Netherlands Environmental Assessment Agency

Reduction potential and costs based on the IMAGE/TIMER/FAIR model

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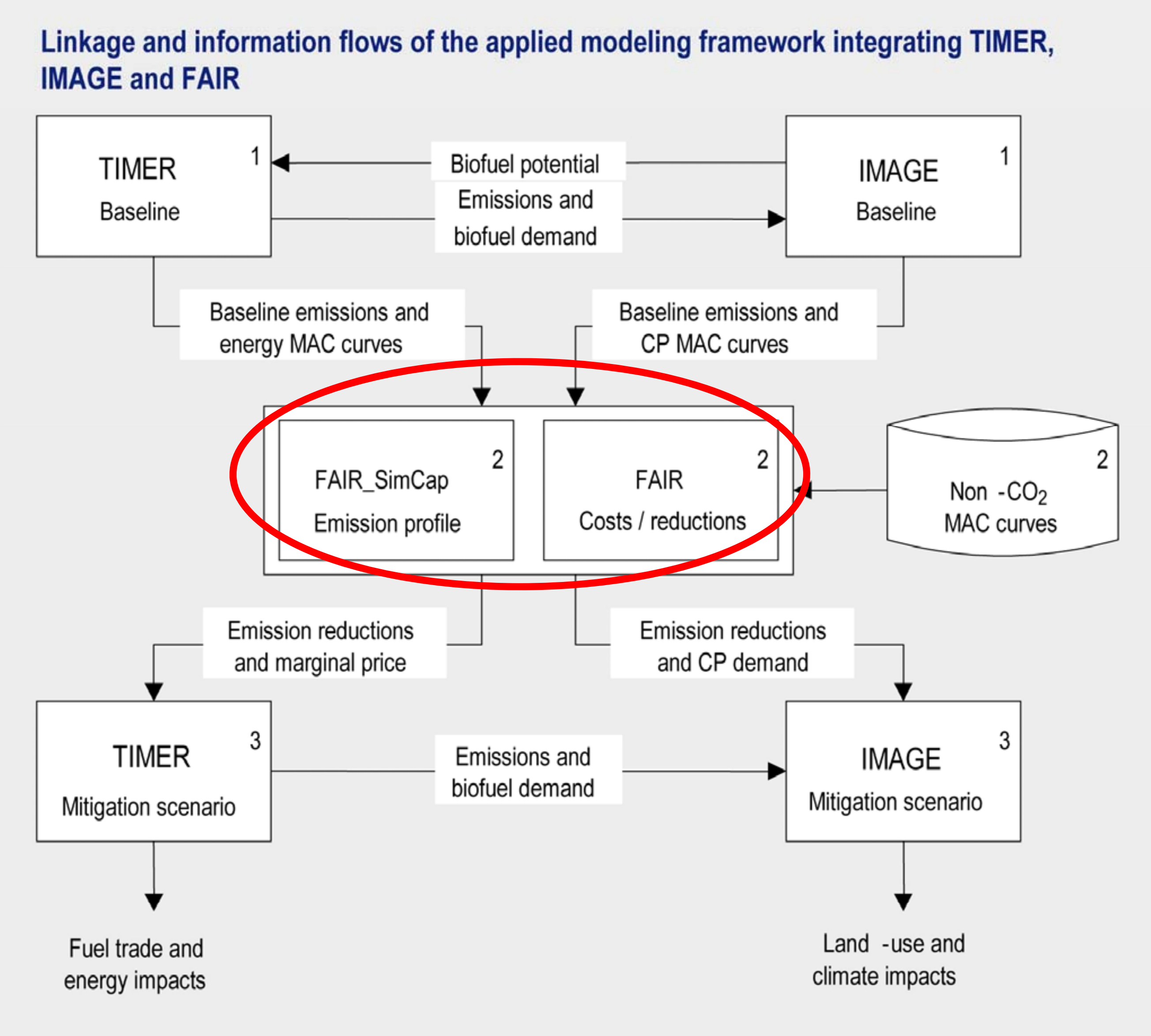
Outline presentation

1. Methodology
2. Analysis
- Low stabilisation scenarios
- Carbon tax scenarios (OECD Environmental Outlook)
3. Conclusions

Part of integrated IMAGE model to develop climate mitigation scenarios



1.Baseline and MACs

2. Global emission pathway, regional targets and costs

3. Energy and land use changes

Van Vuuren et al, 2007, Stabilising greenhouse gas concentrations, Climatic Change

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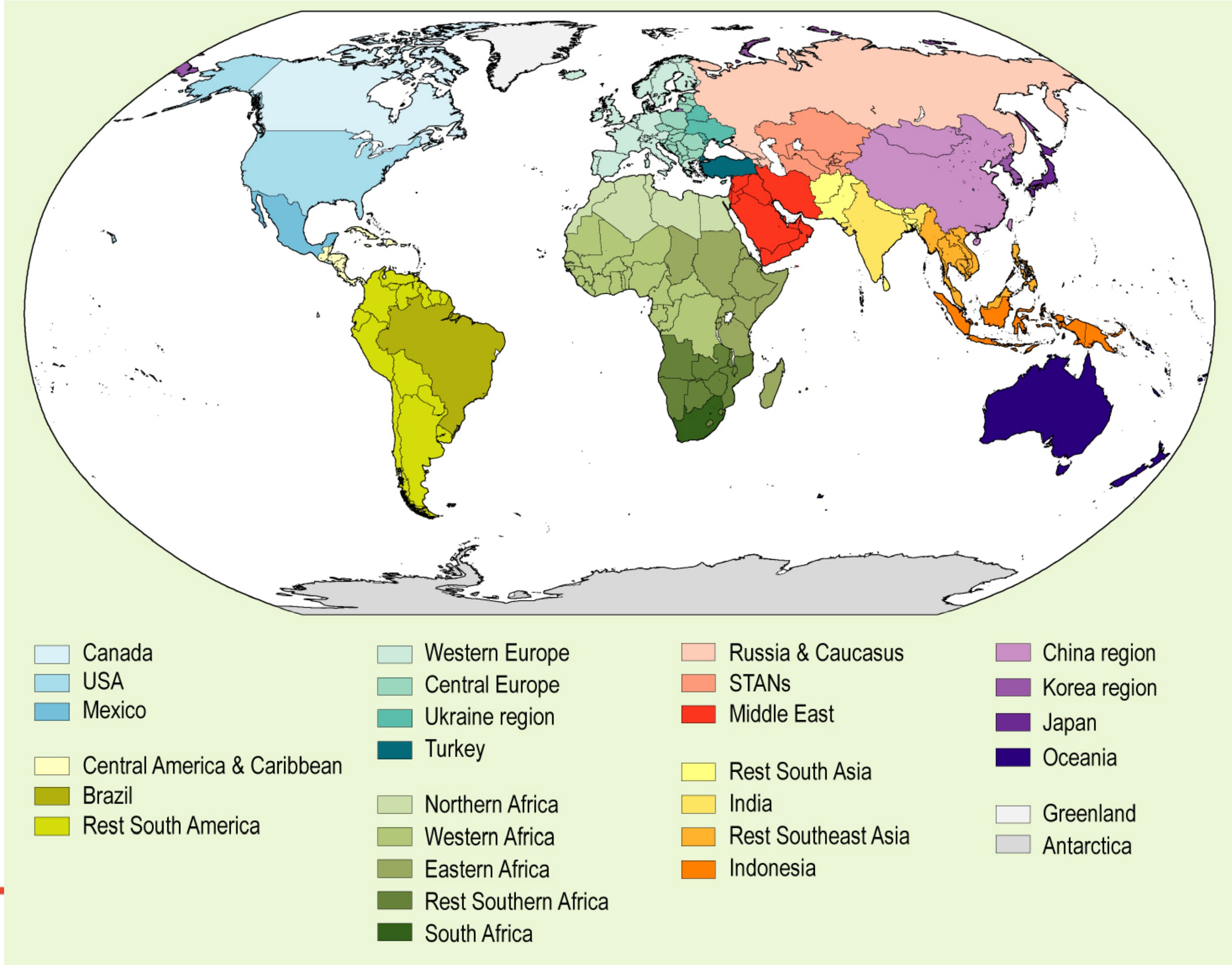
Regions



Canada
USA
Mexico
Central America & Caribbean
Brazil
Rest South America
Western Europe
Central Europe
Ukraine region
Turkey
Northern Africa
Western Africa
Eastern Africa
Rest Southern Africa
South Africa
Russia & Caucasus
STANs
Middle East
Rest South Asia
India
Rest Southeast Asia
Indonesia
China region
Korea region
Japan
Oceania
Greenland
Antarctica

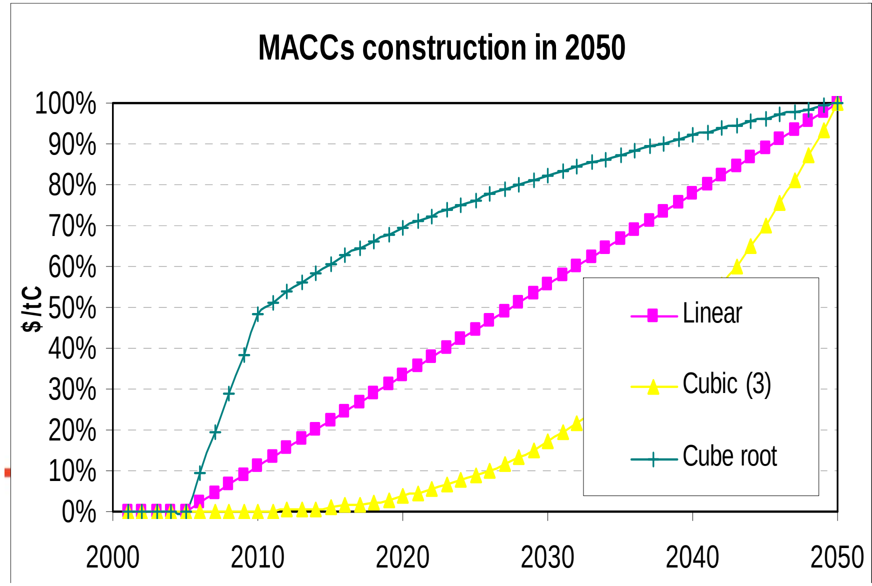
Marginal Abatement Costs (MAC) curves

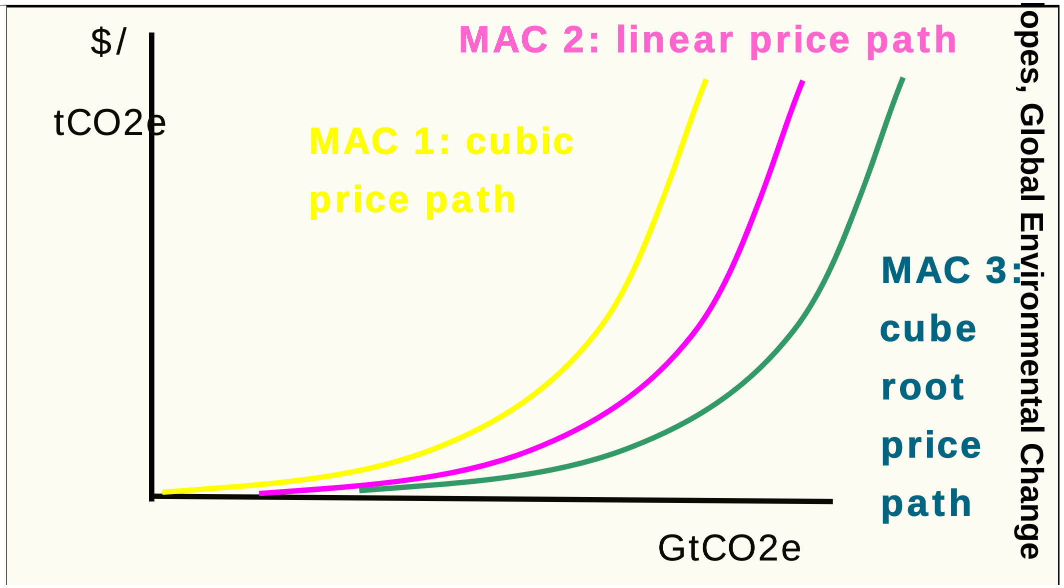
- Energy CO_2 emissions from energy models TIMER and POLES
  - accounting technological improvements, energy inertia and learning effects
  - Many sectors and mitigation options (inc. CCS, renewables)
- Non-CO_2 emissions based on extended EMF non-CO_2 MAC curves
  - accounting technological improvements and removal of implementation barriers
- Avoiding deforestation based on MAC curves of GCOMAP model (LBNL), IIASA DIMA forest sector model
- Reforestation MAC based on IMAGE runs
  - accounting difference in productivity between existing vegetation and new forests (at grid-level).

den Elzen et al., 2007, Multi-gas emission envelopes, Global Environmental Change

Path Dependency of MAC curves

- Costs vary depending on what happened in previous years
  - ITC – Induced Technological Change
  - Inertia in energy system – lifetimes times for power plants etc
- Using static MACs does not capture this
- But FAIR tries to take into account by interpolating between 3 “standard” MAC curves, based on 3 “standard” historical price paths





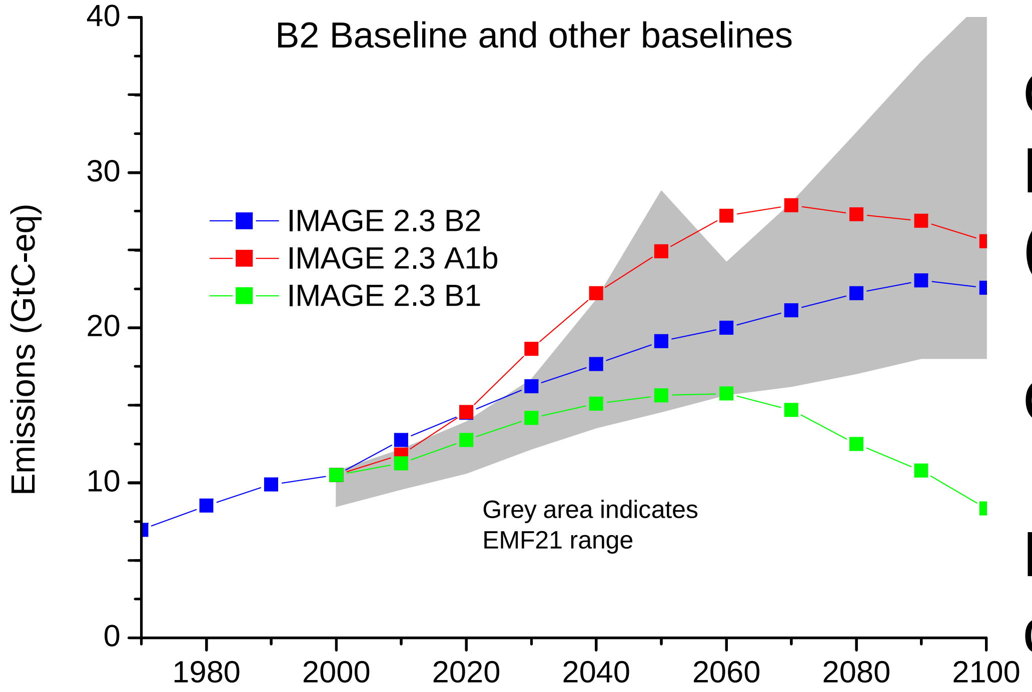
den Elzen et al., 2007, Multi-gas emission envelopes, Global Environmental Change

Methodology Abatement costs model

- Abatement costs include direct costs for climate policy, but do not include: macro-economic effects, gains of ancillary benefits and cost/gains of changes fuel trade
- using Marginal Abatement Cost (MAC) curves and calculating demand & supply curves
- Discount rate of 5%, but energy system also 10% (investments made by private parties)
- Include Transaction costs and CDM accessibility
- Emission trading
  - full trading in case regions participate
  - limited trading for non-participants (CDM)

Van Vuuren et al, 2007, Stabilising greenhouse gas concentrations, Climatic Change

Baseline – developments without Climate Policy



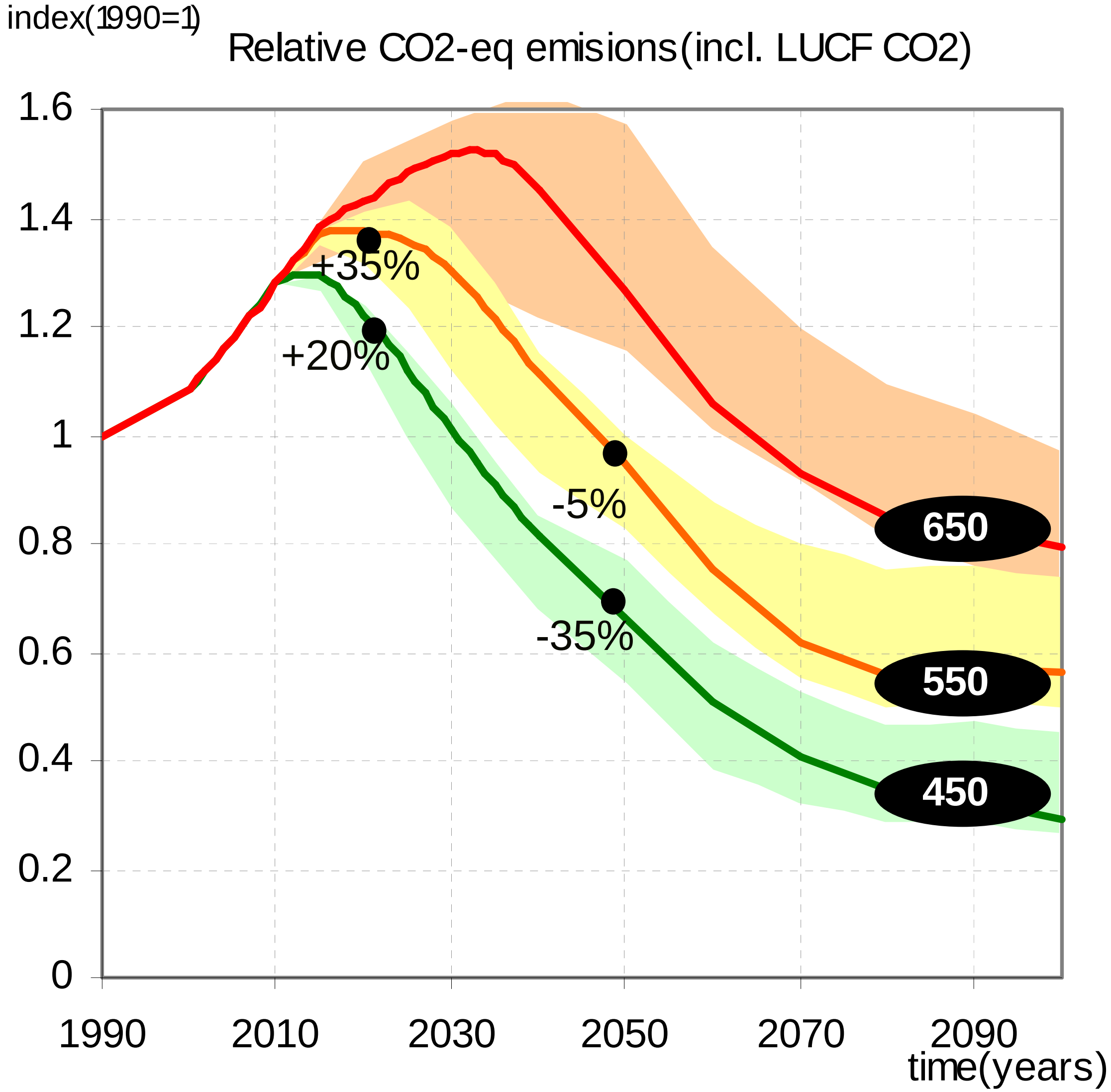
Central case B2:
Population 2100: 9 billion (UN medium)

GDP growth: 2% per year

Energy: near IEA until 2030, conventional development after 2030

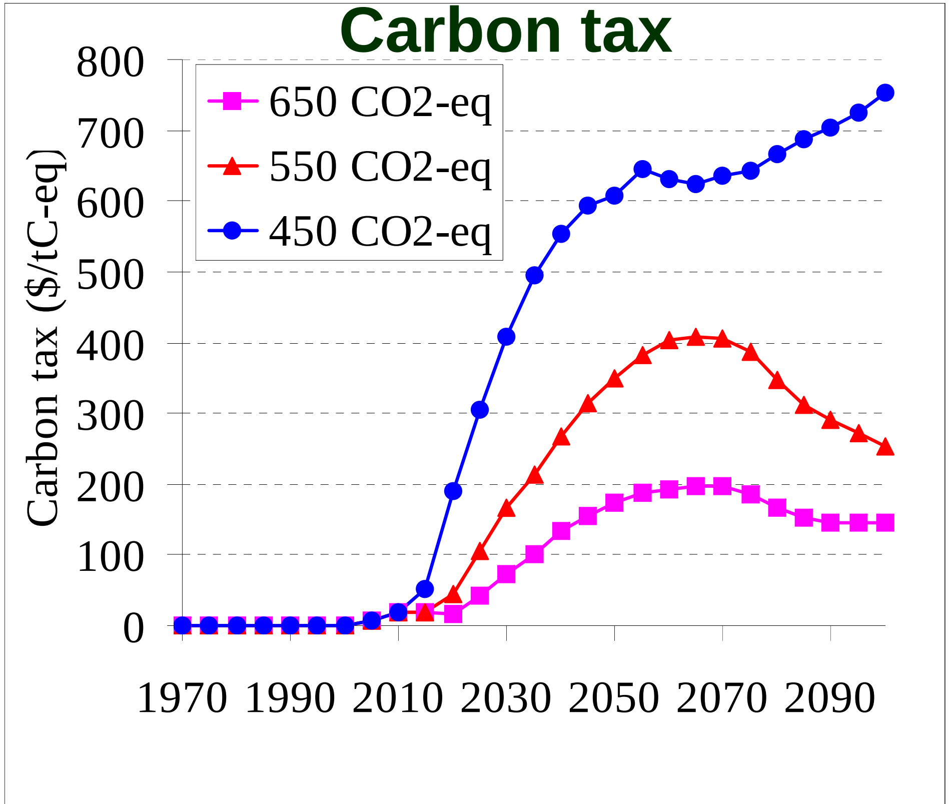
Van Vuuren et al, 2007, Stabilising greenhouse gas concentrations, Climatic Change

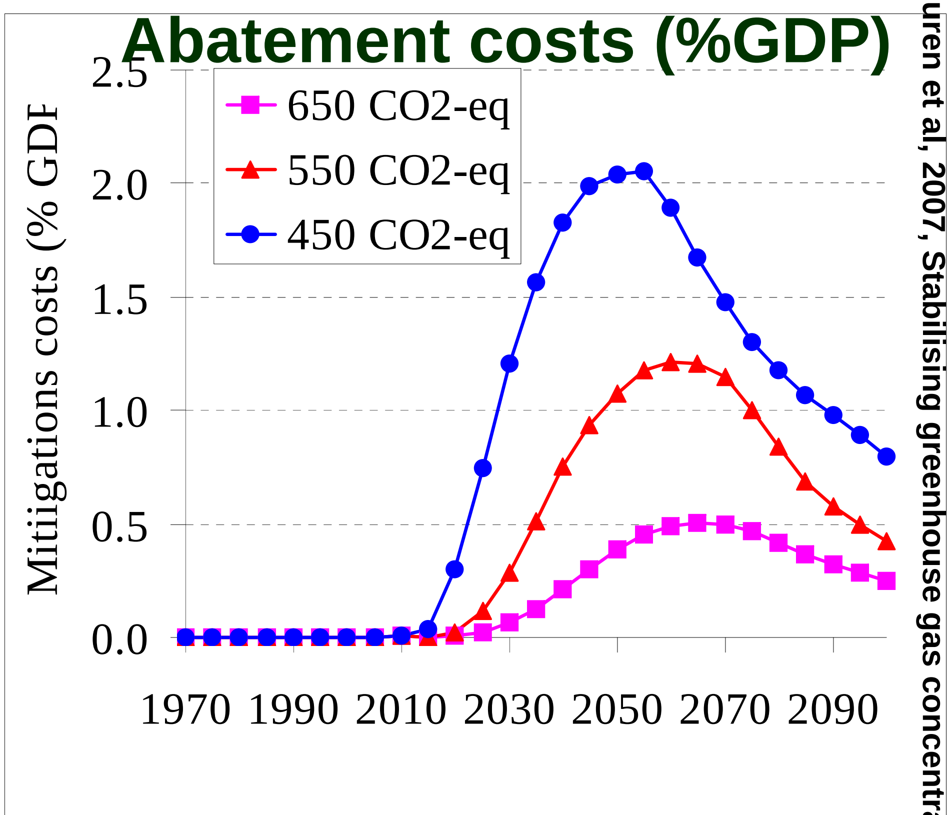
Pathways for stabilisation at 450,550 and 650 ppm CO_2-equivalent



den Elzen et al., 2007, Multi-gas emission envelopes, Global Environmental Change

Global abatement costs for meeting 450ppm increase up to 2% of world GDP

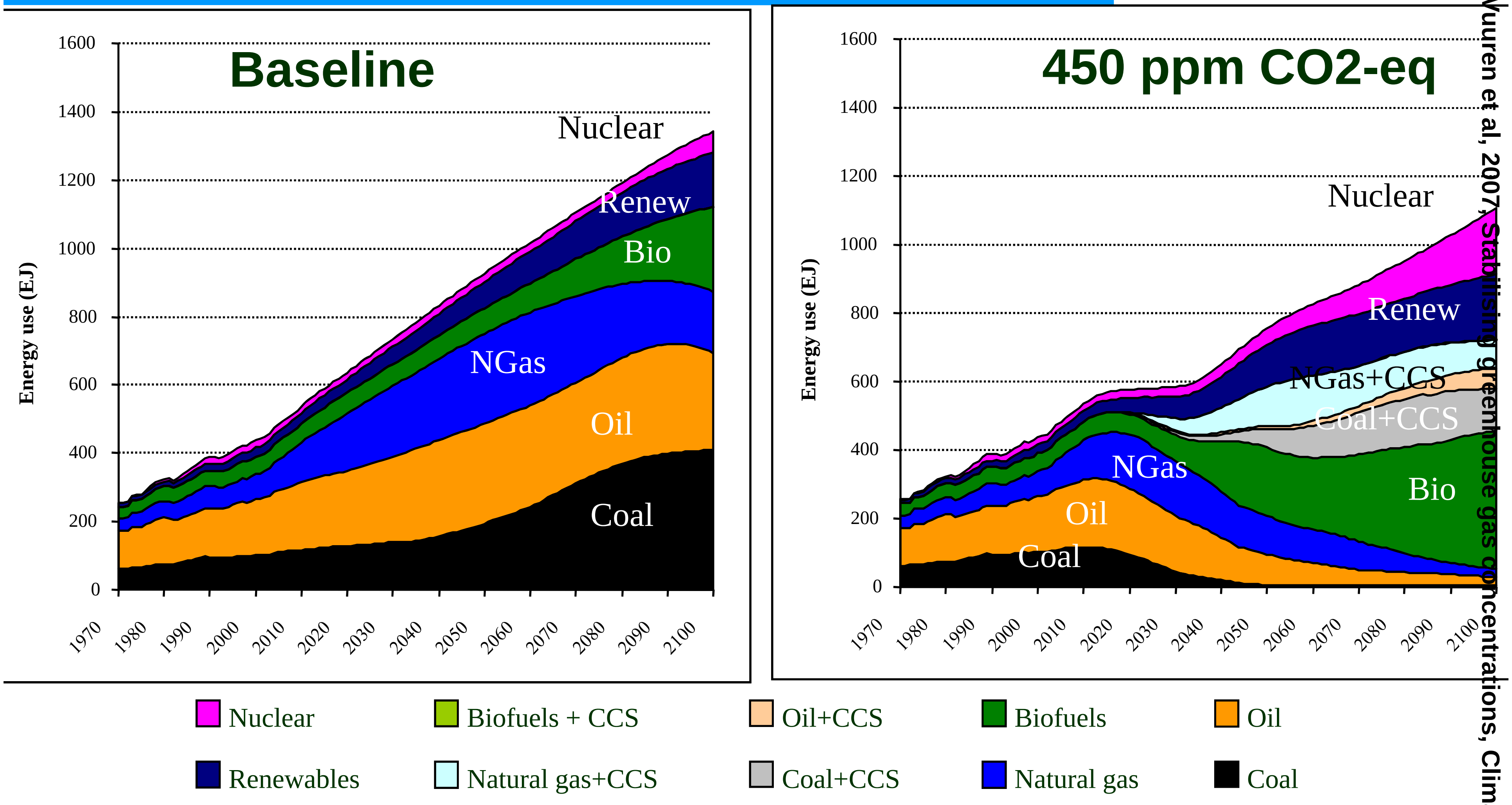




- Carbon taxes in the order of 200 (650) to 600-800 (450) $/tC
- Abatement costs as % of GDP vary over time – and peak around 2030-2050

Van Vuuren et al, 2007, Stabilising greenhouse gas concentrations, Climatic Change

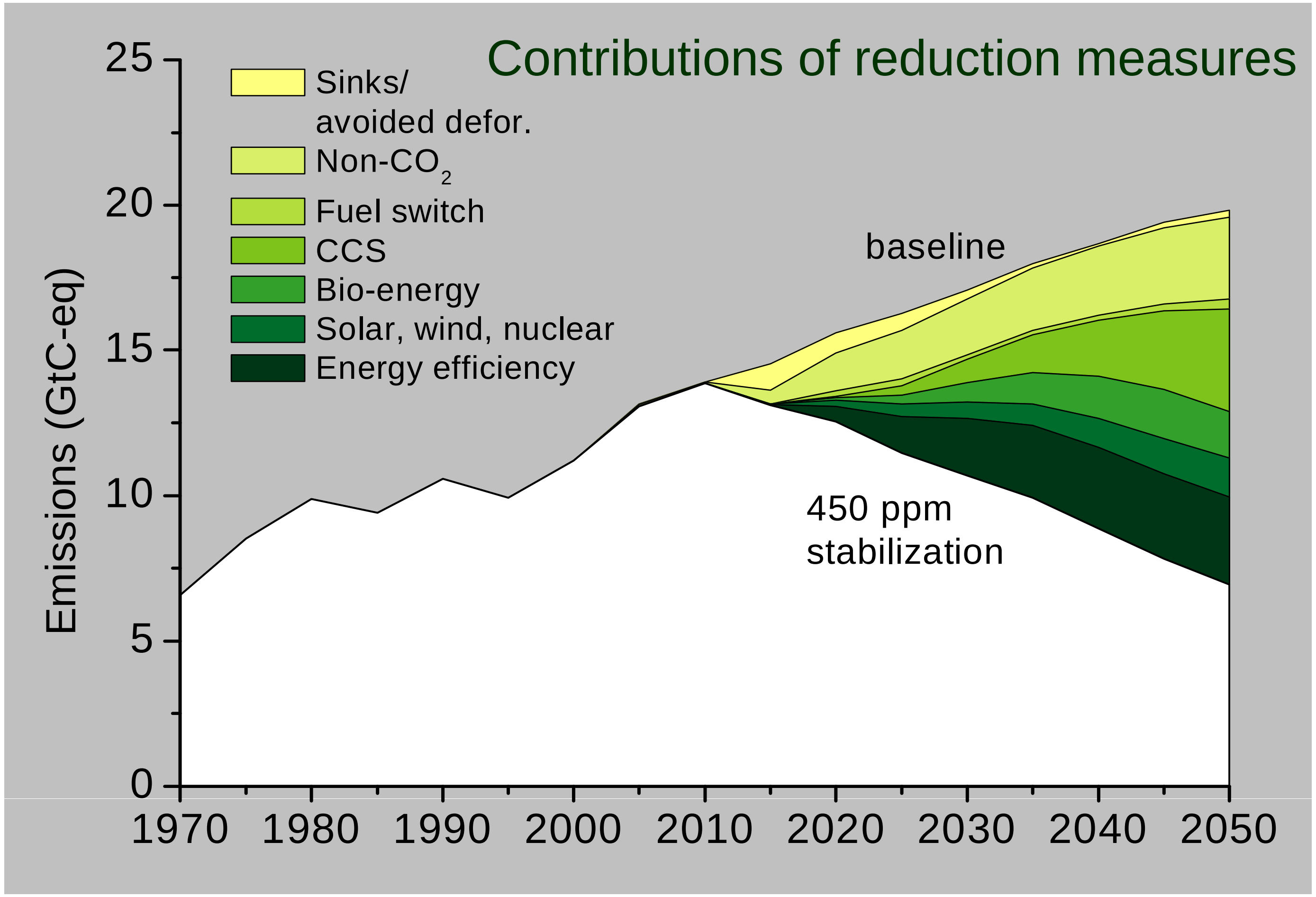
Major changes in the global energy system are required to meet 450ppm



- Energy use in baseline vs. mitigation scenario

Van Vuuren et al, 2007, Stabilising greenhouse gas concentrations, Climatic Change

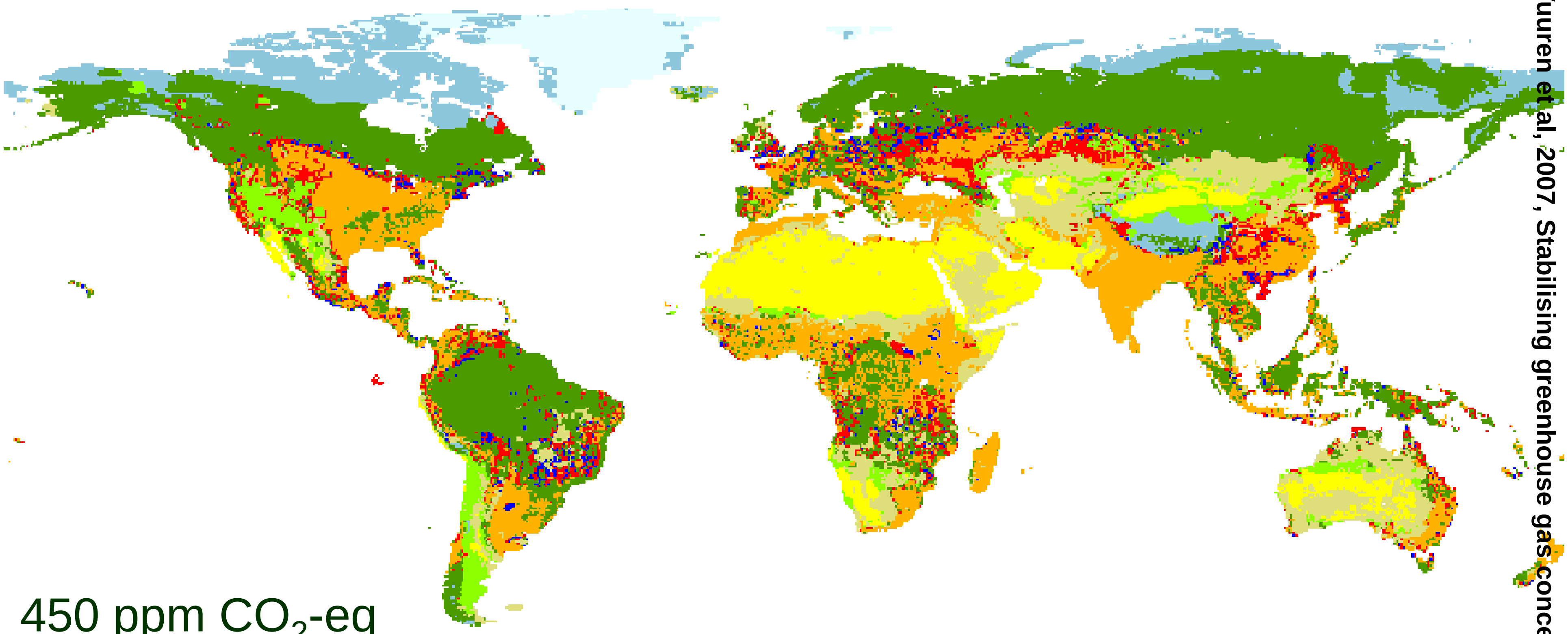
Energy efficiency improvements, bio-energy and CCS contribute the most in the reductions



- Main options short term: non-CO_2, fuel switch and efficiency
- Main options long term: CCS; Biofuels, renewables & nuclear

van Vuuren et al, 2007, Stabilising greenhouse gas concentrations, Climatic Change

Meeting 450ppm also leads to major changes in land use, i.e. bio-energy and C-plantations



- Land use pattern in 450 ppm scenario in 2100

van Vuuren et al, 2007, Stabilising greenhouse gas concentrations, Climatic Change

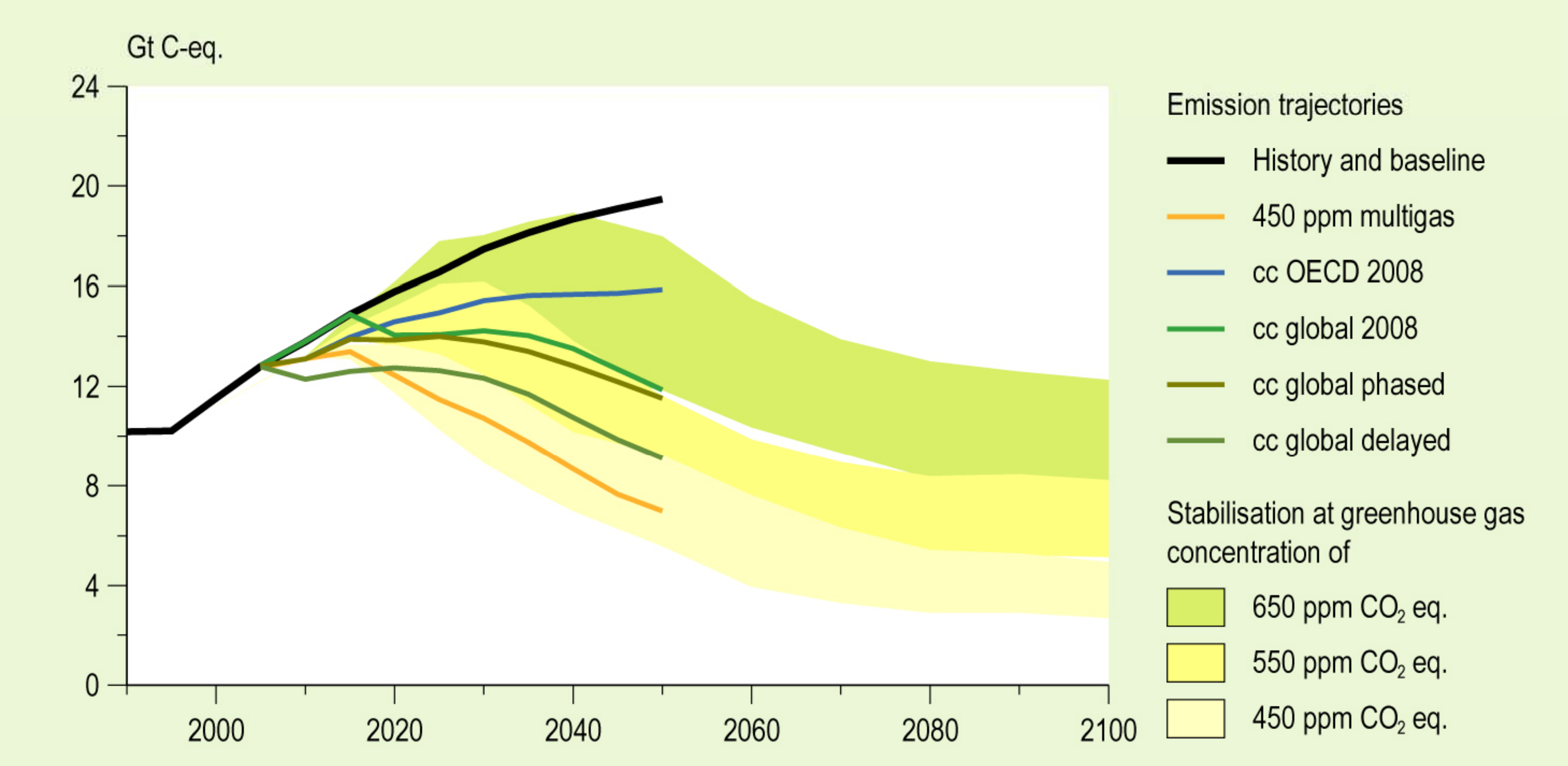
Carbon tax scenarios (OECD Environmental Outlook)

450 ppm	reduce emission in order to stay within 2^{o}C with a 50% probability
CC OECD	Increasing carbon tax in OECD only (2008)
CC Global	Increasing carbon tax in al countries (2008)
CC global (phased)	Increasing carbon tax, all countries (but phased): OECD 2008; BRIC 2020; Rest of World 2030
CC global (delayed)	Increasing tax, but all countries starting in 2020

- Starting at 25 US$/tCO2, increasing with 2.4%/yr (Social Cost of Carbon (SCC) in IPCC's 4th Assessment Report)

Bakkes et al, 2008, Background report to the OECD Environmental Outlook to 2030, MNP

Carbon tax scenarios (OECD Environmental Outlook)

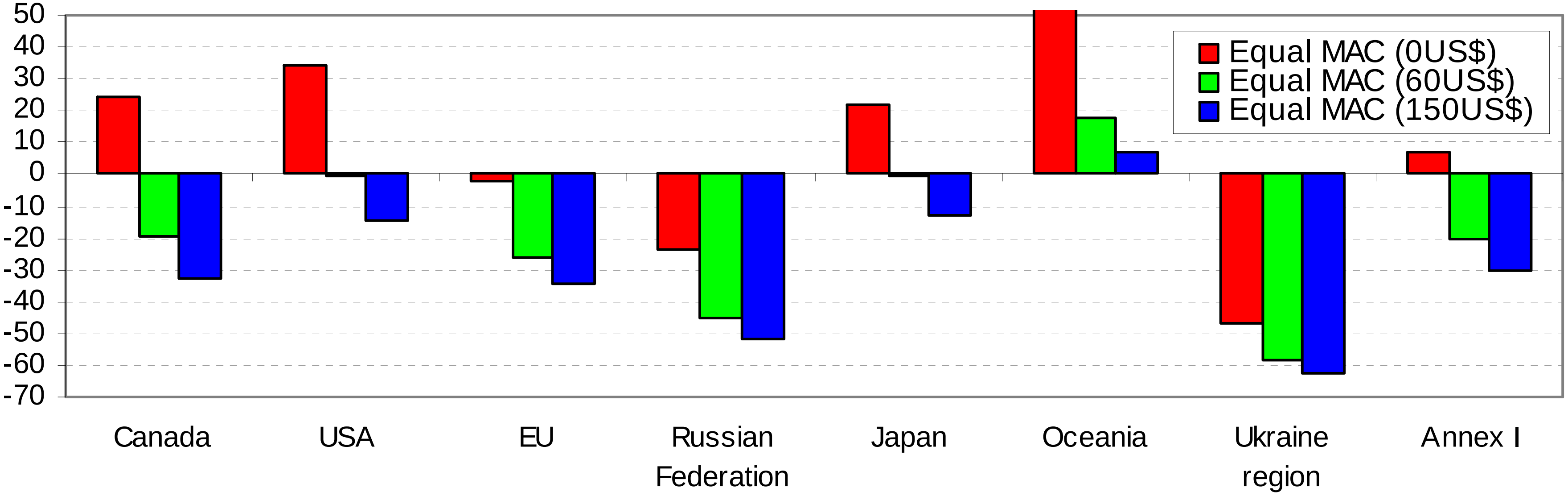


- The difference in implementation in 2008 and 2020 corresponds more or less to stabilization at 550 and 650 ppm CO2-eq.
- No carbon tax scenario meets 2 degree

Bakkes et al, 2008, Background report to the OECD Environmental Outlook to 2030, MNP

Comparable effort analysis: Mitigation reduction potential & Costs for 0, 60 and 150US$/tCO2

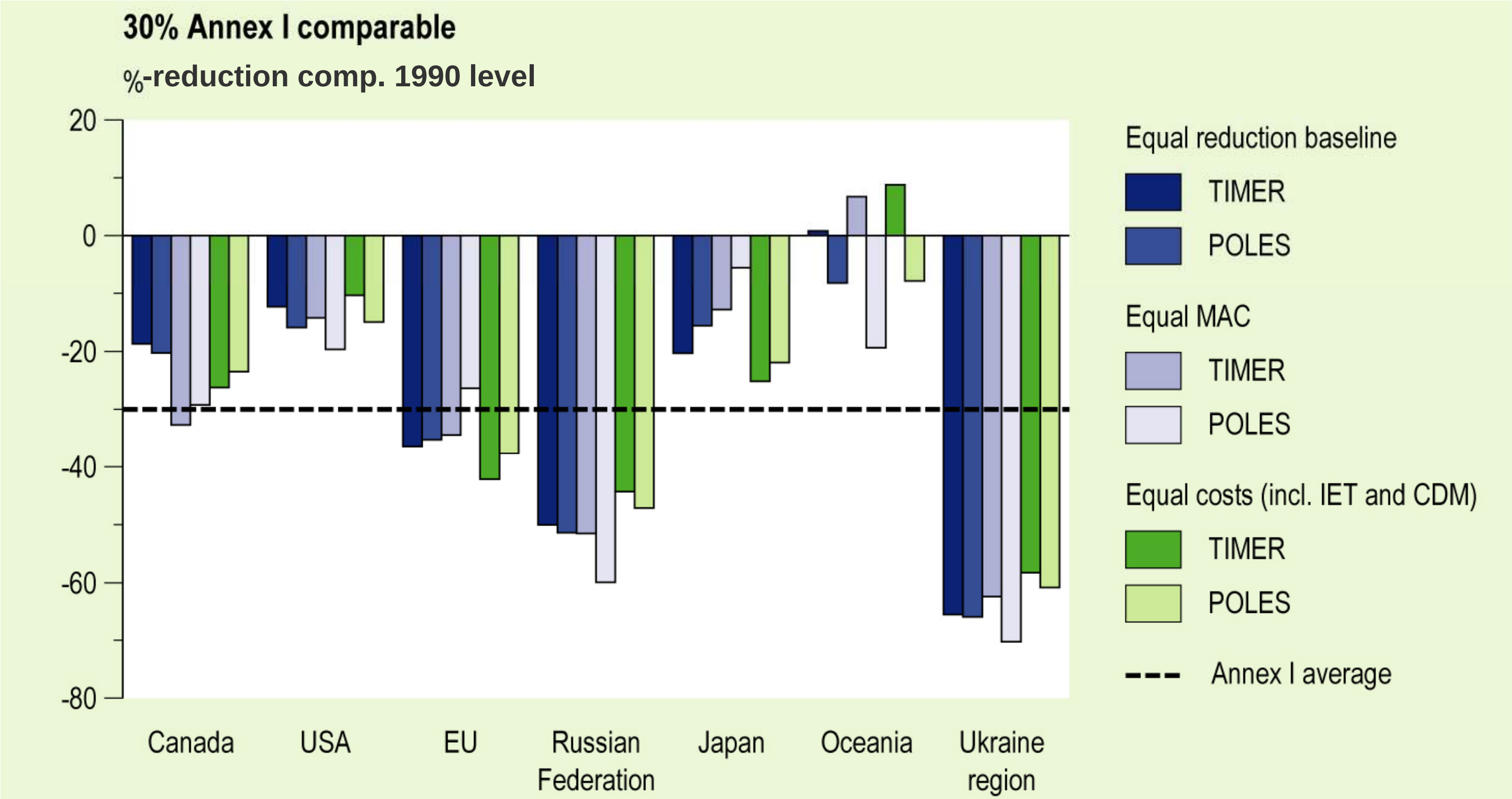
Reduction compared to 1990 emissions in 2020 (%)



- Tax levels corresponds to baseline, and 20% and 30% Annex I reduction scenario
- No emissions trading

Den Elzen et al, 2008, Exploring comparable post-2012 efforts, MNP report

Comparable effort analysis: reductions for Annex I countries



- reductions dependent on the assumed Marginal Abatement Costs curves

Den Elzen et al, 2008, Exploring comparable post-2012 efforts, MNP report

Conclusions

- Stabilizing GHG concentration at low levels (about 450 ppm CO2-eq) in order to meet 2 degree target technically feasible possible with ‘known techniques’
- Portfolio of options needed: substantial contribution CCS and efficiency. Multi-gas approach.
- Abatement-costs for 450 ppm are in the order of a few percent of world GDP, strongly depending on baseline developments
- Early participation of large emitting countries is needed for meeting the low stabilisation levels

Thank you for your attention

Report (www.mnp.nl¥en):

- den Elzen, M.G.J, Höhne, N., van Vliet, J. and Ellerman, C., 2008. Exploring comparable post-2012 efforts for Annex I countries.
- Bakkes et al, 2008, Background report to the OECD Environmental Outlook to 2030.

Paper:

- van Vuuren, D.P., den Elzen, M.G.J., Eickhout, B., Lucas, P.L., Strengers, B.J., 2007. Stabilising greenhouse gas concentrations. Assessment of different strategies and costs using an integrated assessment framework. Climatic Change, 81: 119-159.
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Back-up slides: for information

Publications (www.mnp.nl¥fair):

- den Elzen, M.G.J. and Höhne, N.: 2008, 'Reductions of greenhouse gas emissions in Annex I and non-Annex I countries for meeting concentration stabilisation targets', Climatic Change, in press http://dx.doi.org/10.1007/s10584-008-9484-z.
- den Elzen, M.G.J., Höhne, N. and Moltmann, S.: 2008a, 'The Triptych approach revisited: a staged sectoral approach for climate mitigation', Energy Policy 36 (3): 1107-1124.
- den Elzen, M.G.J. and Lucas, P., 2005. The FAIR model: a tool to analyse environmental and costs implications of climate regimes. Environmental Modeling and Assessment, 10(2): 115-134.
- den Elzen, M.G.J., Lucas, P. and van Vuuren, D.P.: 2008c, 'Regional abatement action and costs under allocation schemes for emission allowances for achieving low CO2-equivalent concentrations', Climatic change 90 (3): 243–268
- den Elzen, M.G.J., Meinshausen, M. and van Vuuren, D.P., 2007. Multi-gas emission envelopes to meet greenhouse gas concentration targets: costs versus certainty of limiting temperature increase. Global Environmental Change, 17: 260–280.
- Lucas, P., van Vuuren, D.P., Olivier, J.A. and den Elzen, M.G.J.: 2007, 'Long-term reduction potential of non-CO2 greenhouse gases', Environmental Science & Policy 10 (2): 85-103.

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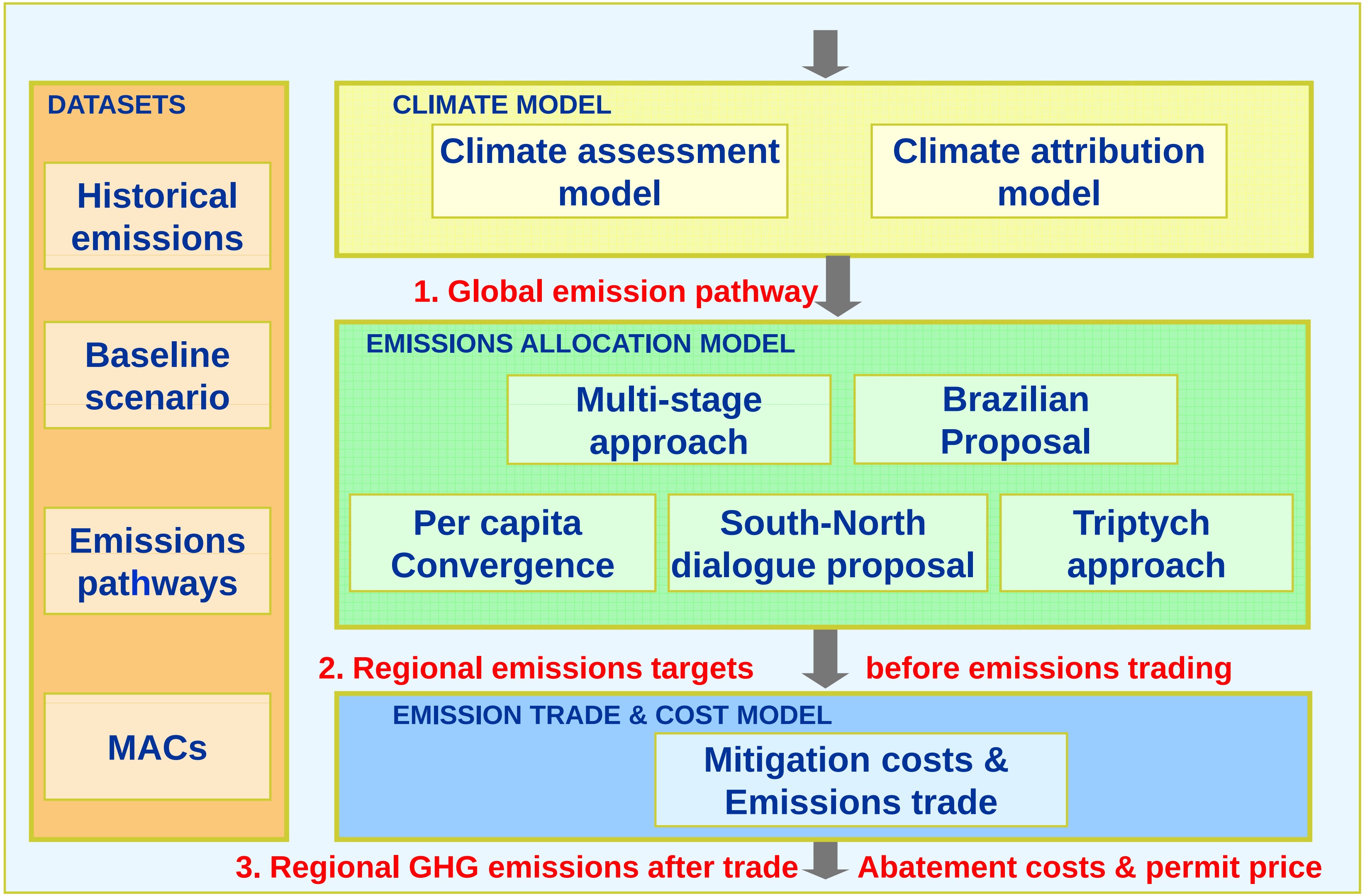
FAIR 2.0 model: to assess regional emissions and costs for post-2012 mitigation regimes



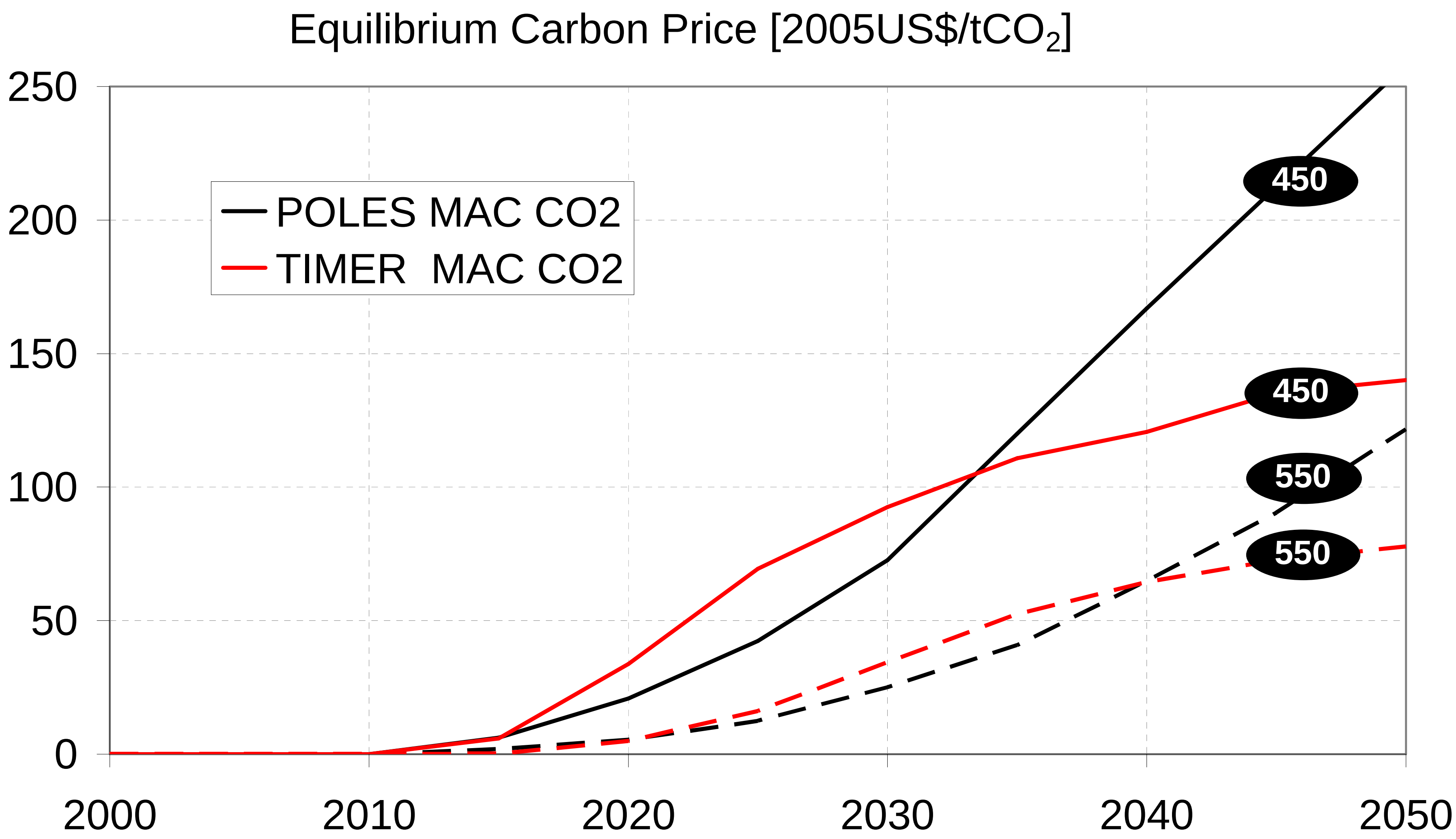
den Elzen, Lucas, 2005, The FAIR 2 model, Environmental Modelleing Assessment

Objective Abatement costs model

- To calculate abatement costs and permit price (multi-gas)
- To calculate the buyers and sellers and financial flows on the international permit market
- To distribute the global reduction objective over the different regions, gases and sectors following a least-cost approach, making use of the flexible Kyoto mechanisms

den Elzen, Lucas and van Vuuren, 2005, Abatement costs, Energy Policy

Choice of MAC curves matters: POLES gives lower prices till 2035-2040, and higher later



Global costs are manageable for POLES and TIMER MAC curves