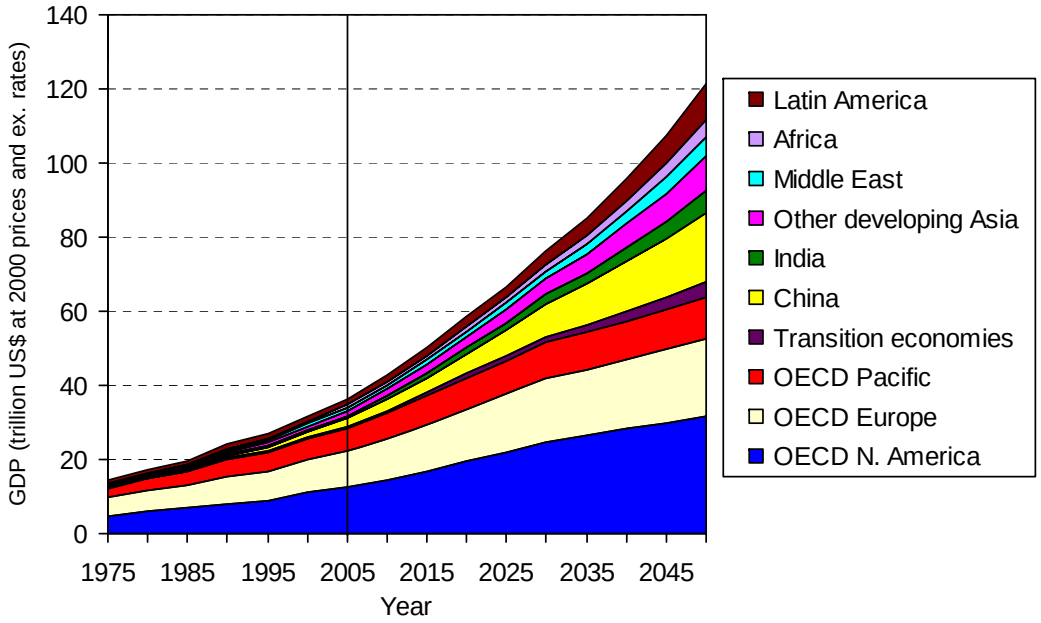


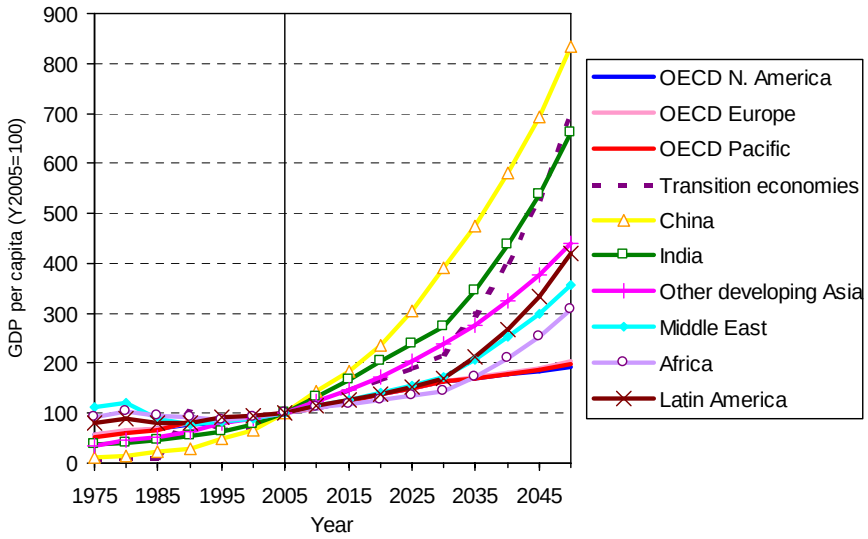
Assumptions of DNE21+ (2/3)

- **GDP**

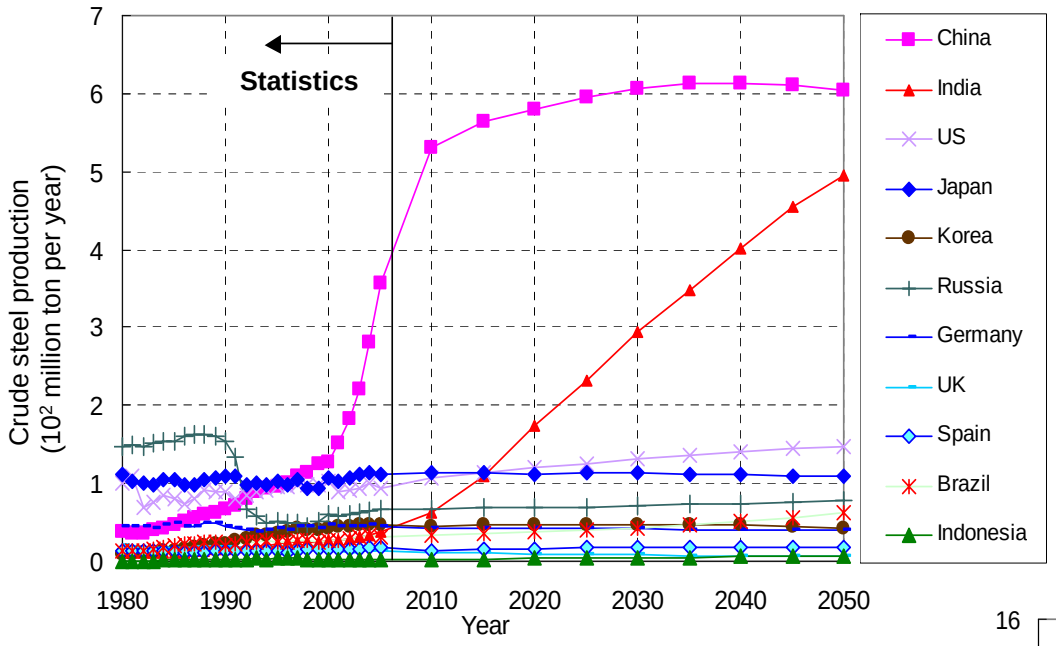
  –Y2030: Based on the prospects by World Bank, “Global Economic Prospects 2007–Managing the Next Wave of Globalization” (2006)

  Y2030–2050: Based on IPCC SRES B2 (2000)



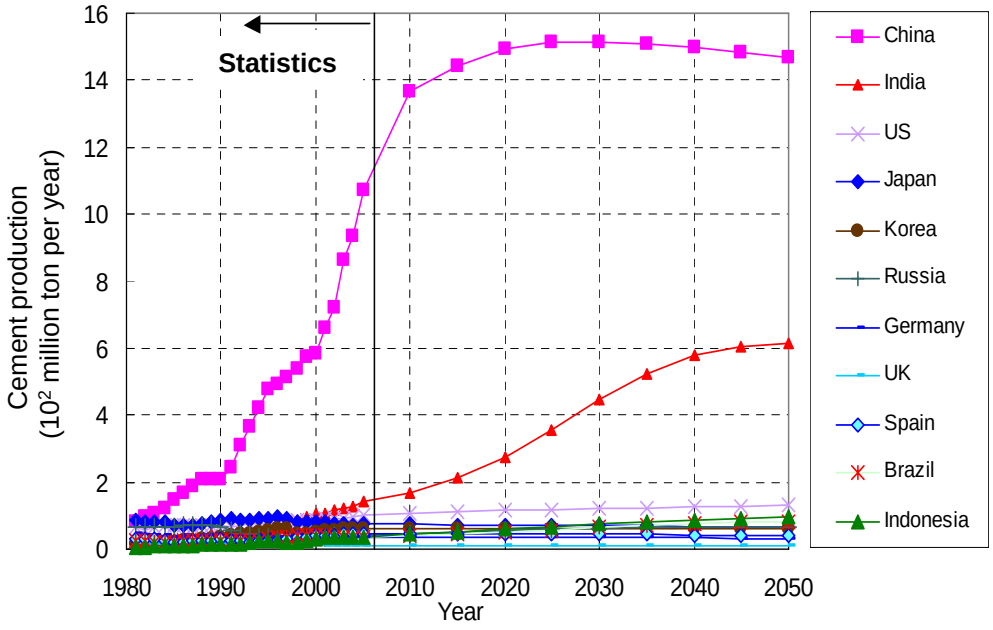


Assumptions of DNE21+ (3/3)

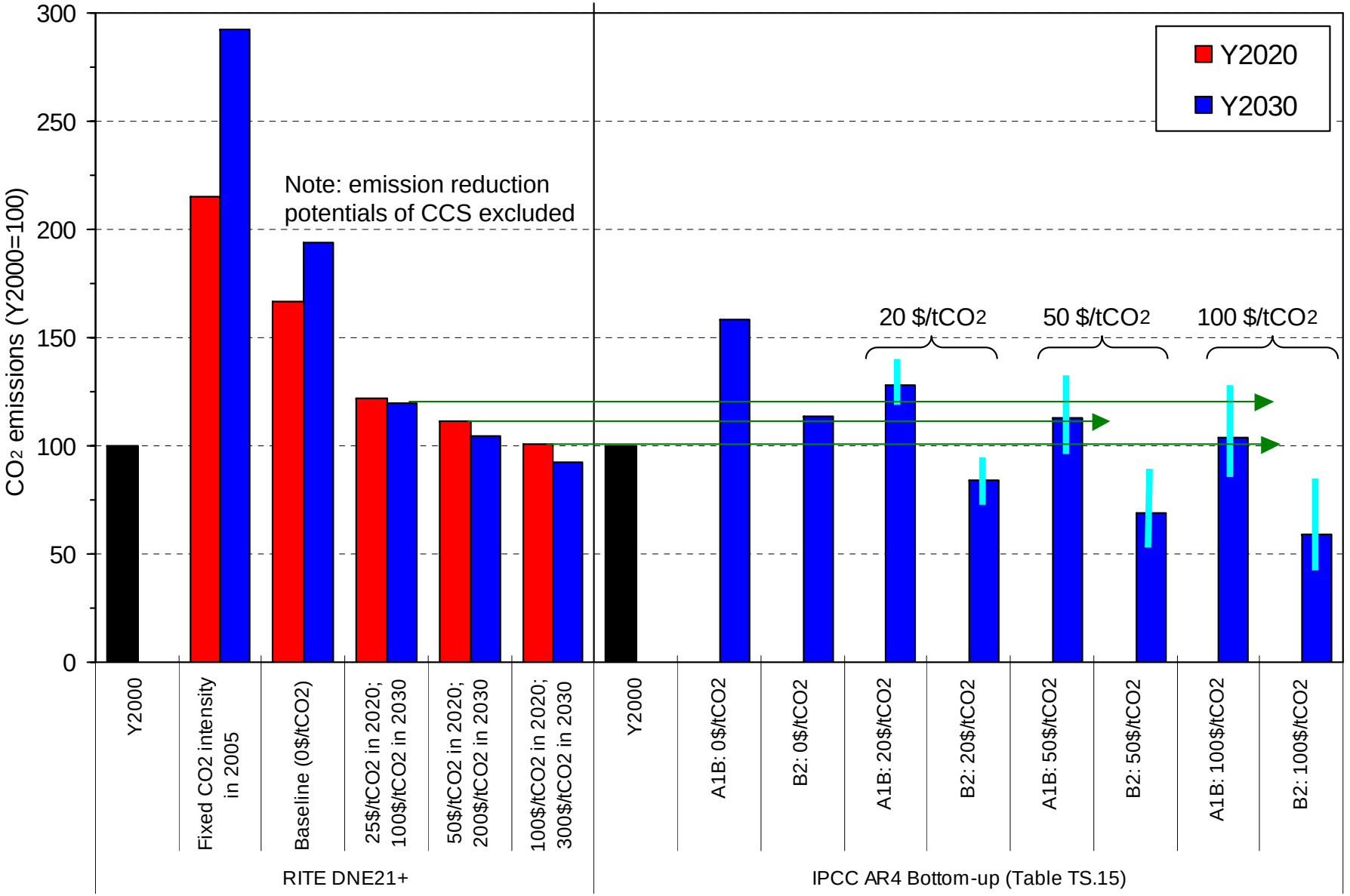


Iron & Steel (Crude steel production)

Cement (Cement production)

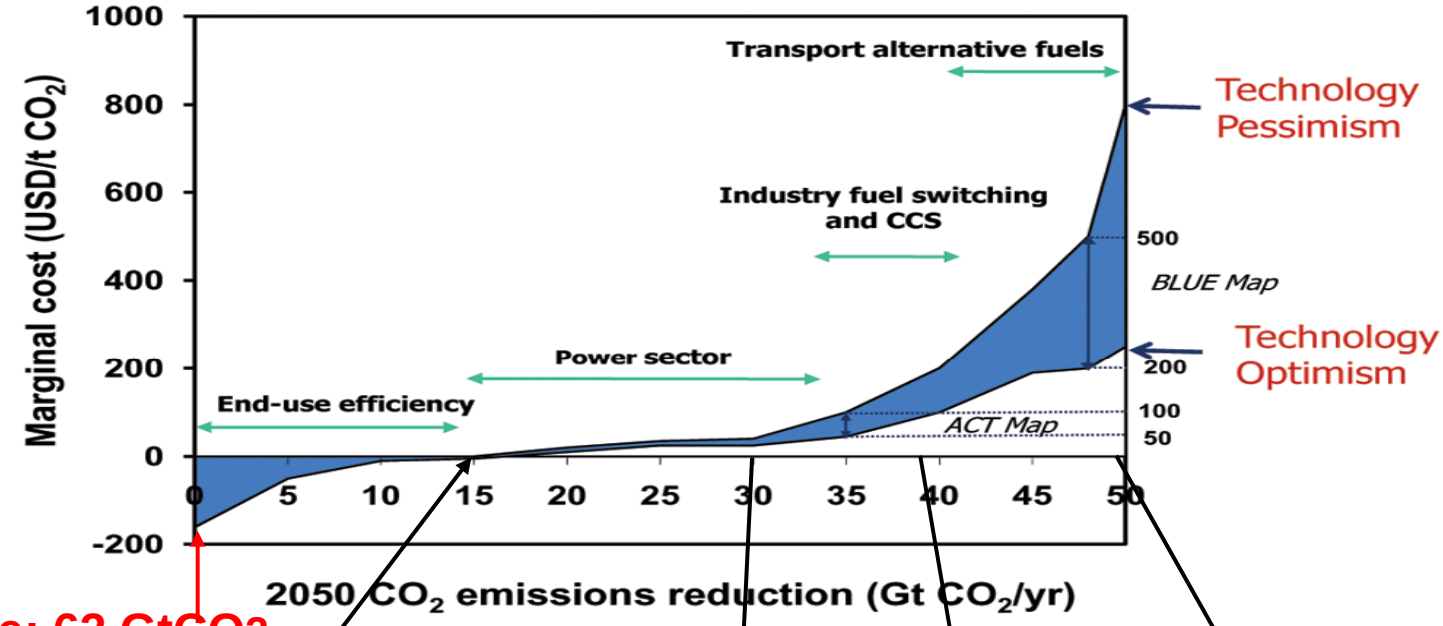


Comparisons of Emission Reduction Potentials between DNE21+ and IPCC AR4



Comparisons of MAC in 2050 between DNE21+ and IEA ETP

IEA ETP2008

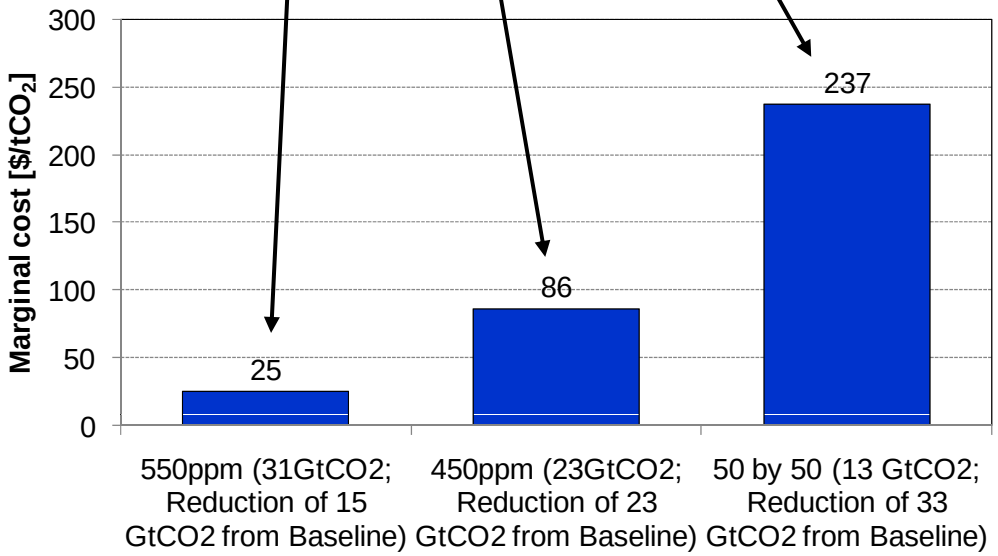


IEA ETP Baseline: 62 GtCO2

RITE DNE21+ (Oct. 2008)

The definition of Baseline by RITE

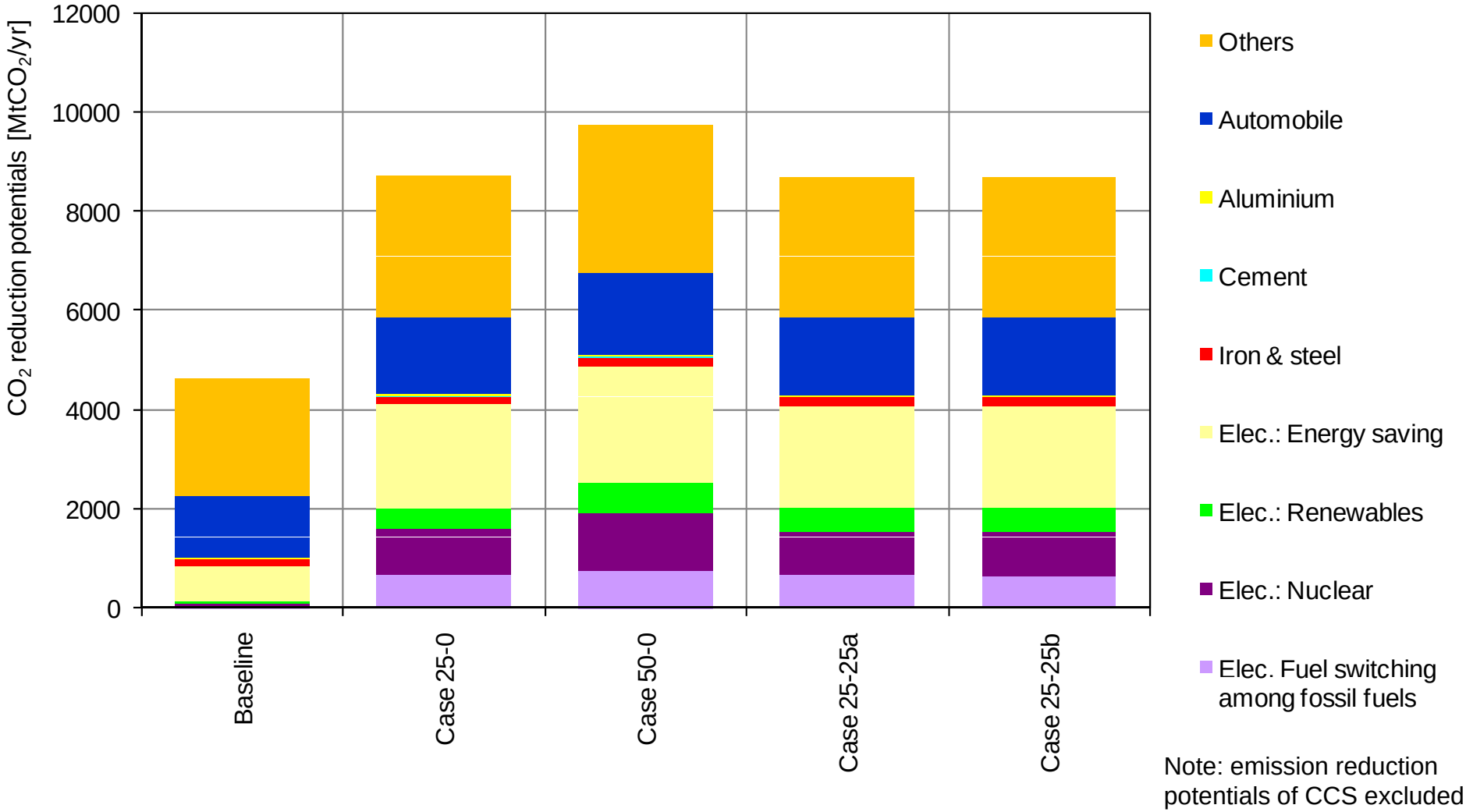
RITE DNE21+ Baseline:
Marginal cost = 0 $/tCO2
46 GtCO2



Expected CO_2 Emission Reduction (2/3)

Reduction Potentials by sector from Sectoral Technology-frozen Case

Annex 1 & OECD

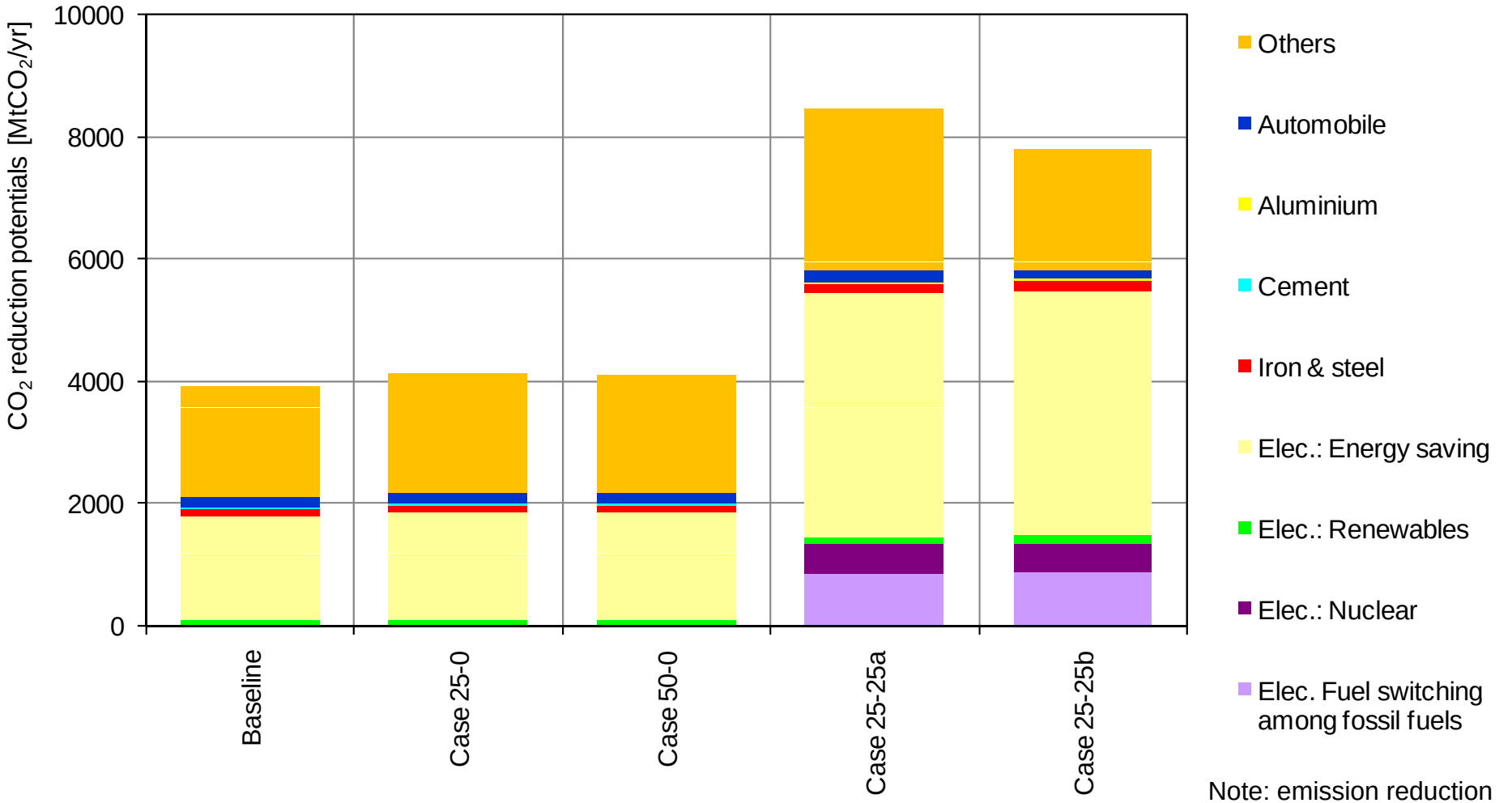


Note: emission reduction potentials of CCS excluded

Expected CO_2 Emission Reduction (3/3)

Reduction Potentials by sector from Sectoral Technology-frozen Case

Major developing countries



Note: emission reduction potentials of CCS excluded