

# Assessing the Effort-Sharing in Ambitious Global Climate Scenarios

Sanna Syri, Tommi Ekholm, Sampo Soimakallio, VTT  
Niklas Höhne, Sara Moltmann, Ecofys  
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Teknologiasta liiketoimintaa  
Business from Technology

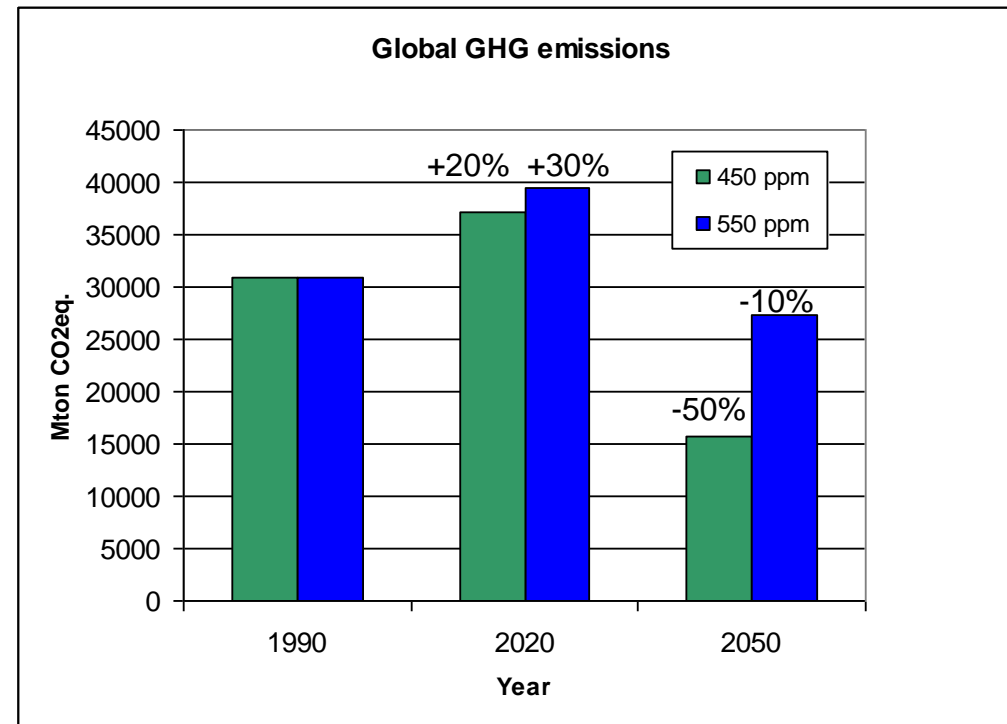
# Goals of the TIMES-TRIP project:

VTT version of the TIAM model and EVOC model of Ecofys

- To assess the properties of alternative effort sharing schemes in ambitious long term climate policies, and to assess the ability of the Triptych method to take into account different properties of country groups (e.g. Resources, industrial structure, emission sources)
- To examine the costs of effort sharing to different country groups
  - Costs, emissions trading, changes in energy production and the price levels
- To improve the understanding and trust to the long-term effort sharing methodologies
- Financed by the Finnish Ministries of Environment and Trade and Industry and VTT
  - Research partners VTT and Ecofys
  - 2006-2008

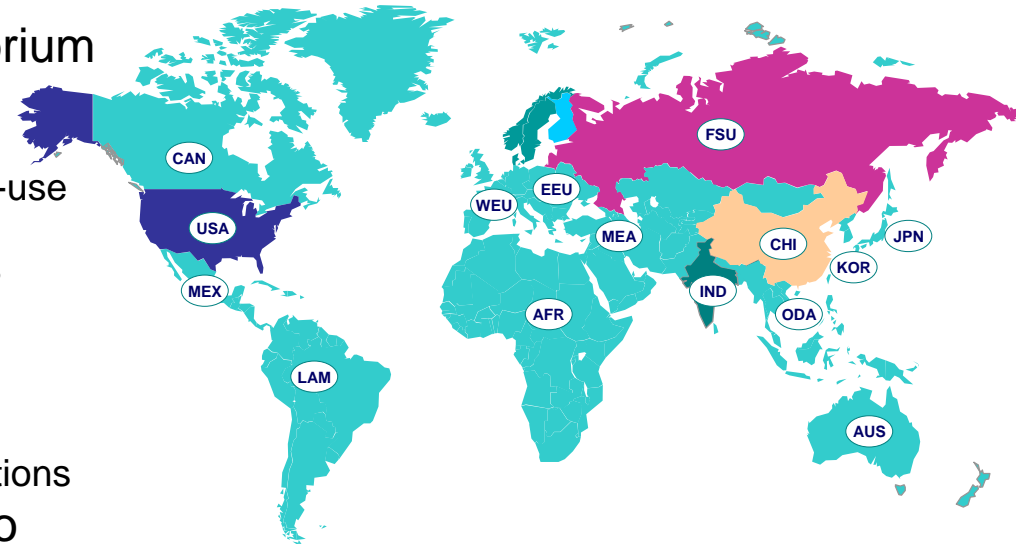
## Scenarios assessed

- Ecofys calculated with EVOG model different effort sharing schemes
  - 550 ppm or 450 ppm CO<sub>2</sub>eq. concentration target
  - Triptych- or Multistage –effort sharing principles
  - Reduction goals globally or assuming incomplete participation
- VTT calculates scenarios with the TIAM model using the initial regional allocations specified by EVOG
  - Structure of energy production
  - Division of costs to different areas
  - Emissions trading, energy consumption and price levels



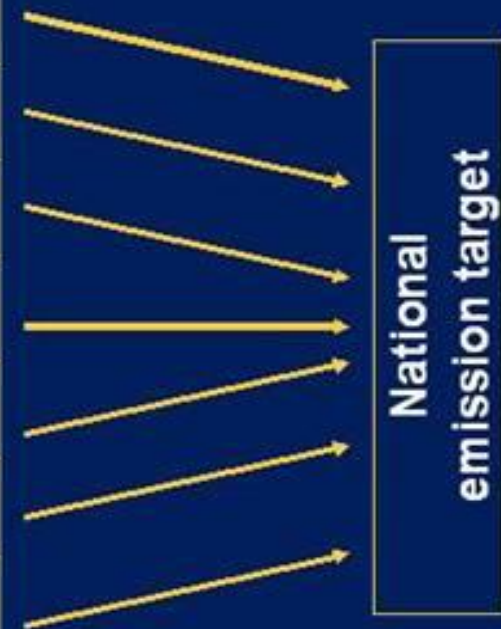
# The global TIMES model – Properties

- ETSAP-TIAM model
- Technology-rich, "bottom-up", partial equilibrium energy system model
  - External projections for energy demand
  - Detailed energy resource, transformation and end-use descriptions
  - Market equilibrium solution under given conditions
- Scenarios up to 2100
- All Kyoto GHGs and emission sources
  - Energy emissions endogenously
  - The rest by external projections with mitigation options
- GHG atmospheric concentrations and link to global mean temperature
- Technology descriptions from international studies and expert judgement
  - Resource potentials and cost-curves, technology efficiencies, investments, O&M costs, etc.
- Demand-side response to emission reductions is modeled by using price-elasticity (demand reacts to the changes in energy prices in policy scenarios)
- Regions are connected to each other through the trade of energy carriers and emission allowances



# Triptych

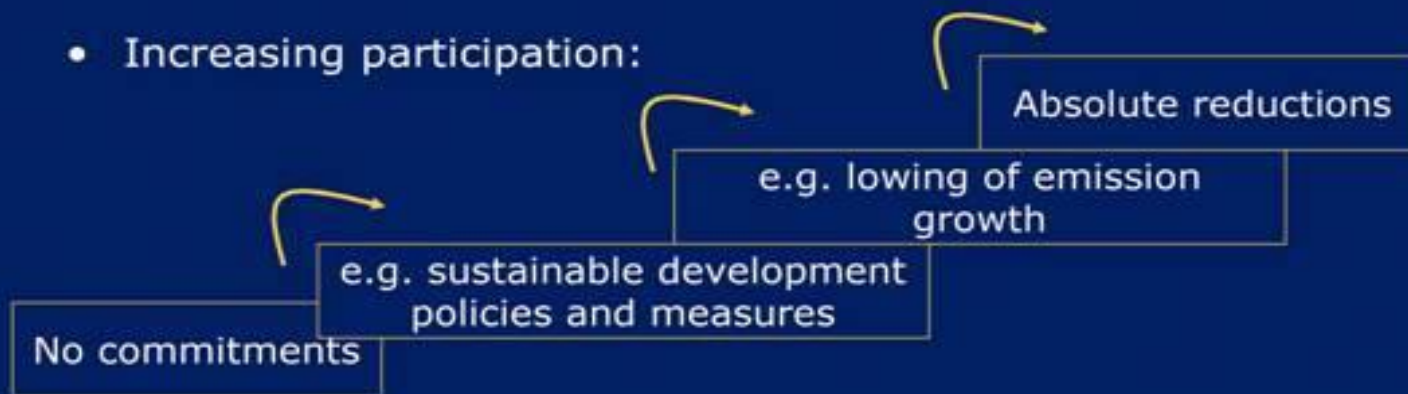
<b>Industry</b>	Adjusted BAU production growth with efficiency improvement
<b>Electricity</b>	Adjusted BAU production growth with limit on sources
<b>Domestic</b>	Converging per-capita emissions
<b>Fossil fuel production</b>	Decline to low level
<b>Agricultural</b>	Percentage reduction below BAU
<b>Waste</b>	Converging per-capita emissions
<b>Land use change and forestry</b>	Decline to zero



A SUSTAINABLE ENERGY SUPPLY FOR EVERYONE

## Multistage

- Increasing participation:

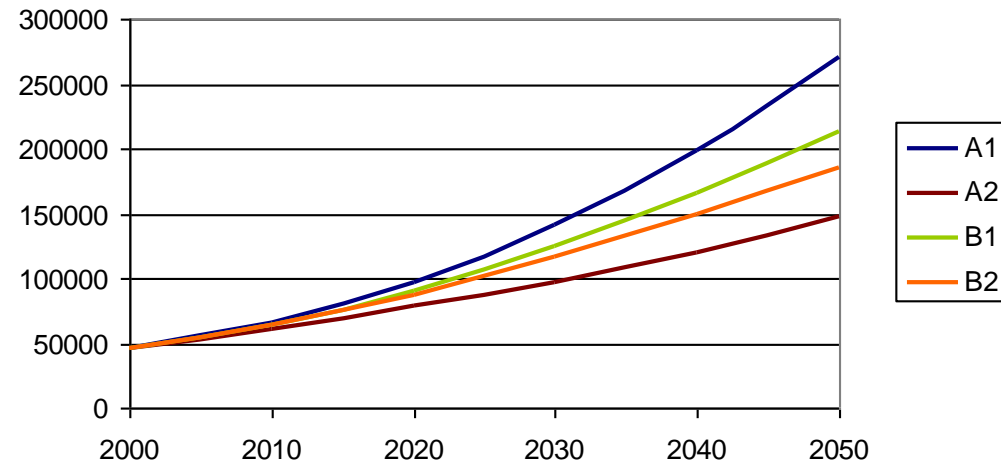


- Countries "graduate" into the next steps based on thresholds (emissions/cap, GDP/cap, human development index)

See also EU (EGFA), scientific community (RIVM, Wuppertal Institut), NGOs (CAN proposal)

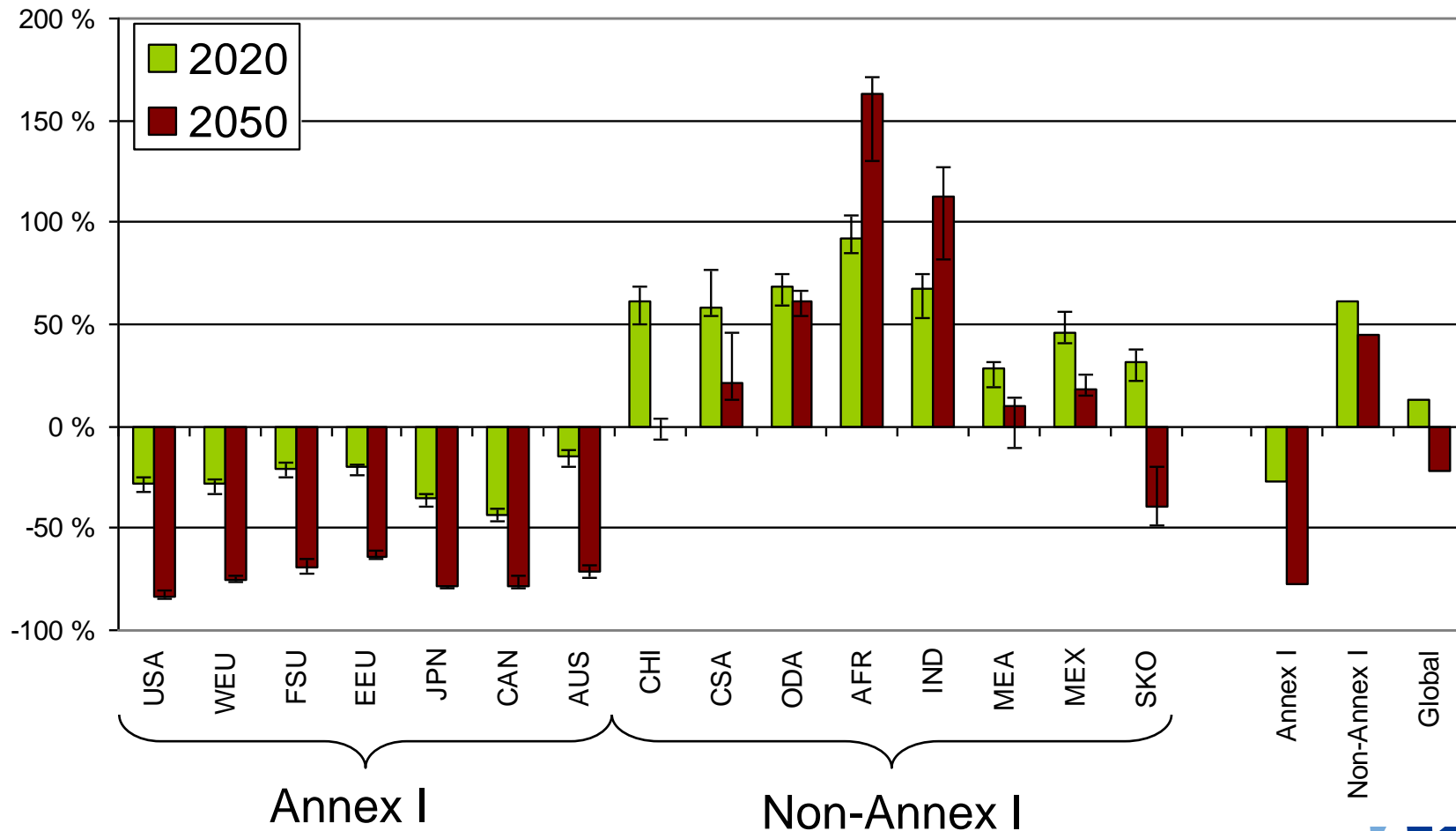
## Scenarios assessed

- GDP, population from IPCC SRES scenarios A1, A2, B1 & B2
- GHG emissions limitations from 2020
- Initial emissions allocations from the EVOC model
- Perfect emissions trading without transaction costs was assumed
  - This proved necessary: e.g. Australian target in 450ppm scenario, -86% by 2050, would be impossible without trading
  - In addition, sensitivity analysis with transaction costs was included

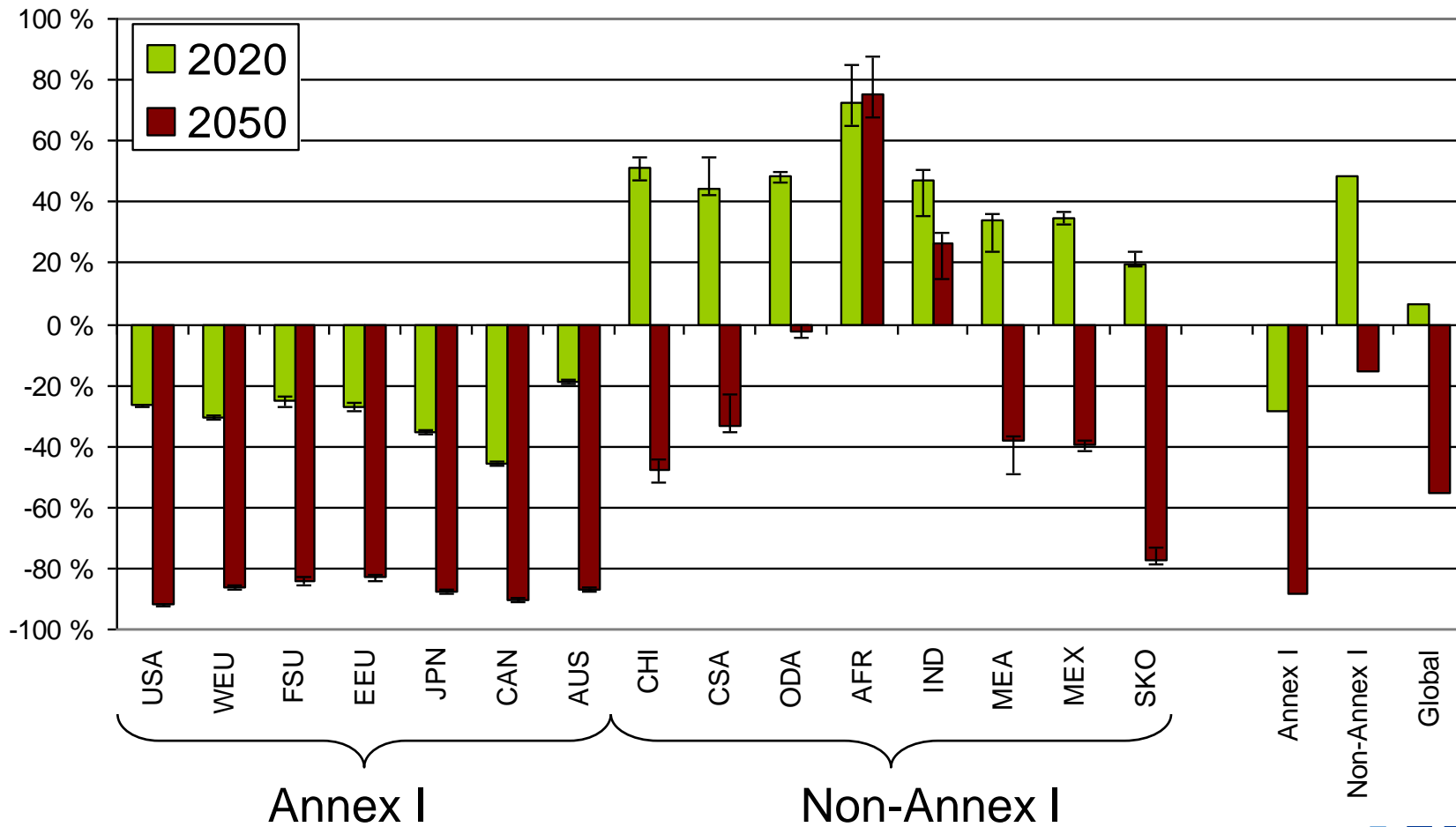


Global GDP in the Baseline scenarios [Bln. USD, PPP]

# Initial regional allocations specified by EVOc in 2020 and 2050 in relation to 2000, 550 ppm scenario



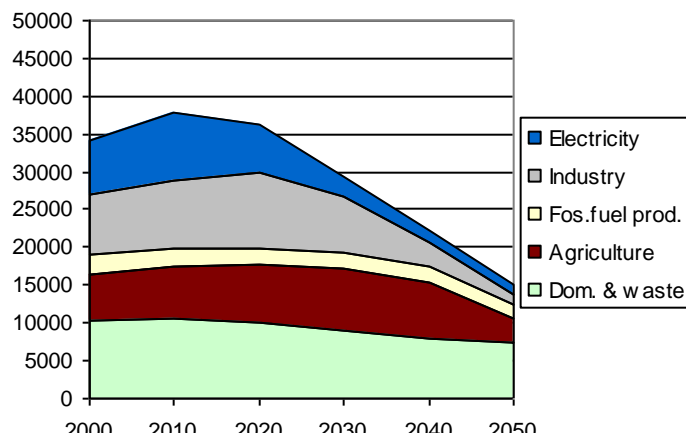
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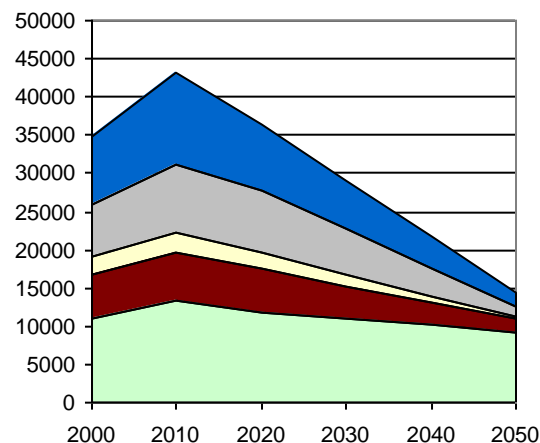
# Global emissions TIMES vs. EVOC [Mt CO<sub>2</sub>-eq]

450 ppm

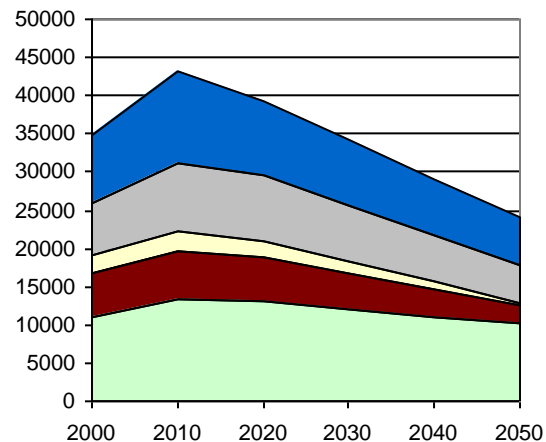
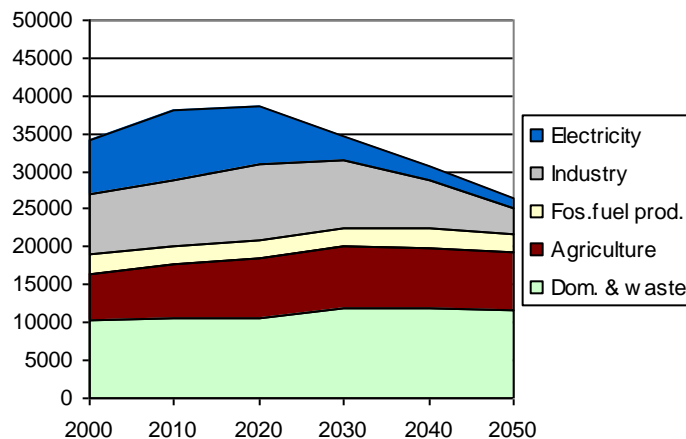
TIMES:



EVOC:



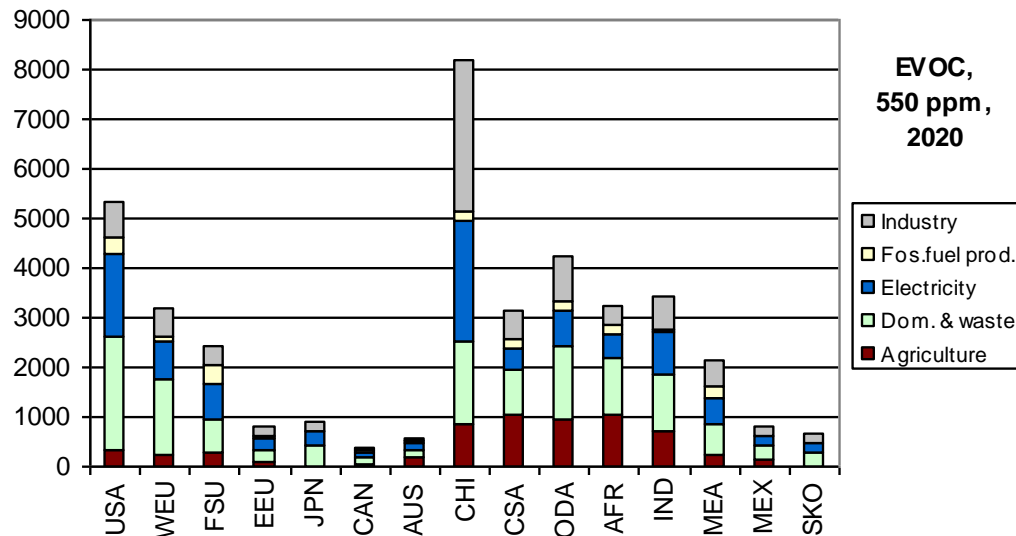
550 ppm



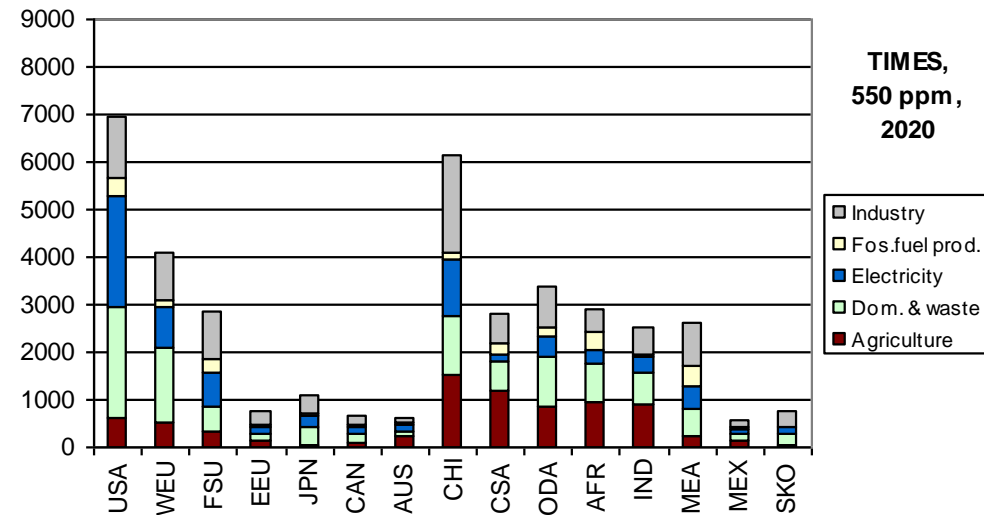
- The cost-optimal solution of TIMES emphasizes reductions in electricity production and industry, whereas in agriculture, the reduction potential is very limited

# Regional emissions in 2020 [Mt CO<sub>2</sub>-eq], 550 ppm

Triptych:



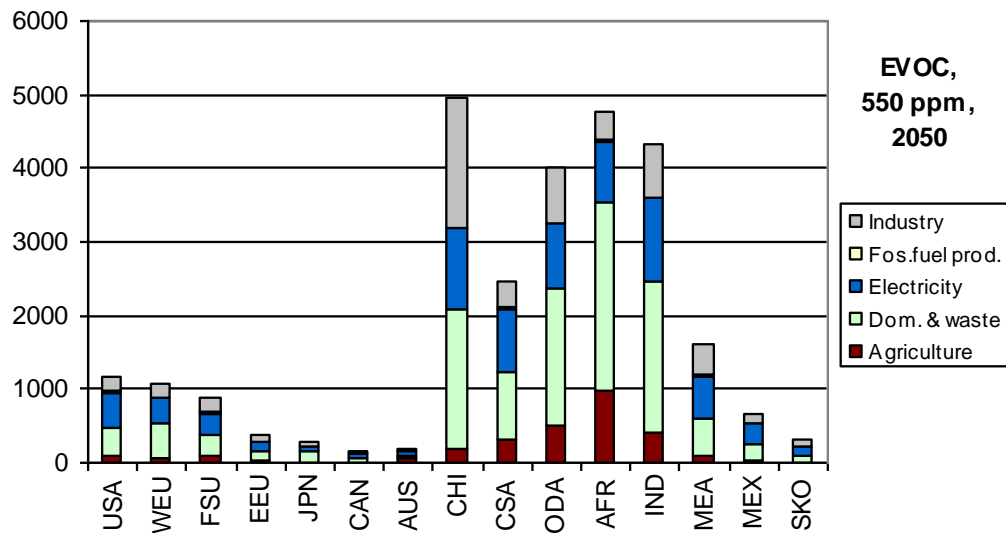
TIMES:



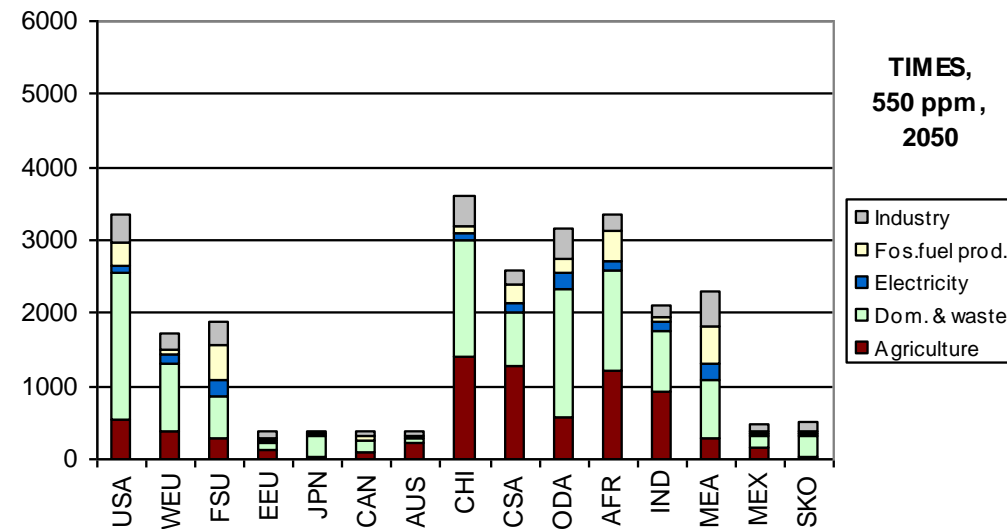
- Larger cost-effective potential in electricity & industry sectors in TIMES reduces emissions in many developing regions (=provides sales of emission allowances)

# Regional emissions in 2050 [Mt CO2-eq], 550 ppm

## Triptych:

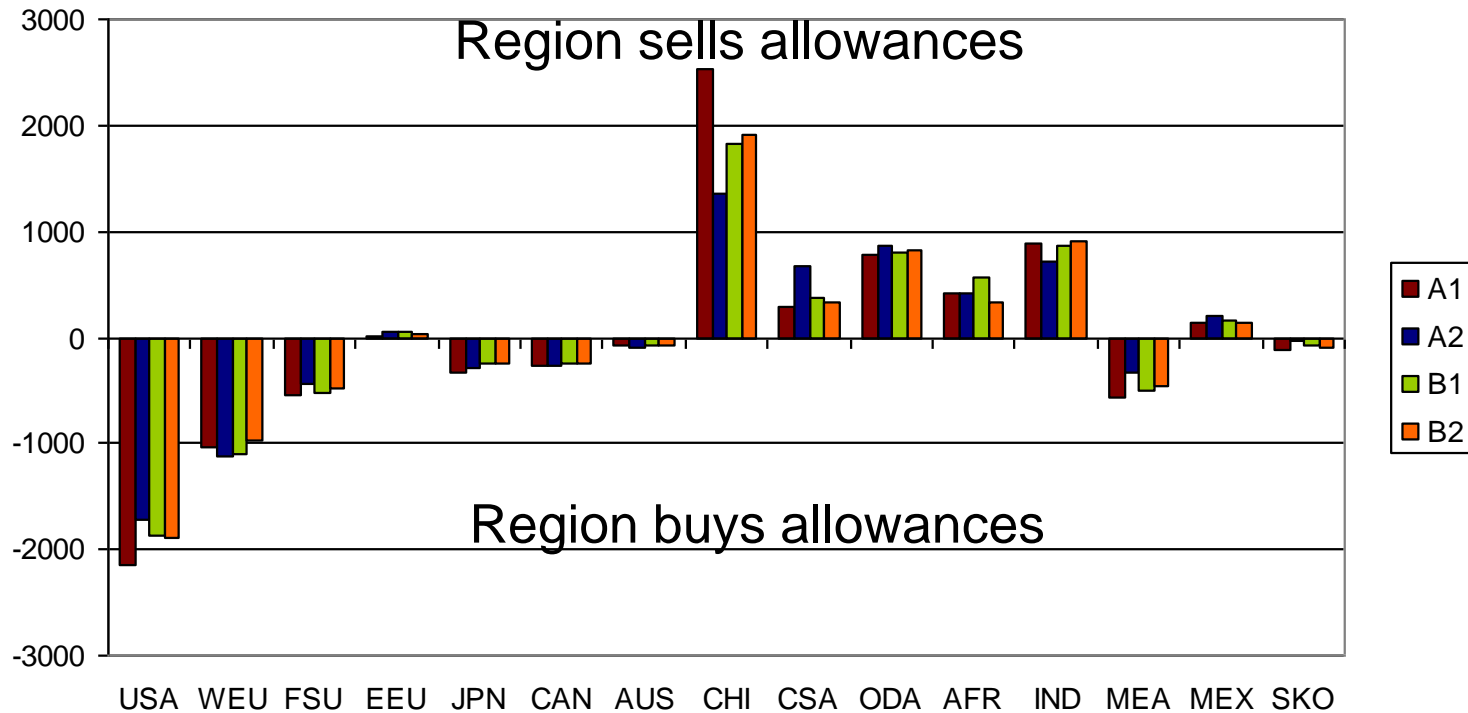


## TIMES:



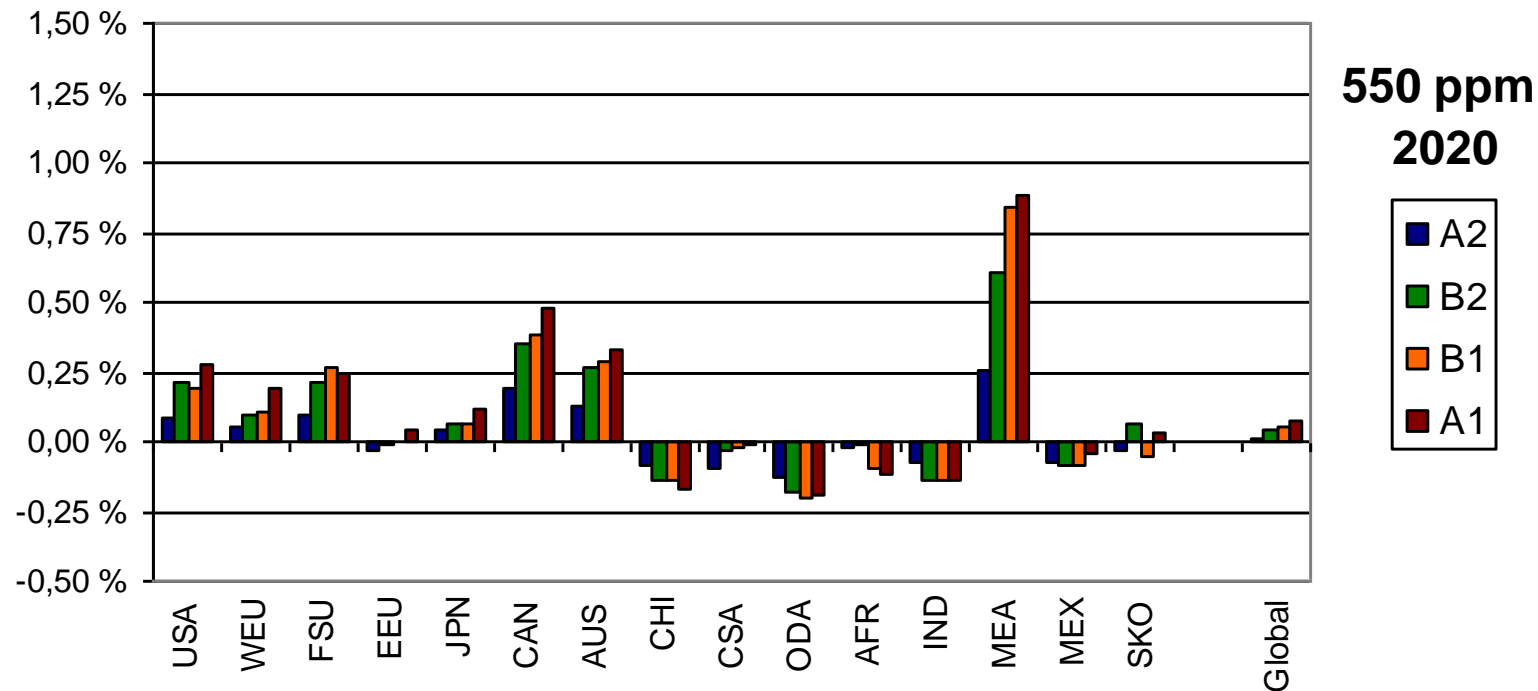
- In the TIMES cost optimal solution, agriculture's share becomes large
- Significant differences in emission source structure between EVOC and TIMES

# TIMES results: Emissions trading in 2020 [Mt CO<sub>2</sub>-eq], 550 ppm



- Emissions trading volumes could be significant: @ 20 €/ton CO<sub>2</sub> e.g. China could sell with 30 – 50 bln. €/yr

## TIMES results: Direct emission reduction costs per GDP in 2020



- Developing countries still have room for growth in 2020 + profits from emission trading
- For oil exporters (MEA), large costs incur as lost oil export revenues from reduced demand, BUT TIMES does not include market effects

## Conclusions and future work

- EVOC overestimates the reduction potential of e.g. agricultural sector in comparison to the detailed modelling of TIMES
- 450 ppm scenario proved very challenging with TIAM: e.g. fusion and biomass+CCS were implemented at large scales by 2050
- Perfect emissions trading without transaction costs proved a necessary assumption in many cases
  - Due to the rather pessimistic estimates of reduction potentials in agriculture, aviation etc. of TIMES, -80-90% reductions in Annex I countries would otherwise be impossible
  - Imperfect markets were assessed in separate scenarios: transaction costs, single regions not participating etc.
- Results with Multistage method are forthcoming: Multistage is more favourable to the least developed regions, only minor differences for Annex I
- **All models and indicators have their pros and cons – use of many different models and several criteria to support climate negotiations is recommended !**

Final report of the work will be available in August 2008.

Thank you for your attention !

[Sanna.Syri@vtt.fi](mailto:Sanna.Syri@vtt.fi)  
[Tommi.Ekholm@vtt.fi](mailto:Tommi.Ekholm@vtt.fi)  
[Sampo.Soimakallio@vtt.fi](mailto:Sampo.Soimakallio@vtt.fi)