International Workshop
Sectoral Approaches for International Climate Policy
IEA, Paris, France, 14 - 15 May 2008
Session 2

Sectoral analysis of mitigation potential

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- Model analysis results include
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  - Emission reduction potentials in 2020 by country, sector and mitigation cost range
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  - CO_2 emission reduction outlook in Japan
  - CO_2 emission reductions by sector toward the 50 by 50
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  - Energy and CO_2 intensity trajectories
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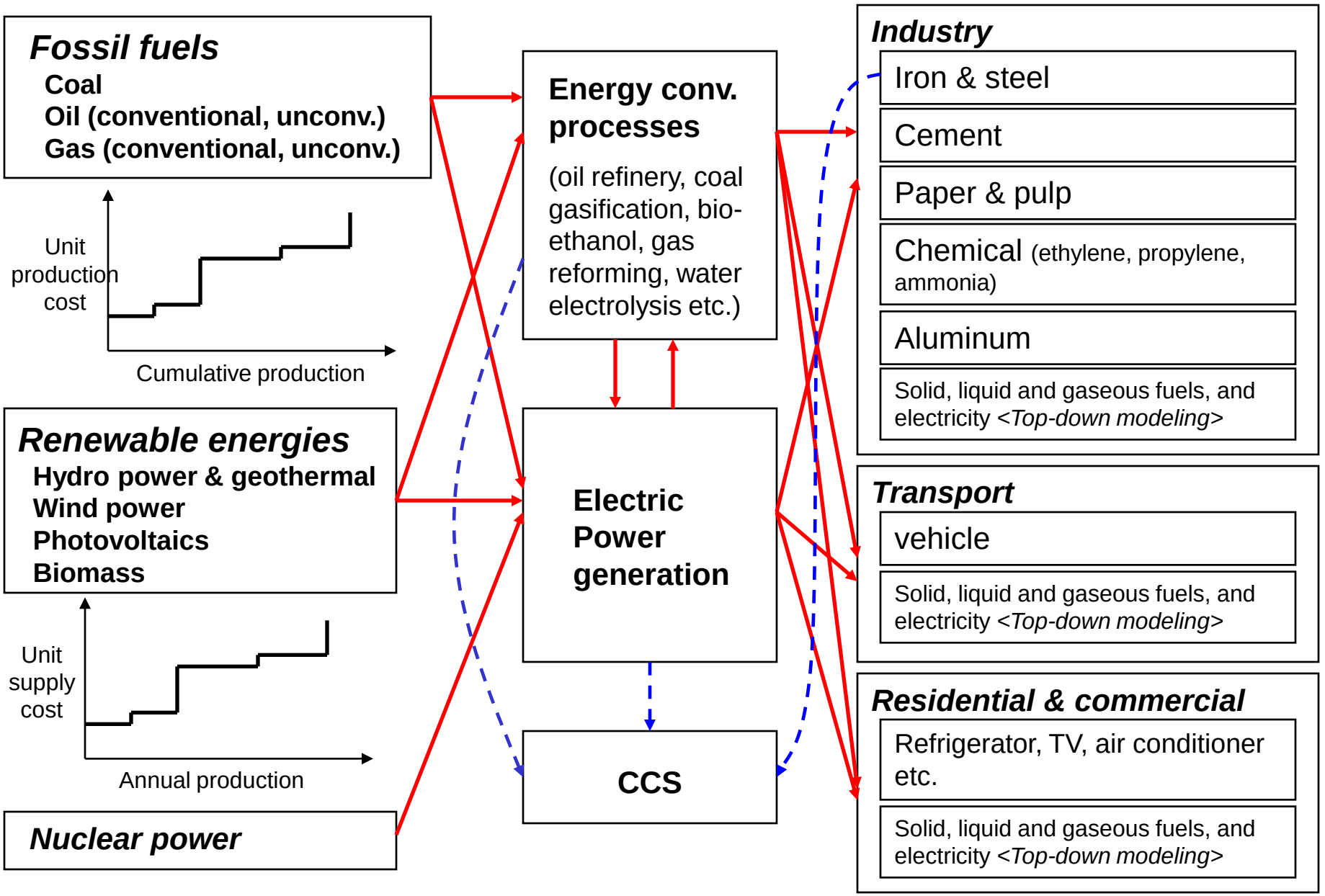
Assessment Framework: DNE21+ Model

- 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.

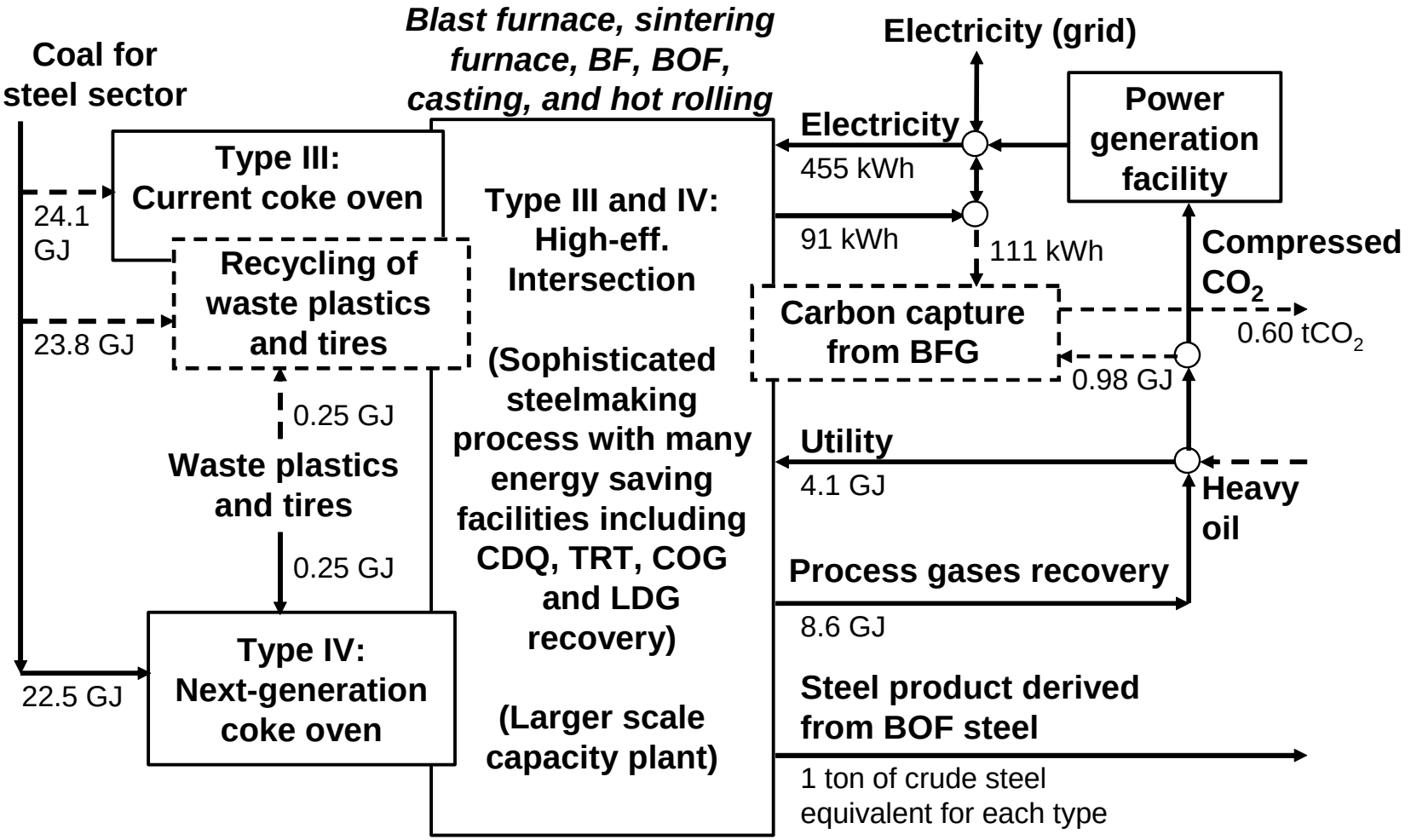
-The model has high resolutions in regions and technologies to analyze sectoral approach.
- Consistent analyses among regions and sectors can be conducted.

Technology Descriptions in DNE21+ (1/2)



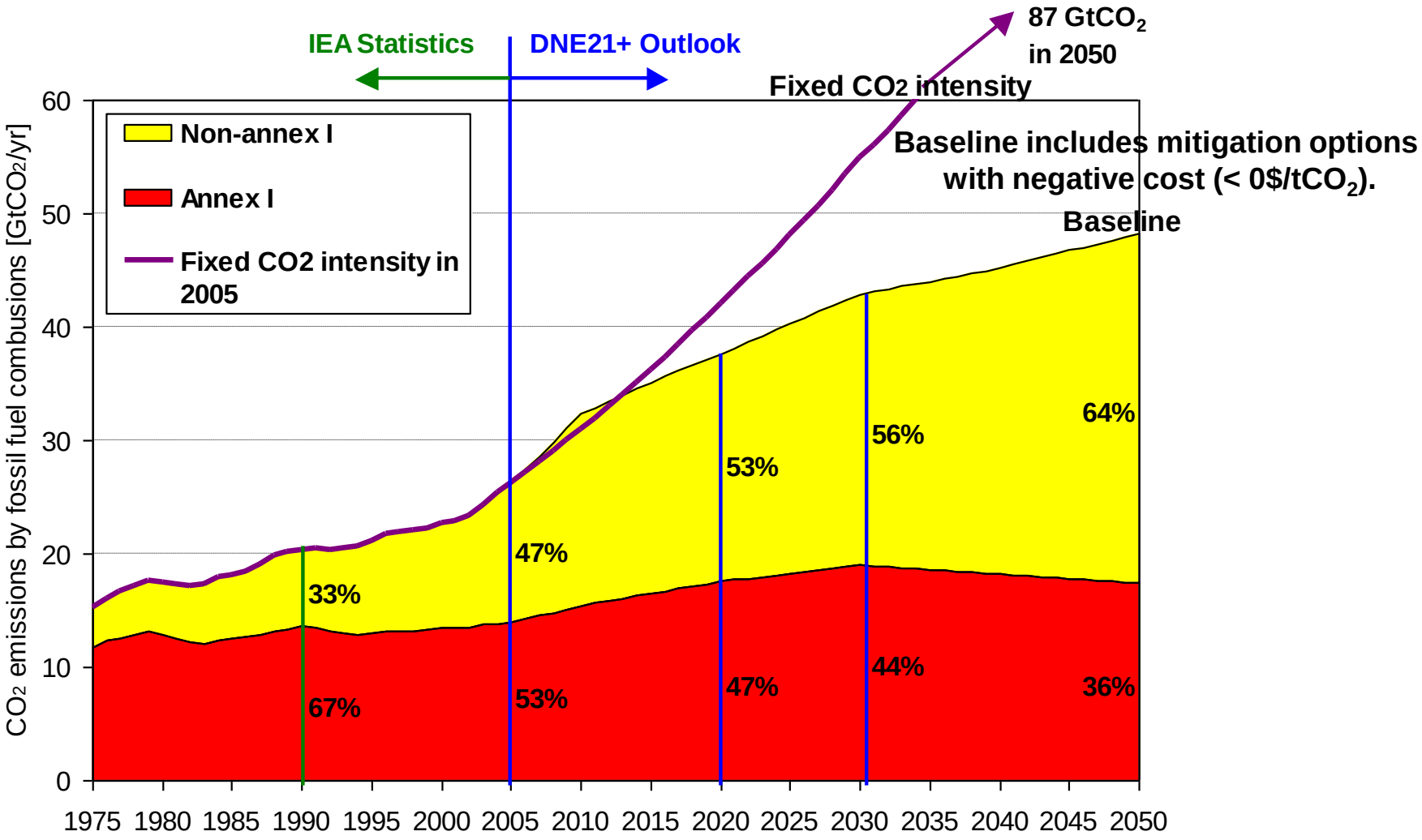
Technology Descriptions in DNE21+ (2/2)

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



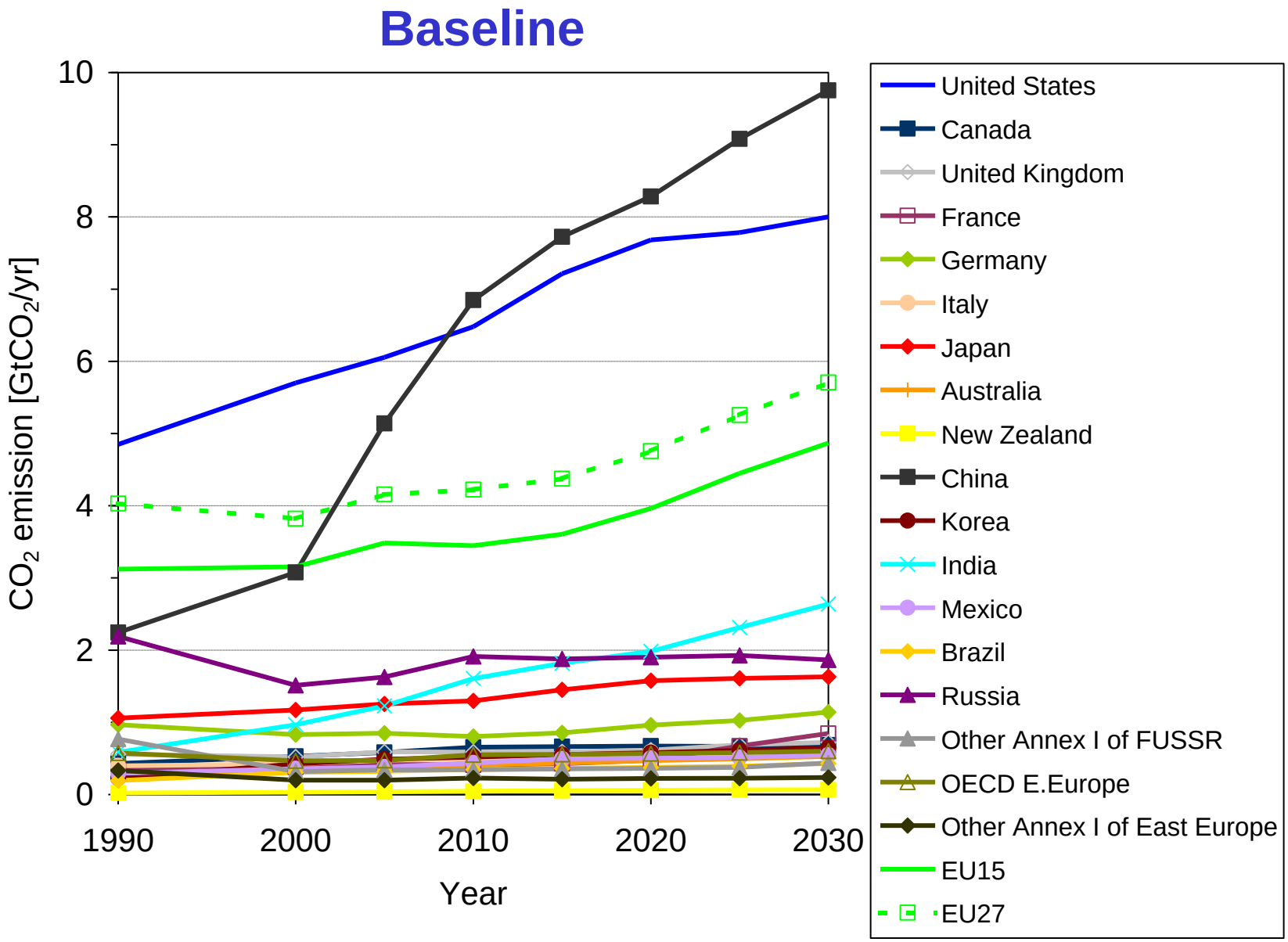
BF: blast furnace, BOF: basic oxygen furnace, CDQ: Coke dry quenching,
TRT: top-pressure recovery turbine, COG: coke oven gas, LDG: oxygen furnace gas

CO_2 Emissions in Reference Case

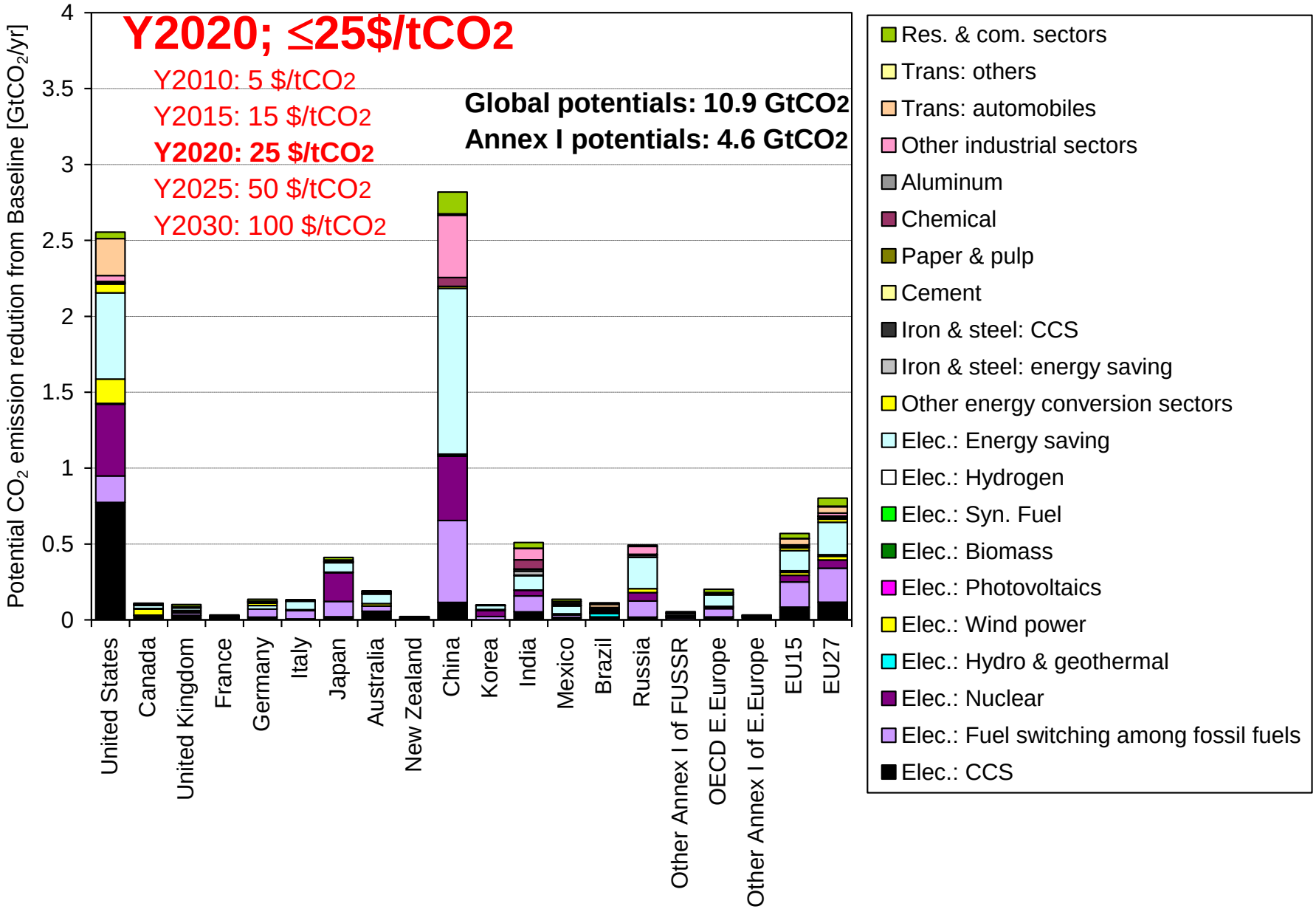


- Large efforts are required even for achieving the emissions in Baseline.
- High emission growth in Non-annex I countries are estimated for the future.

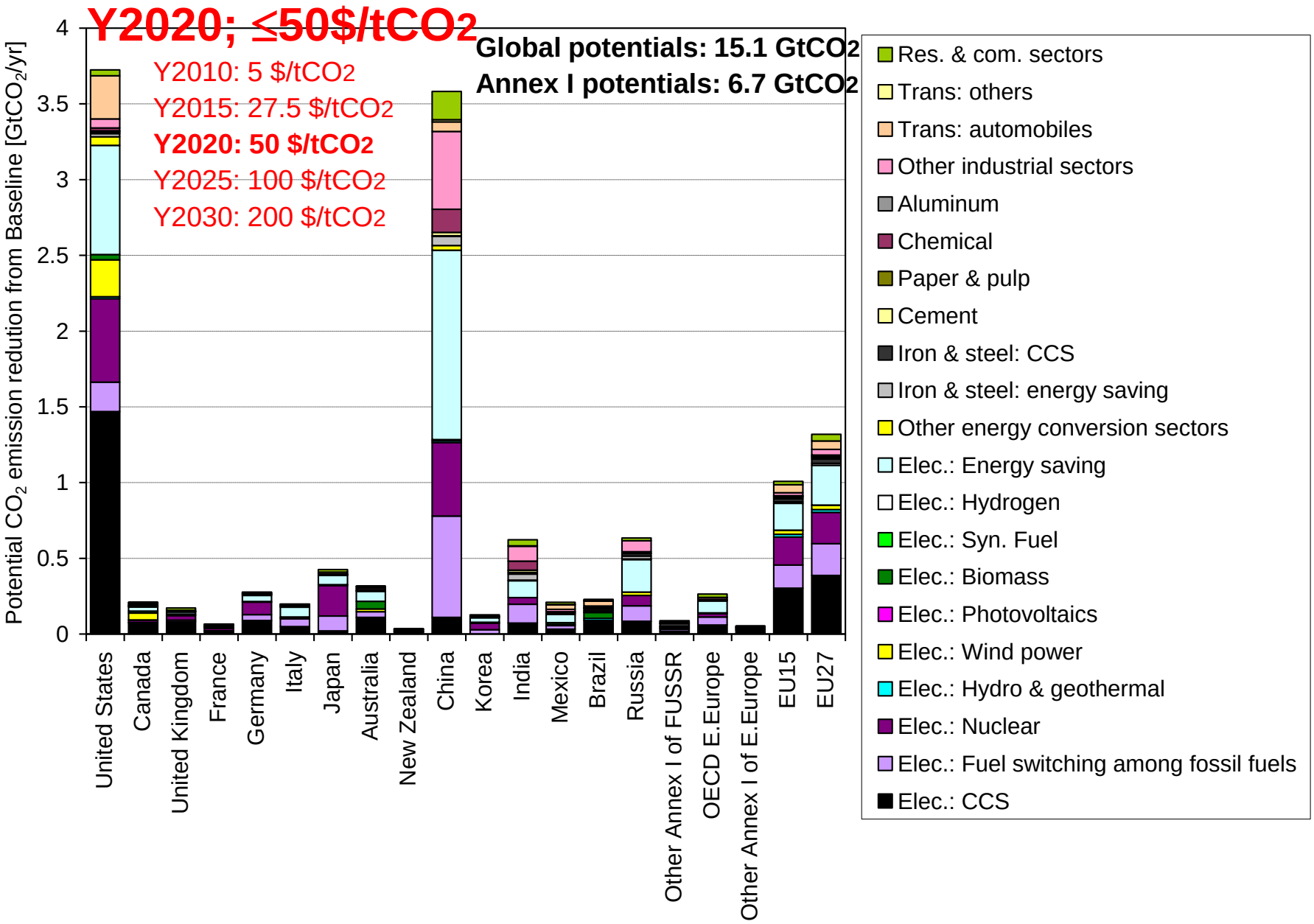
CO_2 Emissions in Baseline by Country



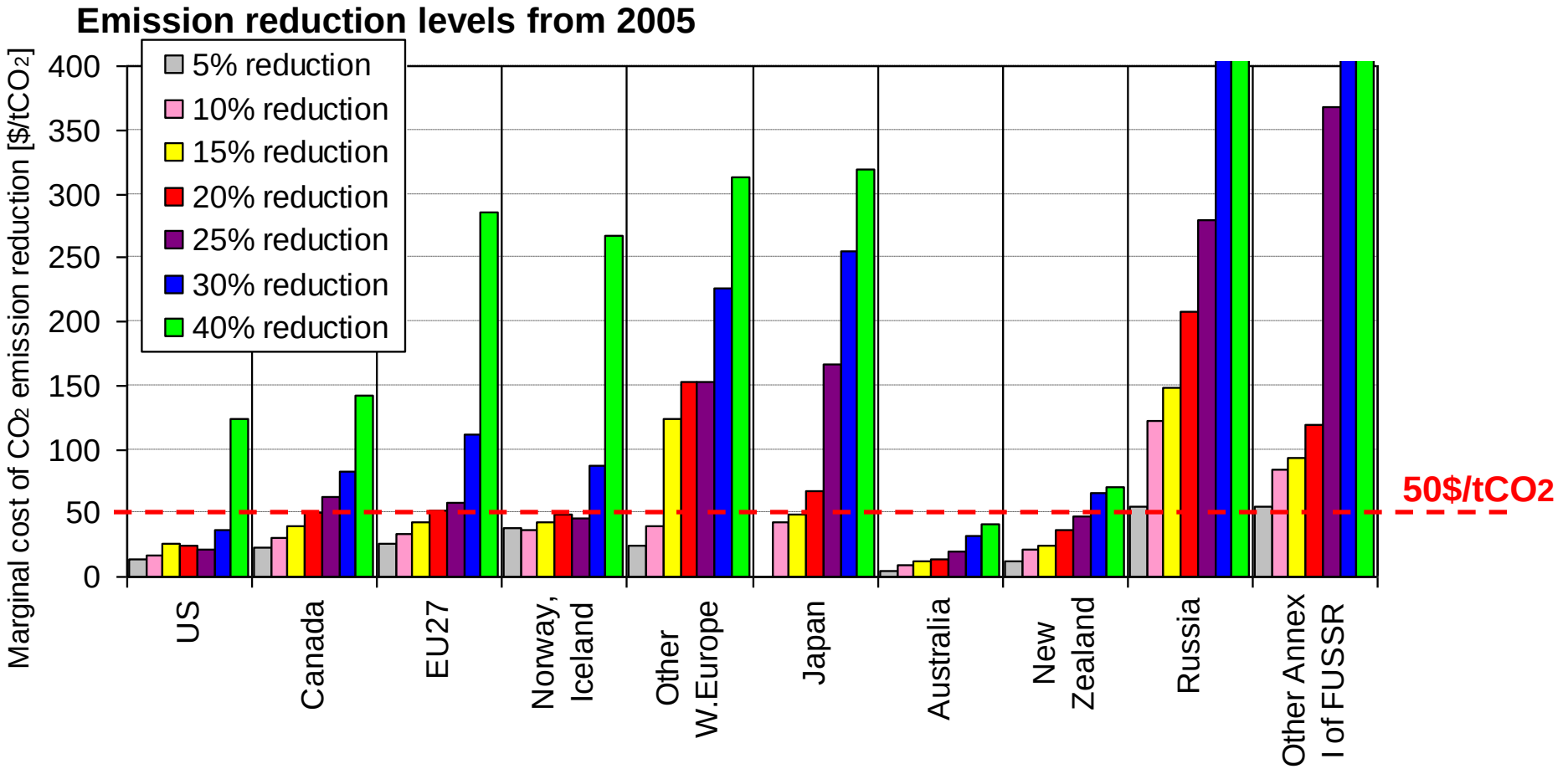
Sectoral Emission Reduction Potentials in 2020



Sectoral Emission Reduction Potentials in 2020

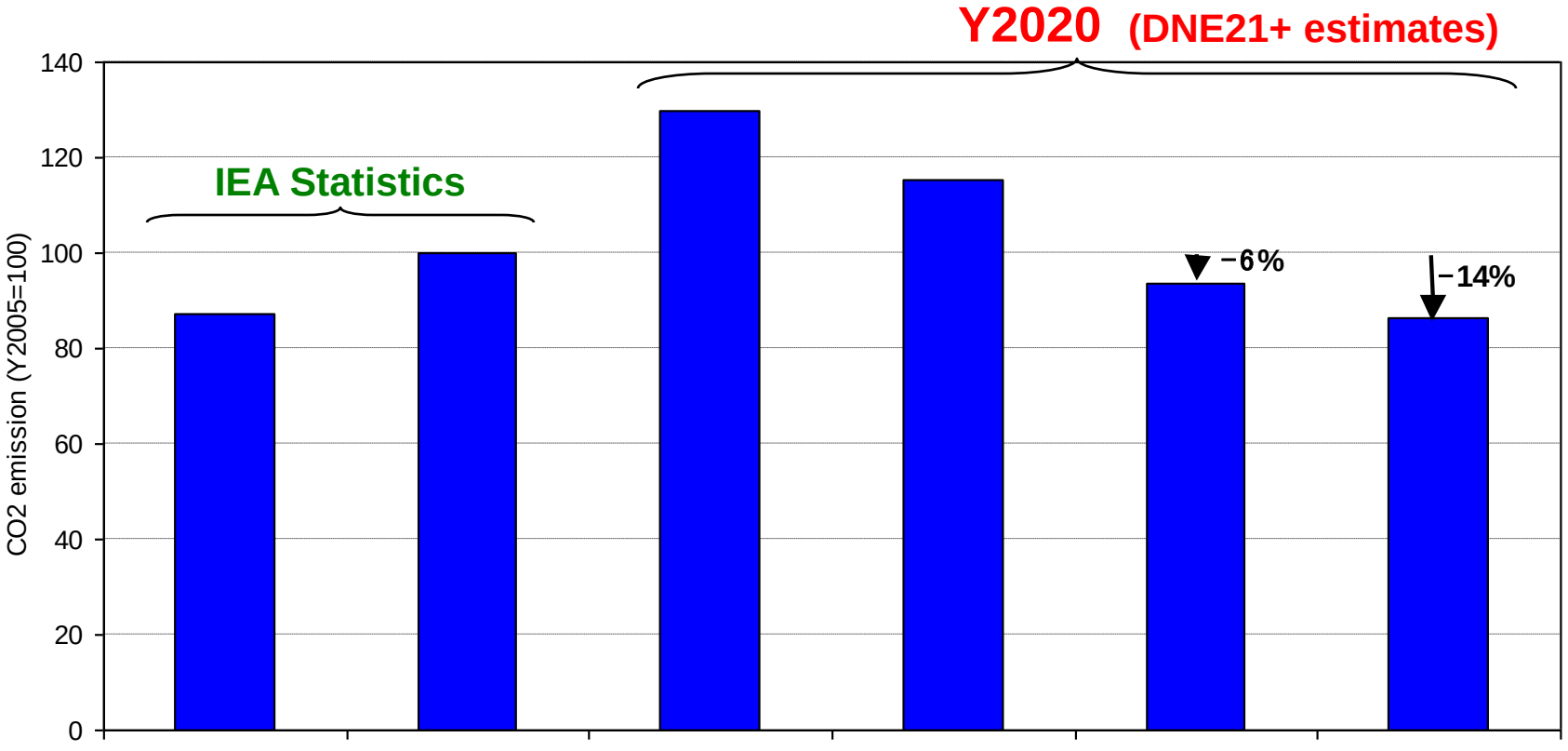


Marginal Costs of CO_2 Emission Reductions in 2020 by Country



- The estimated potential reduction of CO_2 emissions from the 2005 levels by measures below 50$/t$CO_2$ are 3.1 GtCO_2 in Annex I countries (22% from the 2005 levels).
- The potential in Japan, EU27 and US is around 15%, 20% and over 30%, respectively.

Emission Reduction Outlook in Japan



Almost consistent with New National Energy Strategy in Japan, 2006

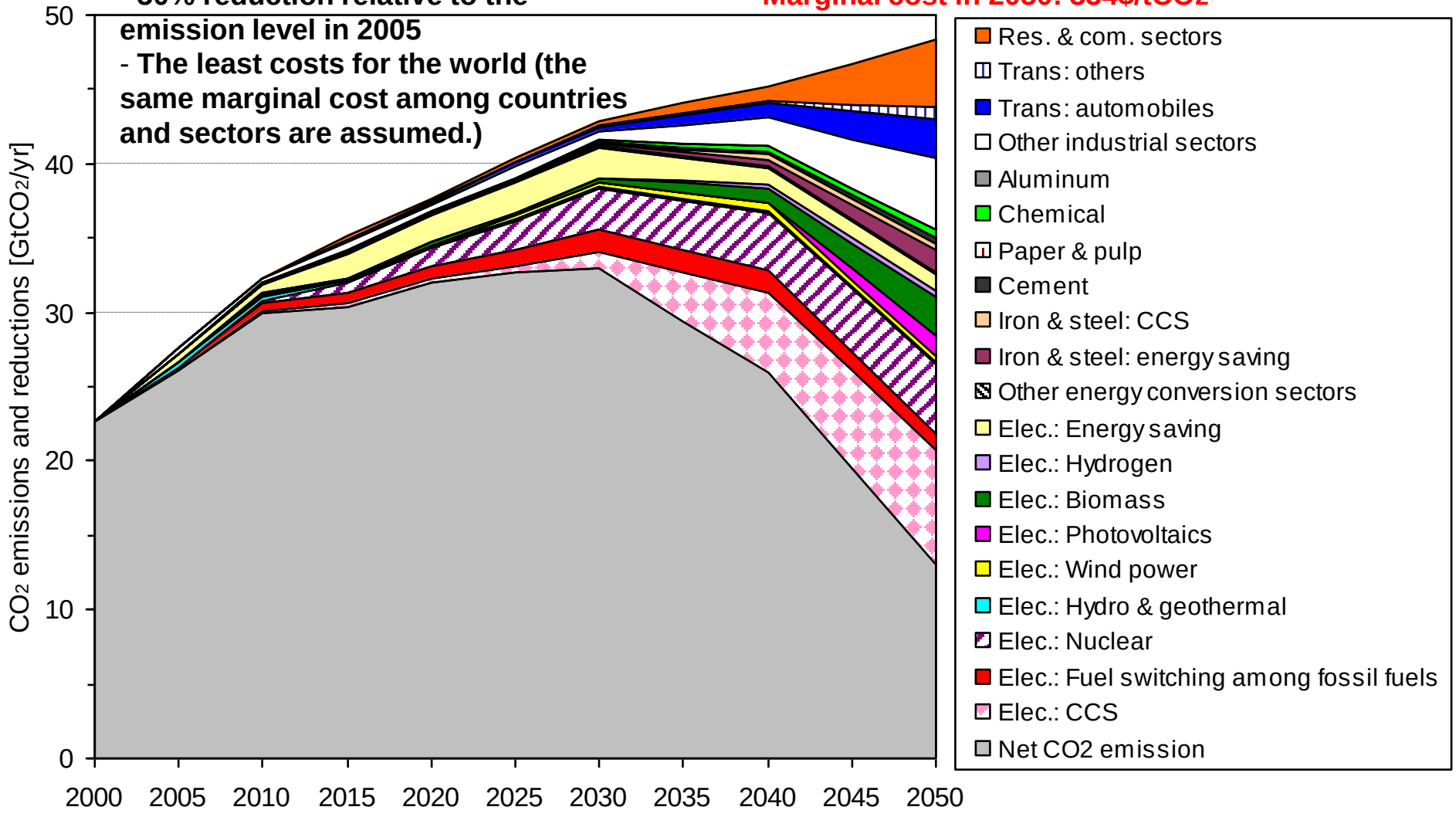
Almost same cost for EU27 to achieve 20% reduction from the 1990 emission level

Almost consistent with the most challenging scenario in New Long-term Energy Outlook in Japan, 2008

CO_2 Emission Reductions by Sector toward the 50 by 50

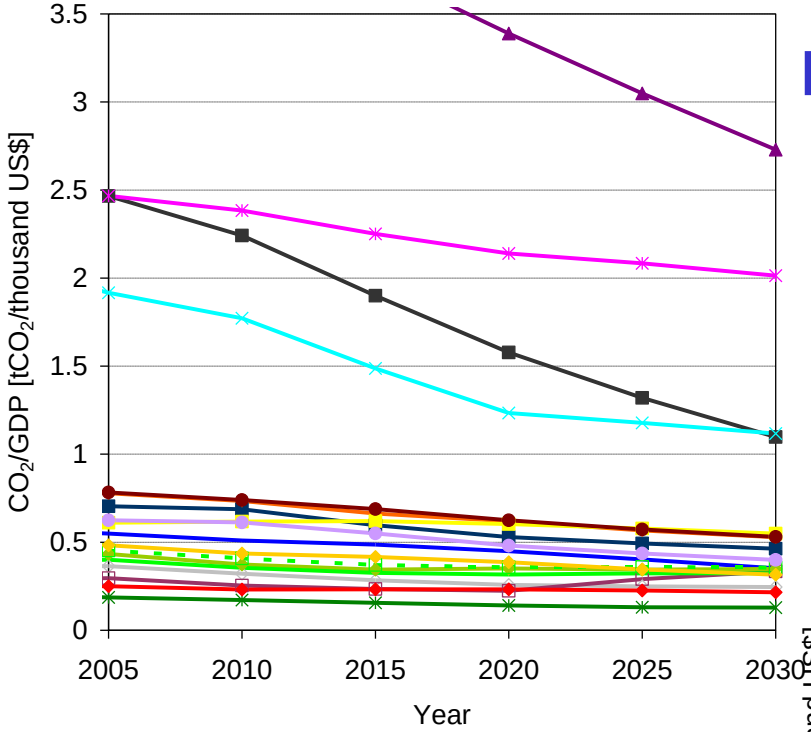
- 50% reduction relative to the emission level in 2005
- The least costs for the world (the same marginal cost among countries and sectors are assumed.)

Marginal cost in 2050: 334$/t$CO_2$



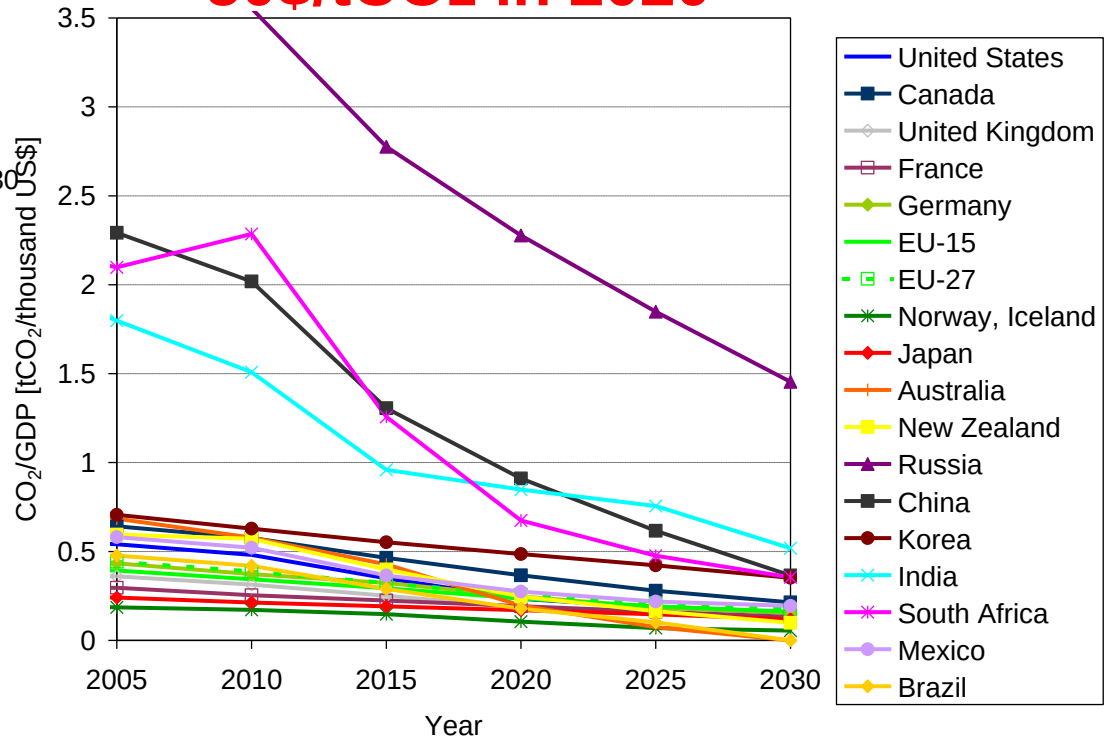
The estimated marginal cost in 2050 is large even if large improvements of energy efficiencies and large cost reductions in renewable energies, CCS etc. are assumed.

CO_2 Intensity Profiles by Country



Baseline

50$/tCO2 in 2020



＜50$/tCO2 in 2020 Scenario＞

Y2010: 5 $/tCO2

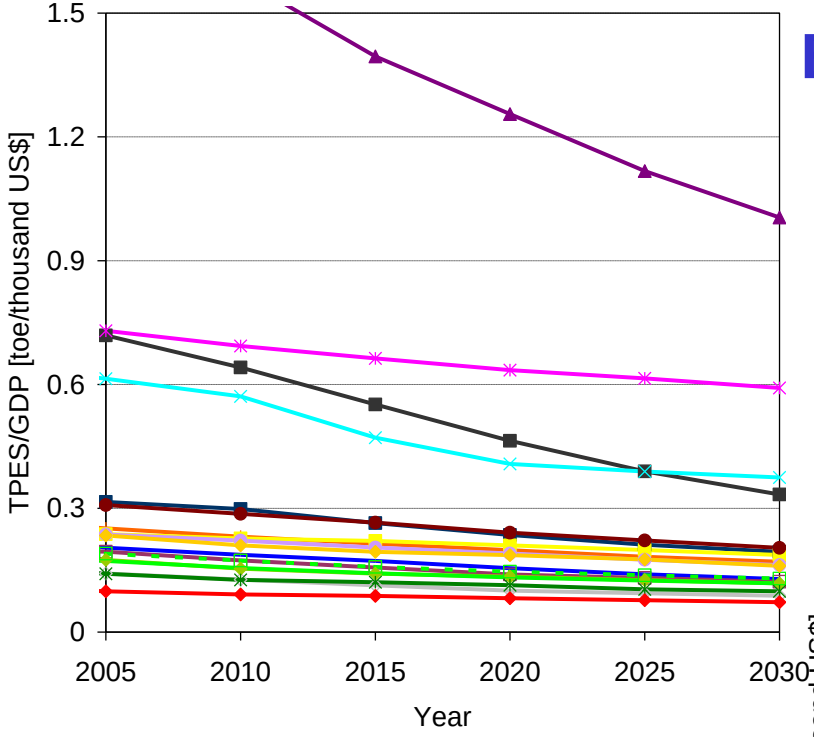
Y2015: 27.5 $/tCO2

Y2020: 50 $/tCO2

Y2025: 100 $/tCO2

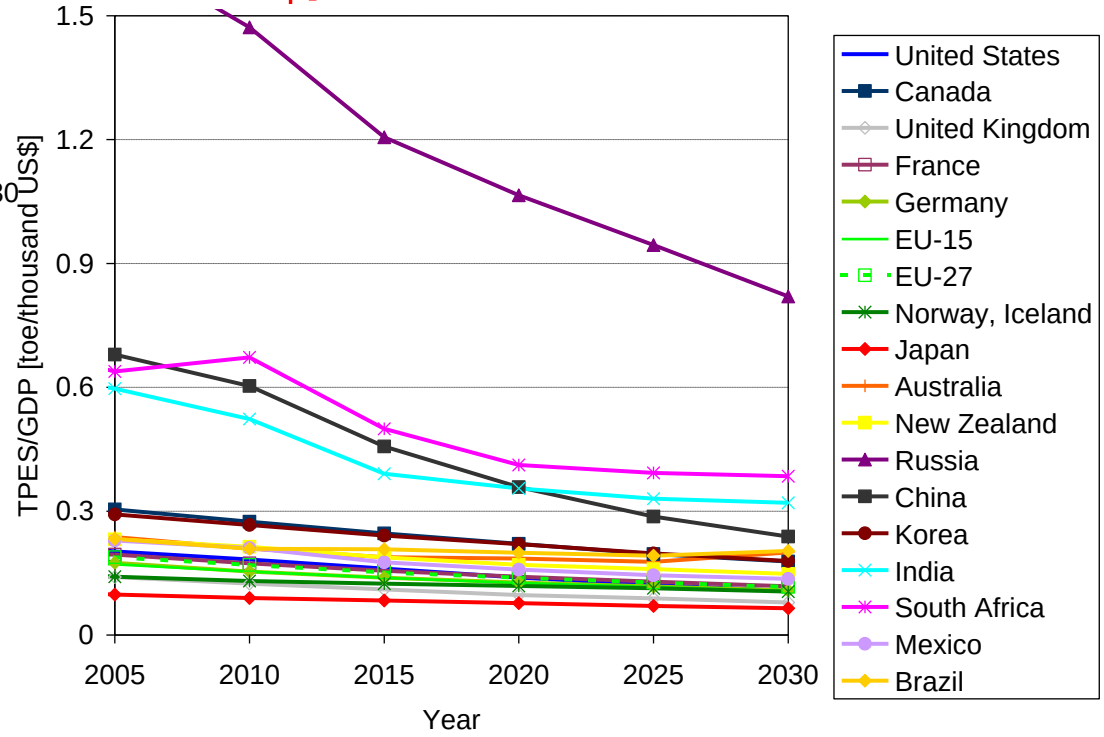
Y2030: 200 $/tCO2

Energy Intensity Profiles by Country



Baseline

50$/tCO2 in 2020



＜50$/tCO2 in 2020 Scenario＞

Y2010: 5 $/tCO2

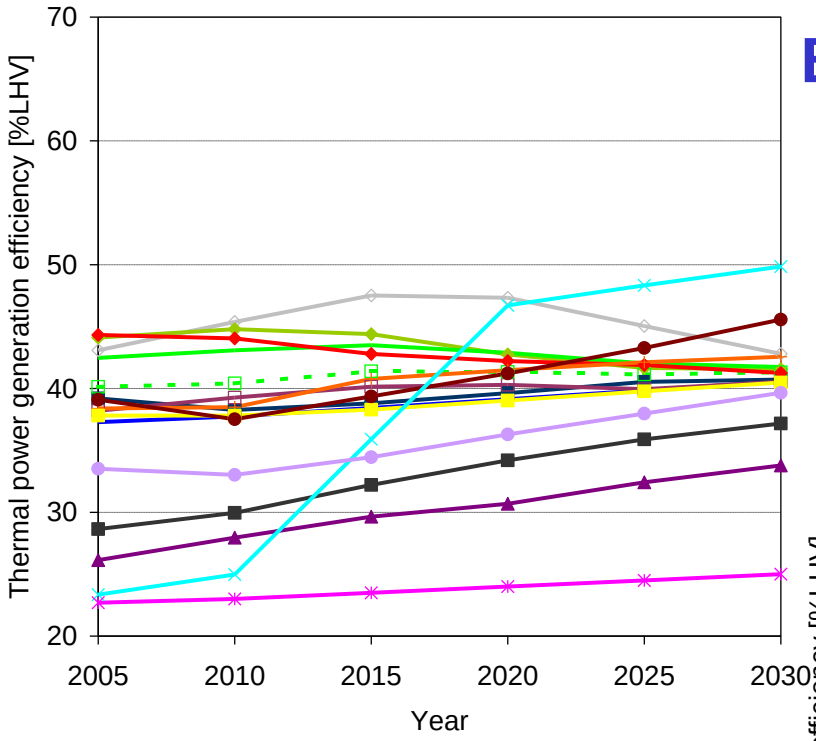
Y2015: 27.5 $/tCO2

Y2020: 50 $/tCO2

Y2025: 100 $/tCO2

Y2030: 200 $/tCO2

Energy Efficiency of Power Sector by Country



Baseline

Note: fossil fuel only

＜50$/tCO2 in 2020 Scenario＞

Y2010: 5 $/tCO2

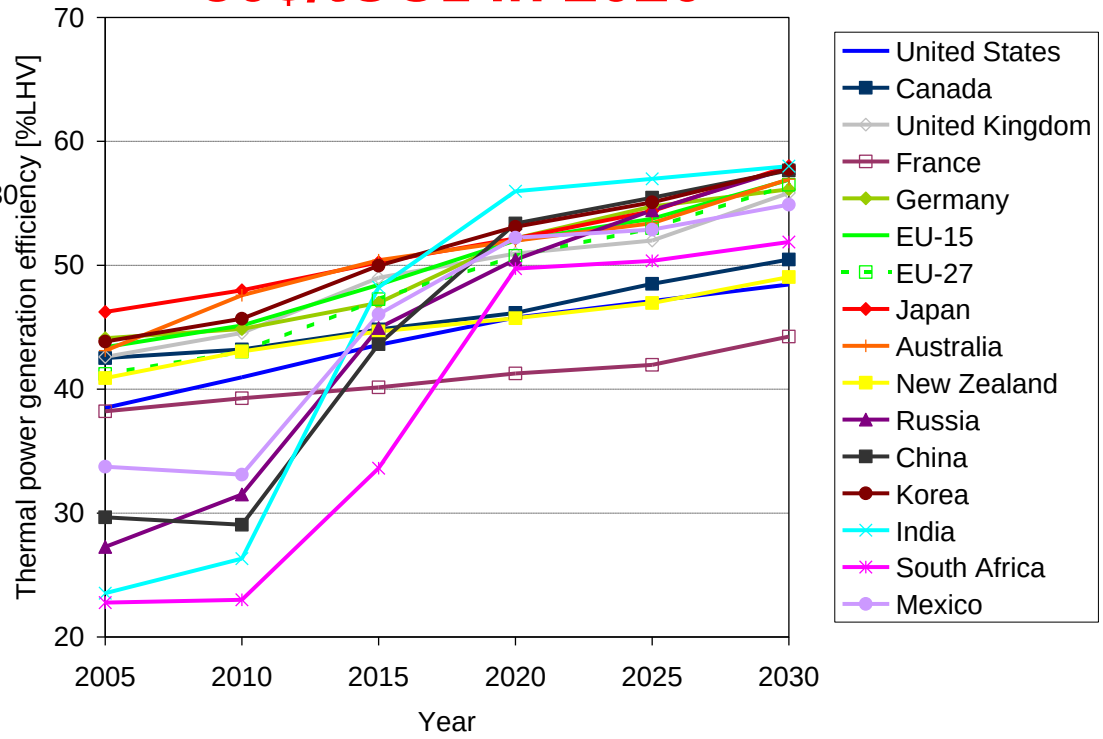
Y2015: 27.5 $/tCO2

Y2020: 50 $/tCO2

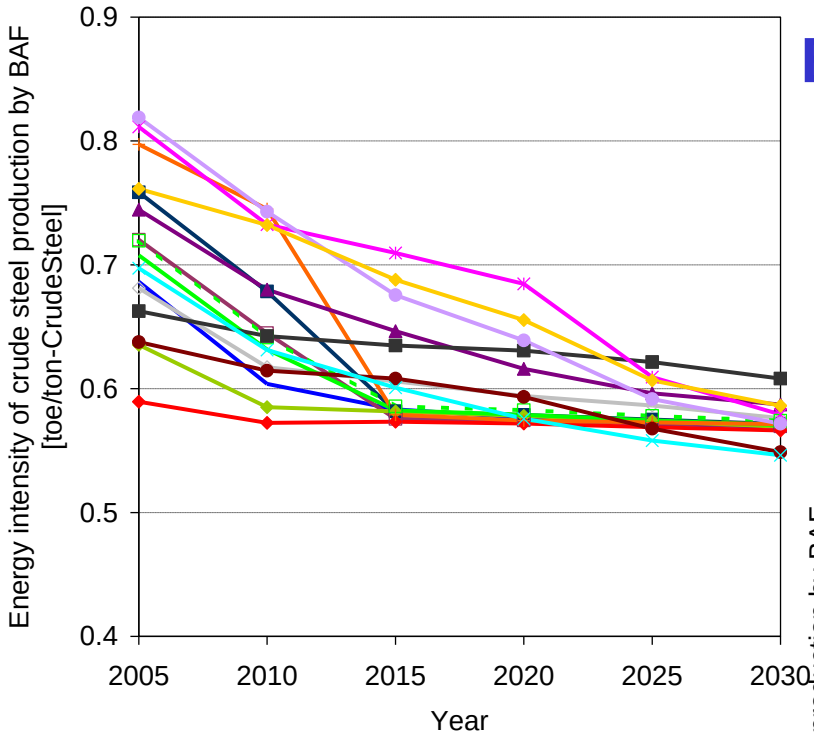
Y2025: 100 $/tCO2

Y2030: 200 $/tCO2

50$/tCO2 in 2020



Energy Intensity of Iron&Steel Sector by Country

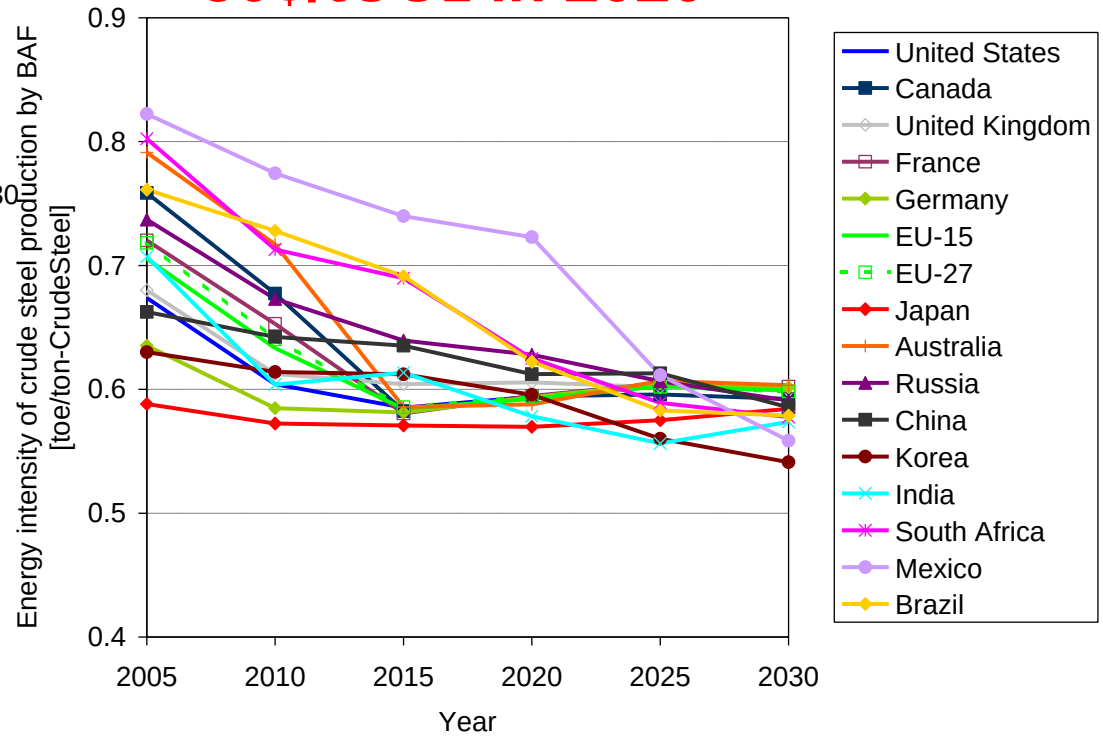


Baseline

Note: BF-BOF only

The energy efficiency deteriorates if CCS are adopted under emission reduction cases (although the CO2 intensity improves).

50$/tCO2 in 2020



Conclusion

- Mitigation potentials and costs were evaluated by using a consistent assessment model which has high resolutions in regions and mitigation technologies.
- According to the analyses,

  - If mitigation measures below around 50 $/tCO2 in developed countries are adopted, around 7 GtCO2 of potential emission reductions from baseline emissions are expected in Annex 1 in 2020 (corresponds to around 20% reductions from 2005 emission levels).

  - The potential reduction from the 2005 emission level in Japan, EU27 and US is around 15%, 20% and over 30%, respectively.

  - The estimated marginal cost for the 50 by 50 is large (334$/$tCO_2$).

  - Power sectors have large potentials to reduce CO2 emissions for long-term.
- Energy efficiency and/or CO2 intensity by sector and by country will be also good indicators to consider the targets.

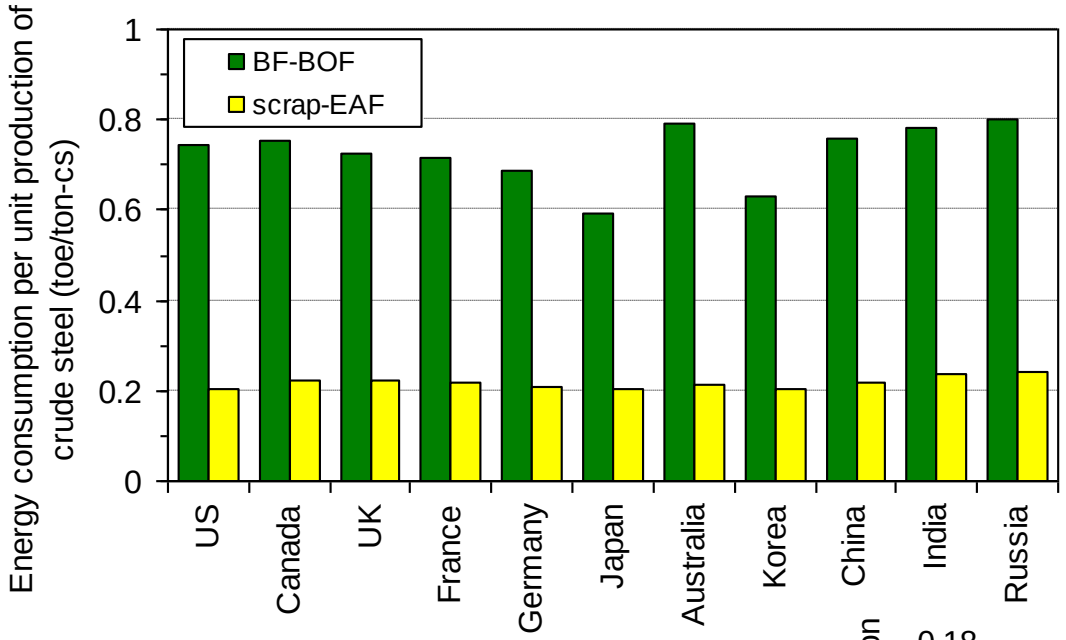
Cautions

- Models can show consistent analysis results under assumed conditions, but they are NOT predict our future.
- Models are much simpler than real societies. For example, there are several barriers to avoid achievements of efficiencies and effectiveness of technology diffusions, policy measures etc. But models neglect most of the barriers.
- In addition, particularly costs have large uncertainties.
- Marginal costs of emission reductions are NOT only the sole indicator to consider fair emission reduction targets.
- Energy efficiency and/or CO_2 intensity etc. by sector and by country are also important to consider the targets.

Appendix

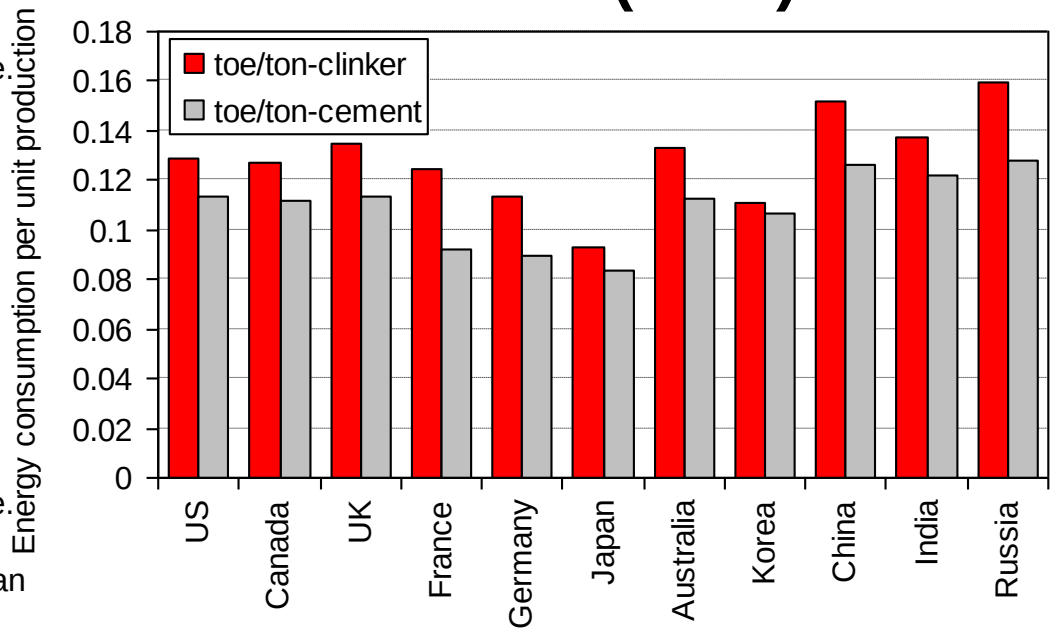
Comparisons of Energy Efficiency (1/2)

Iron & steel (2000)



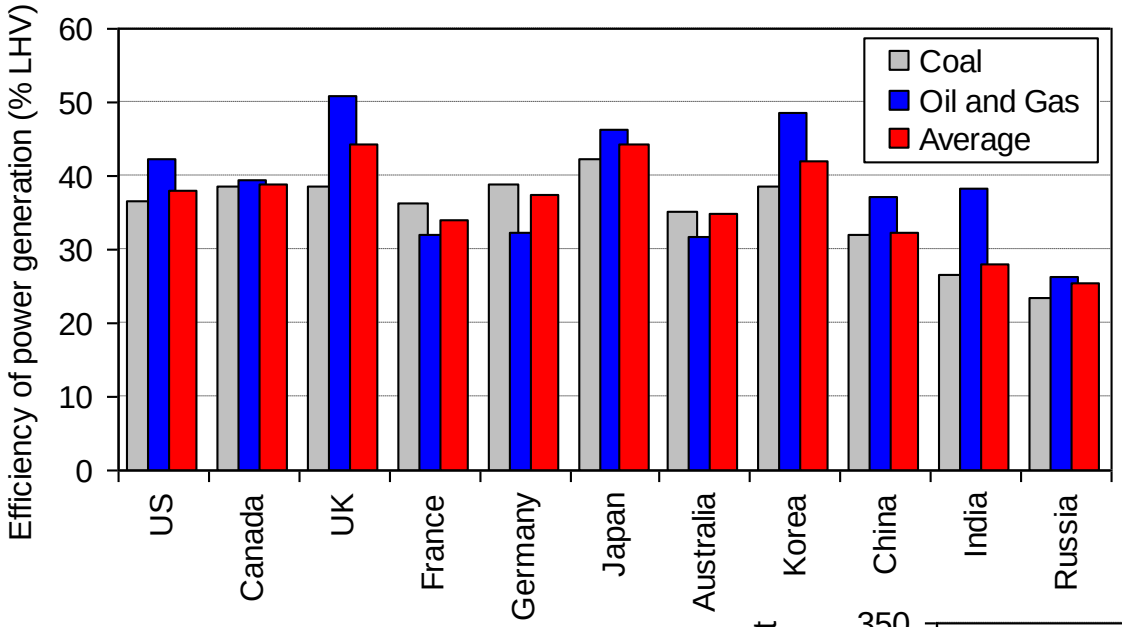
Note: Electricity is converted by using 1MWh=0.086/0.33toe.
Source: Estimates by RITE from IEA (2006),
IISI (2005) etc.

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)

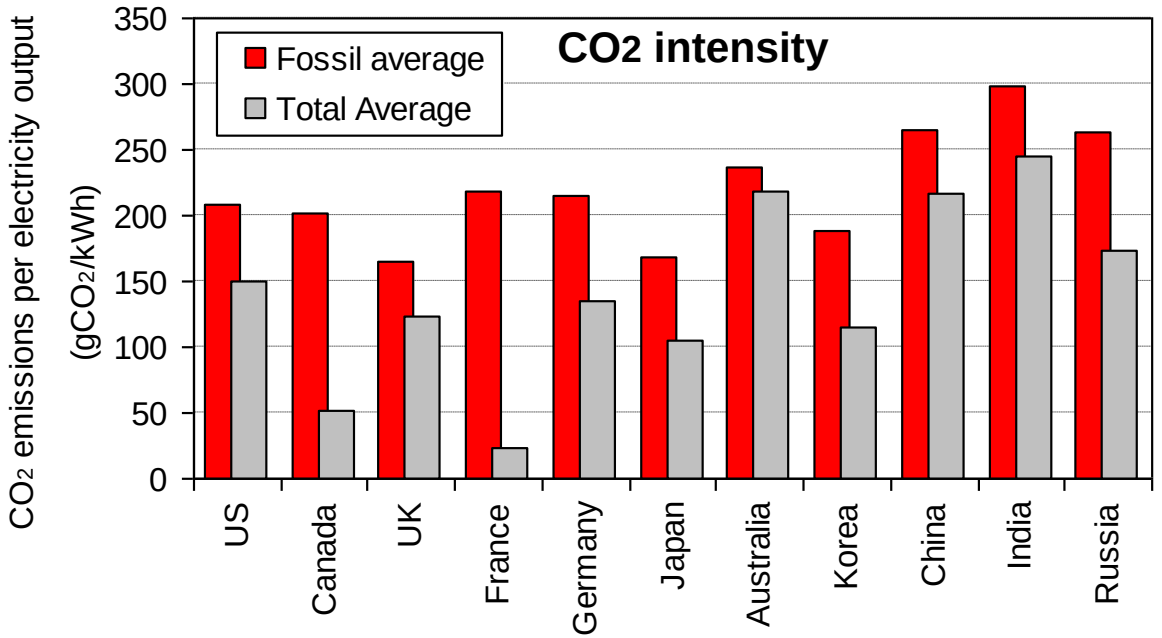


Efficiency

Power sectors (2005)

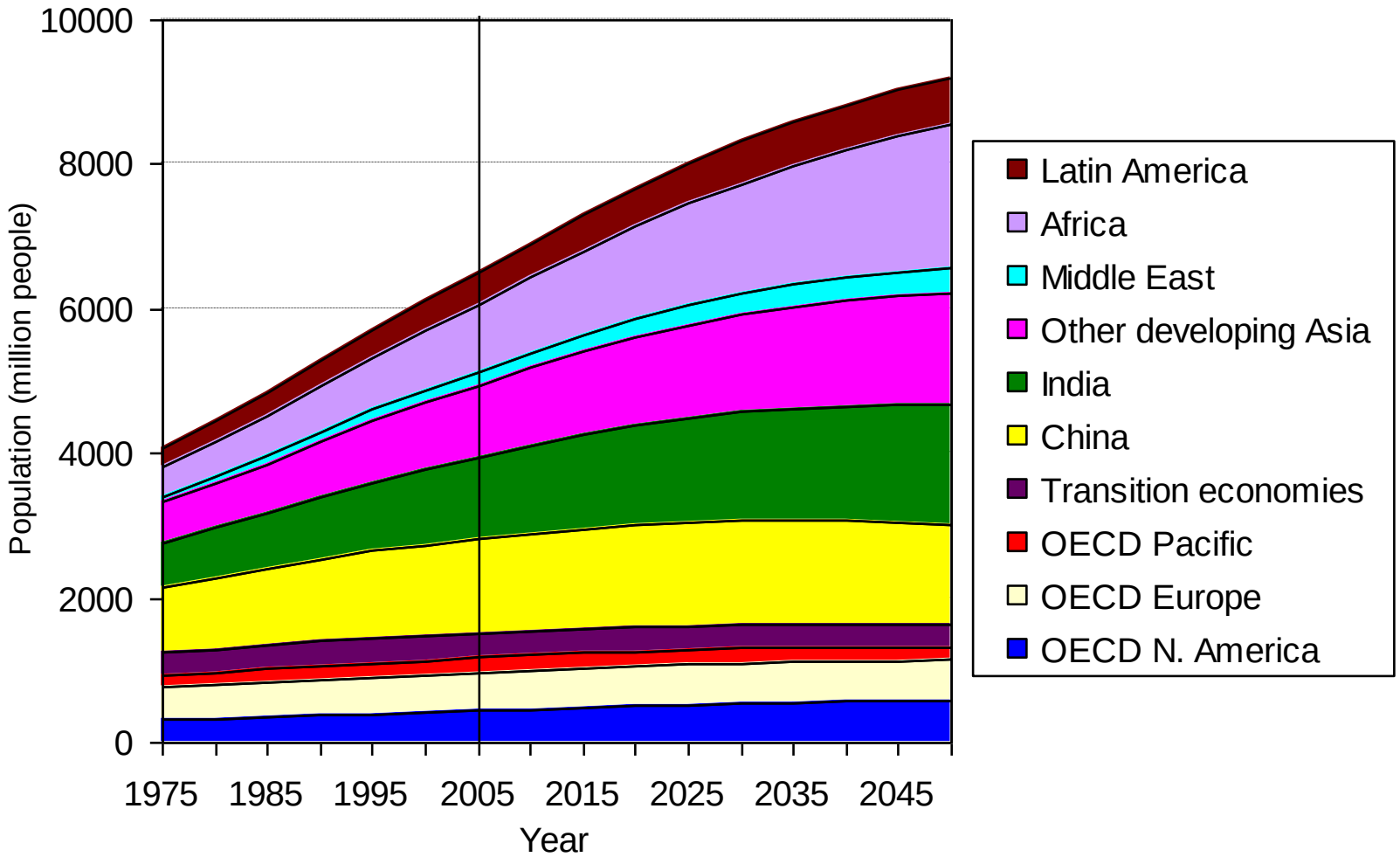
Including CHP

Source: IEA, 2007



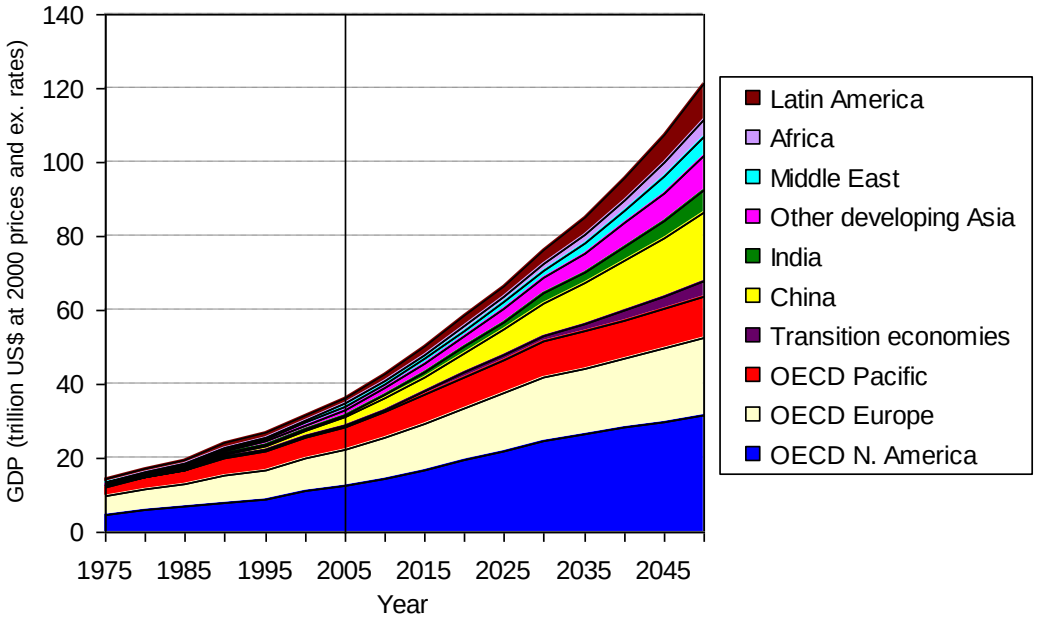
Assumptions of DNE21+ (1/3)

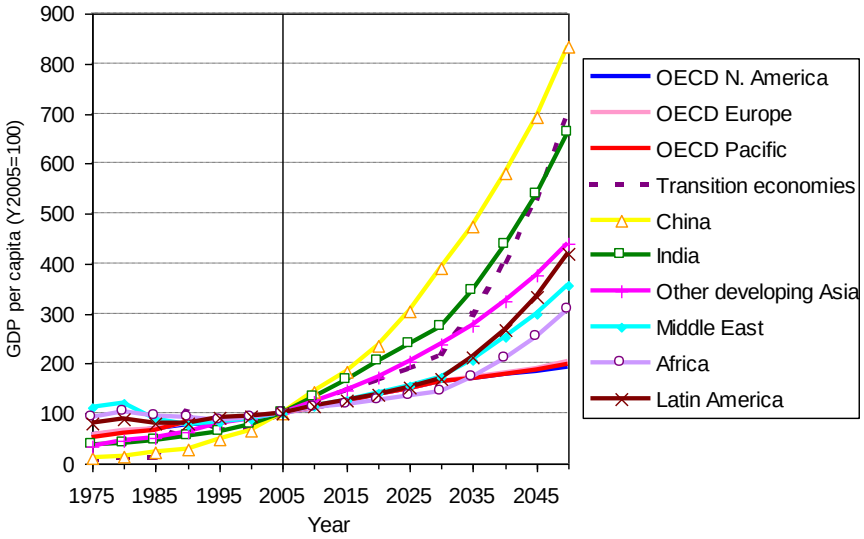
- **Population: UN2006 Medium Scenario**



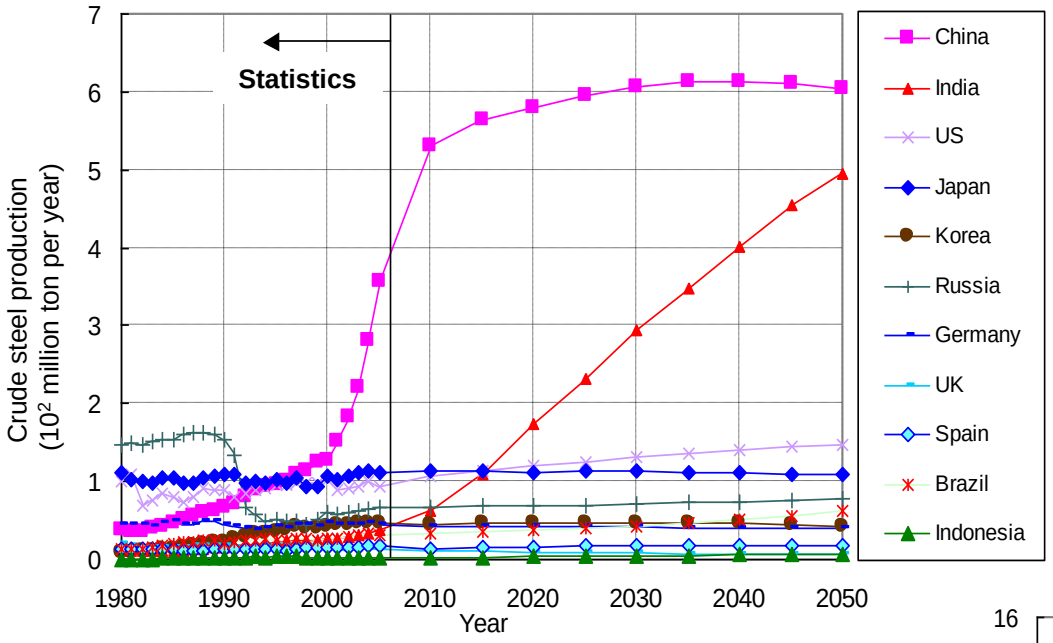
Assumptions of DNE21+ (2/3)

- **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)**



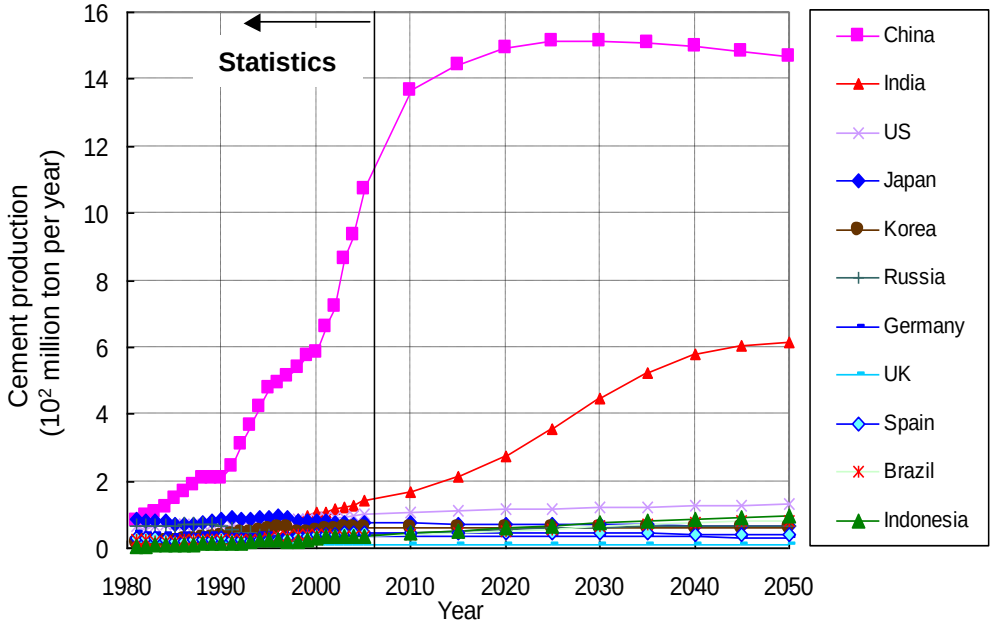


Assumptions of DNE21+ (3/3)

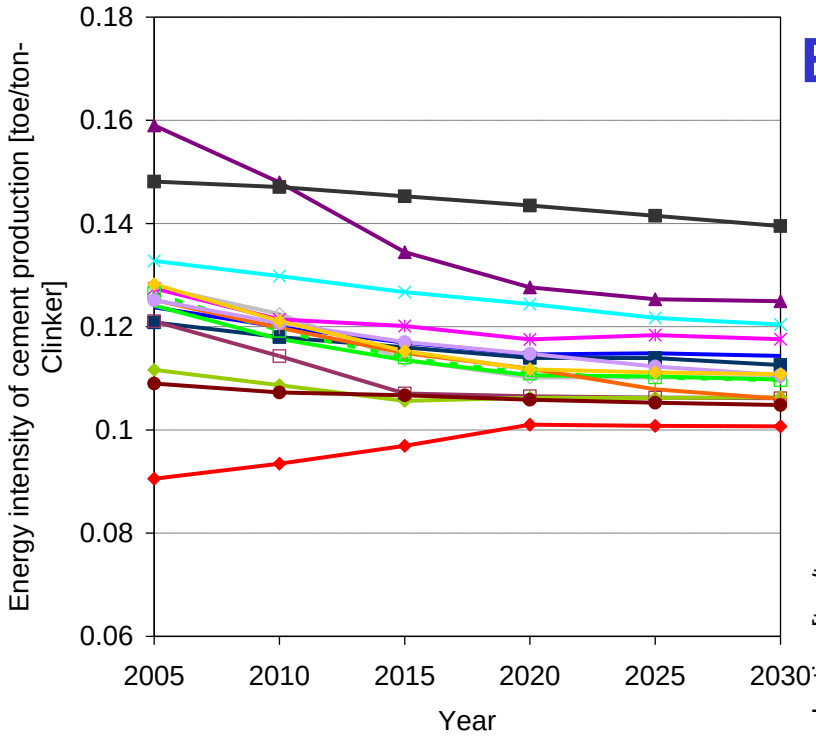


Iron & Steel (Crude steel production)

Cement (Cement production)

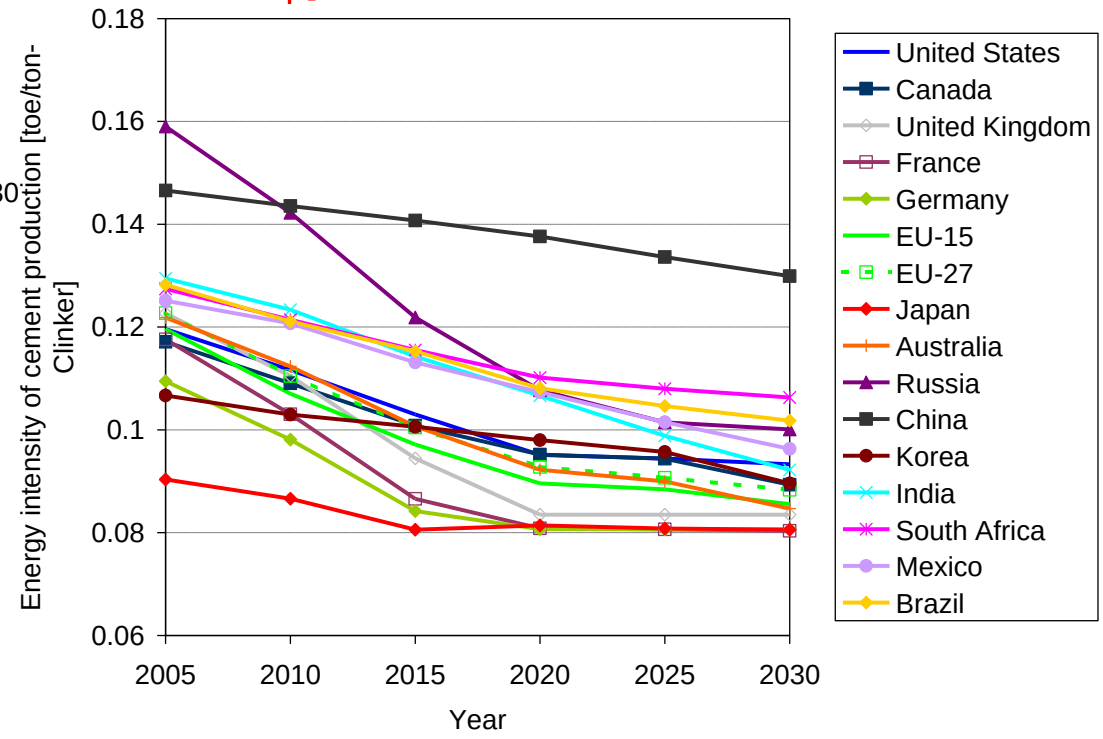


Energy Intensity of Cement Sector by Country

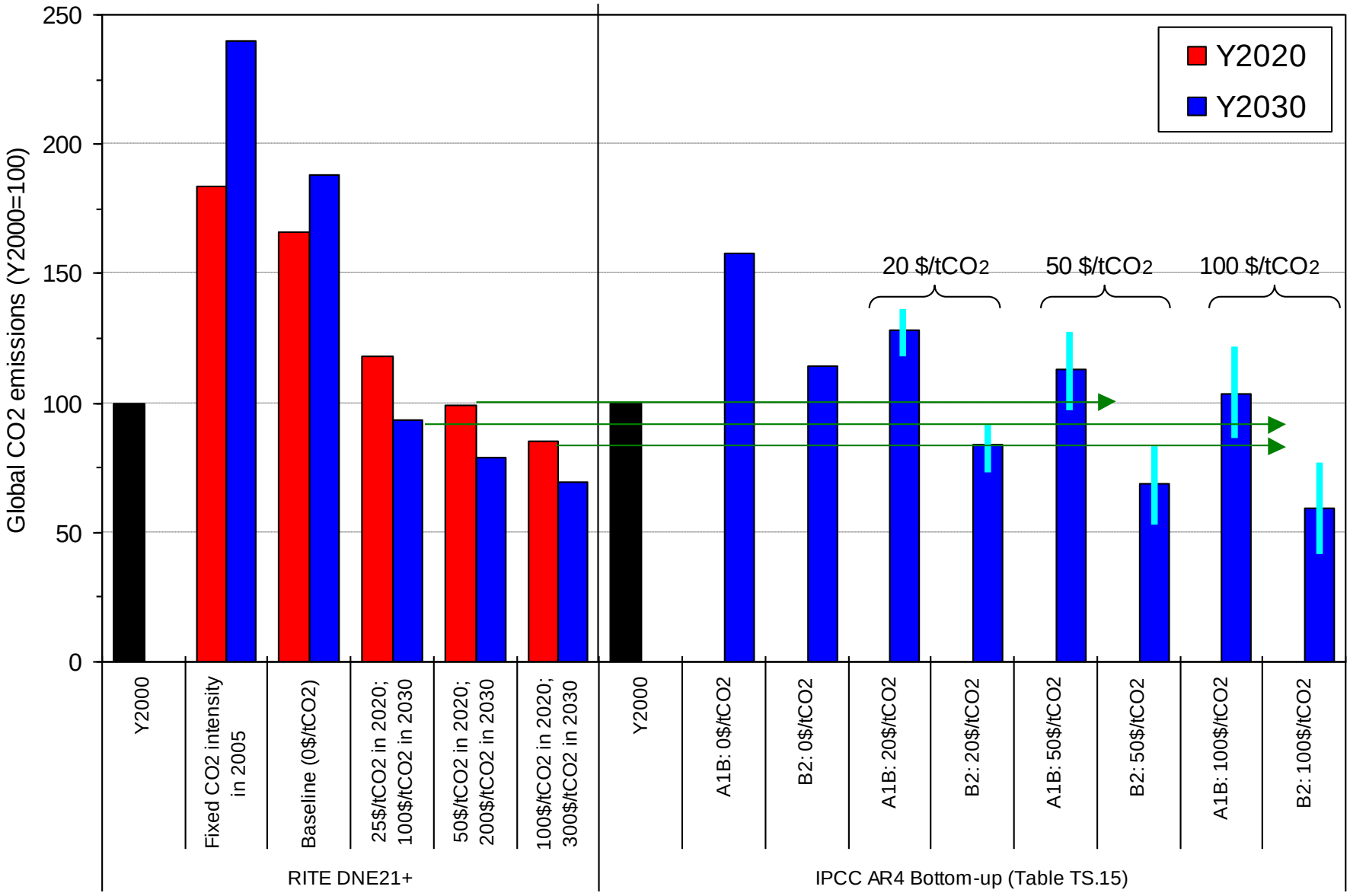


Baseline

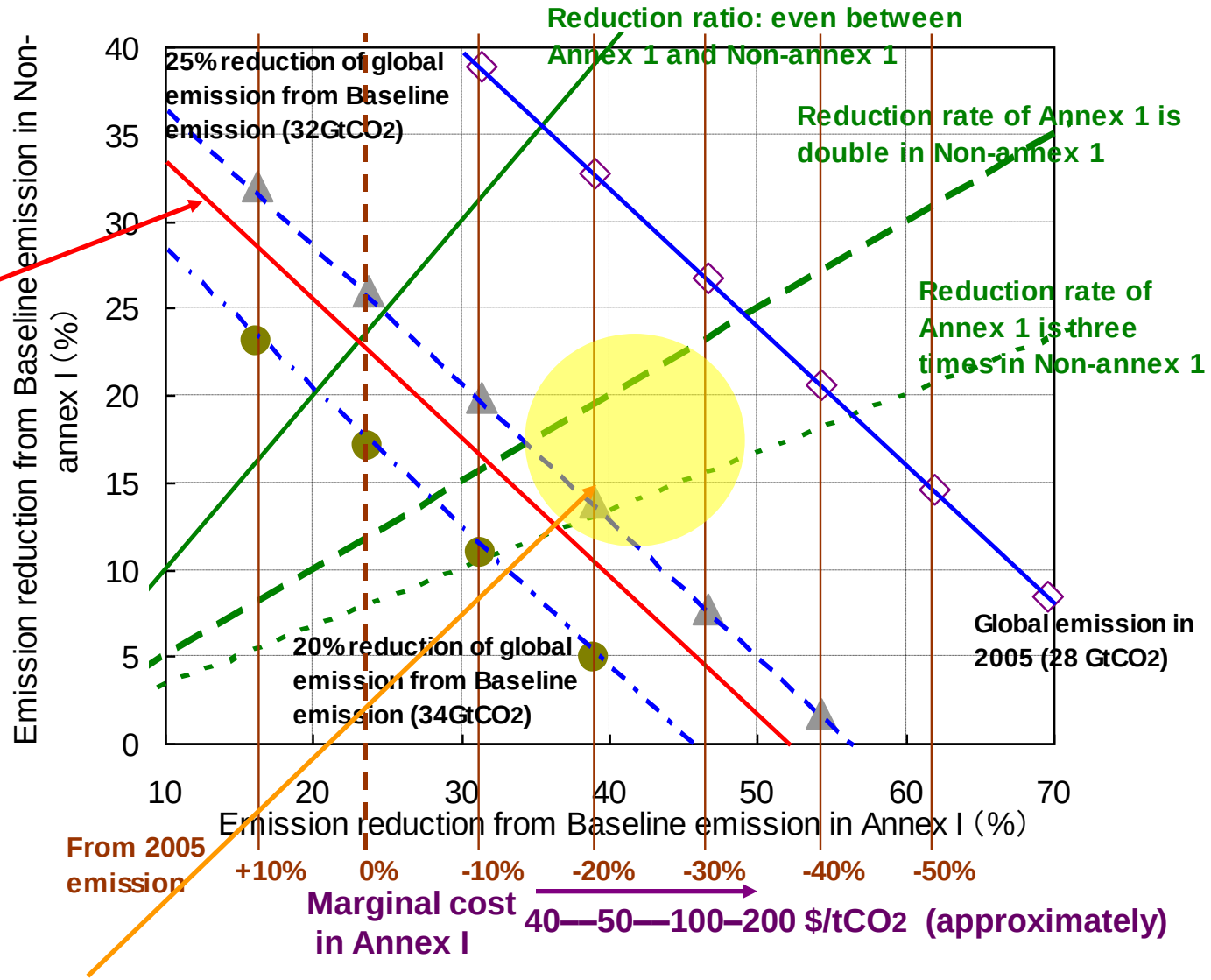
50$/tCO2 in 2020



Comparisons between DNE21+ and IPCC AR4



Considerations of Burden Share between Annex I and Non-annex I Countries in 2030



The global emission in 2030 in the previous slide

- **Subjective burden share between Annex I and Non-annex I countries for global emissions to peak in the next 10 to 20 years**