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Comparison of GHG mitigation efforts between Annex 1 countries

Objectives

- Independent and coherent comparison of GHG mitigation potentials and costs in Annex 1 countries for 2020
  - using a systems approach,
  - based on publicly available data,
  - taking into account co-benefits on air pollution,
  - independent assessment, financed through IIASA's core funds.

- Results, input data and interactive calculator freely available in the public domain:

  http://gains.iiasa.ac.at

Methodology

Bottom-up approach

- at detailed technical level,
- all gases and sectors,
- systems approach,
- starting from IEA, FAO projections of economic activities,
- technical, economic and market potentials (before trading).

Based on earlier work with IIASA's GAINS (Greenhouse gas – Air pollution Interactions and Synergies) model

Disaggregation of emission sources

in domestic and industry sectors

- Domestic sector:
  - Residential/Commercial energy use,
  - Heating+ventilation+AC/Water heating/Cooking/Lighting/ Large appliances/Small appliances,
  - Up to 10 climate regions,
  - Flats/Single family houses,
  - Built before/after 2010

- Industry:
  - 6 sectors:
    Iron and steel, Non-ferrous metals, Non-metal minerals, Chemicals, Pulp and paper, Other industries
  - For each sector up to 13 products:
    (e.g., Raw steel, Finished products, Scrap supply, Coke oven coke, Sinter, Pellets, Pig iron, Direct reduced iron, Open hearth furnace, Basic oxygen, Electric arc furnace, Casting, rolling finishing, Thin slab casting)

Estimating mitigation potentials

Four steps

a) Inventory of ~300 mitigation measures, with technical and economic features

Mitigation measures

~300 options in each country

Structural measures

Sector	Measure
Power plants	• Use of renewables, such as ○ wind, ○ solar photo-voltaic, ○ large hydro power plants, ○ small hydro power, ○ geothermal power instead of fossil fuels. • Gas-fired power plants instead of coal-fired power plants. • Biomass power plants instead of fossil fuel plants. • Combined heat and power (CHP) systems to substitute electric power plants on the one hand, and either industrial boilers or residential boilers. CHP systems increase the overall energy system efficiency. • (Efficiency measures that reduce electricity consumption in industry and the residential/commercial sector that reduce electricity consumption)
Residential sector	• Energy saving packages (3 stages each) for heating, cooling, air conditioning for ○ existing houses, ○ new houses, ○ existing apartments, ○ new apartments. • Energy saving packages (3 stages each) for ○ water heating, ○ cooking, ○ lighting, ○ small appliances, ○ large appliances.
Commercial sector	• Energy saving packages (3 stages each) for heating, cooling, air conditioning for ○ existing buildings, ○ new buildings. • Energy saving packages (3 stages each) for ○ water heating ○ cooking, ○ lighting, ○ small appliances, ○ large appliances.
All industries	• Gas-fired boilers instead of coal-fired boilers. • Combined Heat and Power instead of industrial boilers.
Cement production	• Energy saving packages (3 stages)
Iron and steel industry	• Energy saving packages (3 stages)
Paper and pulp industry	• Energy saving packages (3 stages)
Non-ferrous metals	• Energy saving packages (3 stages)
Chemicals	• Energy saving packages (3 stages)
All transport	• Substitute fossil fuel with bio-fuels

CO_2 measures

Sector	Measure
Power plants	• IGCC (Integrated Gasification Combined Cycle) instead of conventional coal fired power plants • Carbon capture and storage
Passenger cars	• Advanced internal combustion engines • Hybrid vehicles • Plug-in hybrids • Electric vehicles • Hydrogen fuel-cell vehicle • Non-traction related efficiency improvements
Light-duty trucks	• Advanced internal combustion engines • Hybrid vehicles • Plug-in hybrids • Electric vehicles • Hydrogen fuel-cell vehicles • Non-traction related efficiency improvements
Heavy-duty trucks	• Advanced internal combustion engine • Non-traction related efficiency improvements
Buses	• Electric vehicle • Hydrogen fuel-cell vehicle • Non-traction related efficiency improvements (2 stages)
Motorcycles	• Advanced internal combustion engine

CH_4 measures

CH_4	Measure
Agriculture	• Anaerobic digestion of animal manure • Dietary changes for dairy cows and cattle • Alternative rice strains and improved aeration of rice fields • Ban on agricultural waste burning
Waste	• Waste diversion options: recycling of paper and wood waste, composting and bio-gasification of food waste, and waste incineration • Landfill options: gas recovery with flaring or gas utilization
Wastewater	• Domestic urban wastewater collection with aerobic or anaerobic treatment with or without gas recovery • Domestic rural wastewater treatment in latrines or septic tanks. • Industrial wastewater treatment –aerobic or anaerobic with or without gas recovery utilization
Coal mining	• Recovery with flaring or utilization of gas
Gas distribution	• Replacement of grey cast iron networks and increased network control frequency
Natural gas and oil production and processing	• Recovery and flaring of gas

N_2O measures

N_2O	Measure
Agriculture	• Reduced and/or improved timing of fertilizer application • Use of advanced agro-chemicals (e.g., nitrification inhibitors) • Precision farming
Energy combustion	• Combustion modifications in fluidized bed boilers
Industrial processes	• Catalytic reduction in nitric and adipic acid production
Waste water	• Optimization of operating conditions in wastewater plants
Direct N_2O use	• Replacement/reduction in use of N_2O for anaesthetic purposes

F-gas measures

F-gases		Measure
HFC	Aerosols	• Alternative propellant
HFC	Stationary air conditioning and refrigeration	• Good practice: leakage control, improved components, and end-of-life recovery ? • Process modifications for commercial and industrial refrigeration
HFC	Mobile air conditioning and refrigeration	• Alternative refrigerant: pressurized CO_2 • Good practice: leakage control, improved components, and end-of-life recovery
HFC	HCFC-22 production	• Incineration: post combustion of HFC-23
HFC	Foams	• Alternative blowing agents
HFC	Aerosols	• Alternative propellant
PFC	Primary aluminium production	• Conversion of SWPB or VSS to PFPB • VSS and SWPB retrofitting
PFC	Semiconductor industry	• Alternative solvent use: NF_3
SF6	Magnesium production and casting	• Alternative protection gas SO_2
SF6	High and mid voltage switches	• Good practice: leakage control, improved components, and end-of-life recovery
SF6	Other SF6 use	• Ban of SF6 use

Estimating mitigation potentials

Four steps

a) Inventory of ~300 mitigation measures, with technical and economic features

For each source sector in each country:

b) For 2005: Match emissions reported to UNFCCC

- with activity data from UNFCCC, IEA and national statistics,
- adjust implementation rates of mitigation measures.

Estimating mitigation potentials

Four steps

a) Inventory of ~300 mitigation measures, with technical and economic features

For each source sector in each country:

b) For 2005: Match emissions reported to UNFCCC

c) For 2020:

- Match baseline energy use of IEA World Energy Outlook 2008
  - with activity rates projected by IEA, modify implementation rates of energy efficiency measures to reproduce IEA energy projection.
- Develop baseline emission projection
  - adjust implementation rates of mitigation measures as reported in National Communications.

Estimating mitigation potentials

Four steps

a) Inventory of ~300 mitigation measures, with technical and economic features

For each source sector in each country:

b) For 2005: Match emissions reported to UNFCCC

c) For 2020: Match baseline energy use and develop baseline emission projection

d) Determine further mitigation potential

- from implementing the best available (energy efficiency and C mitigation) measures that are not assumed in the baseline,
- considering constraints on replacement of existing capital stock, structural limits, etc.

Estimating mitigation costs

Three steps:

1. Determine unit costs for each mitigation option:
   - Annualized investments + operating costs – savings per unit of reduced emissions
   - Reflect resource costs without transfers (no taxes, subsidies, profits, transaction costs, etc.)
   - Alternative interest rates for annualization of investments:
     - Social (4%/yr)
     - Private (20%/yr)

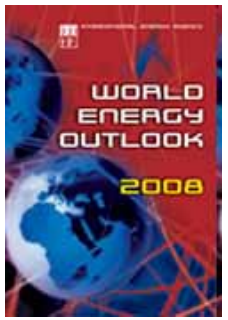
2. For a given mitigation target:
   - Determine least-cost portfolio of mitigation measures (i.e., including upstream effects), through optimization model

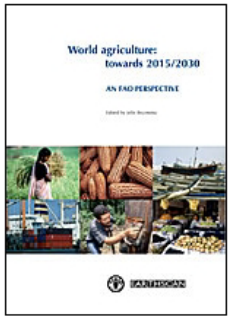
3. Cost curves: Series of optimizations between baseline emissions and maximum mitigation case

An initial implementation

- For largest Annex 1 countries (98% of 1990 emissions), EU25 presented in aggregate

- Based on activity projections of IEA World Energy Outlook 2008 and FAO World Agriculture Perspective



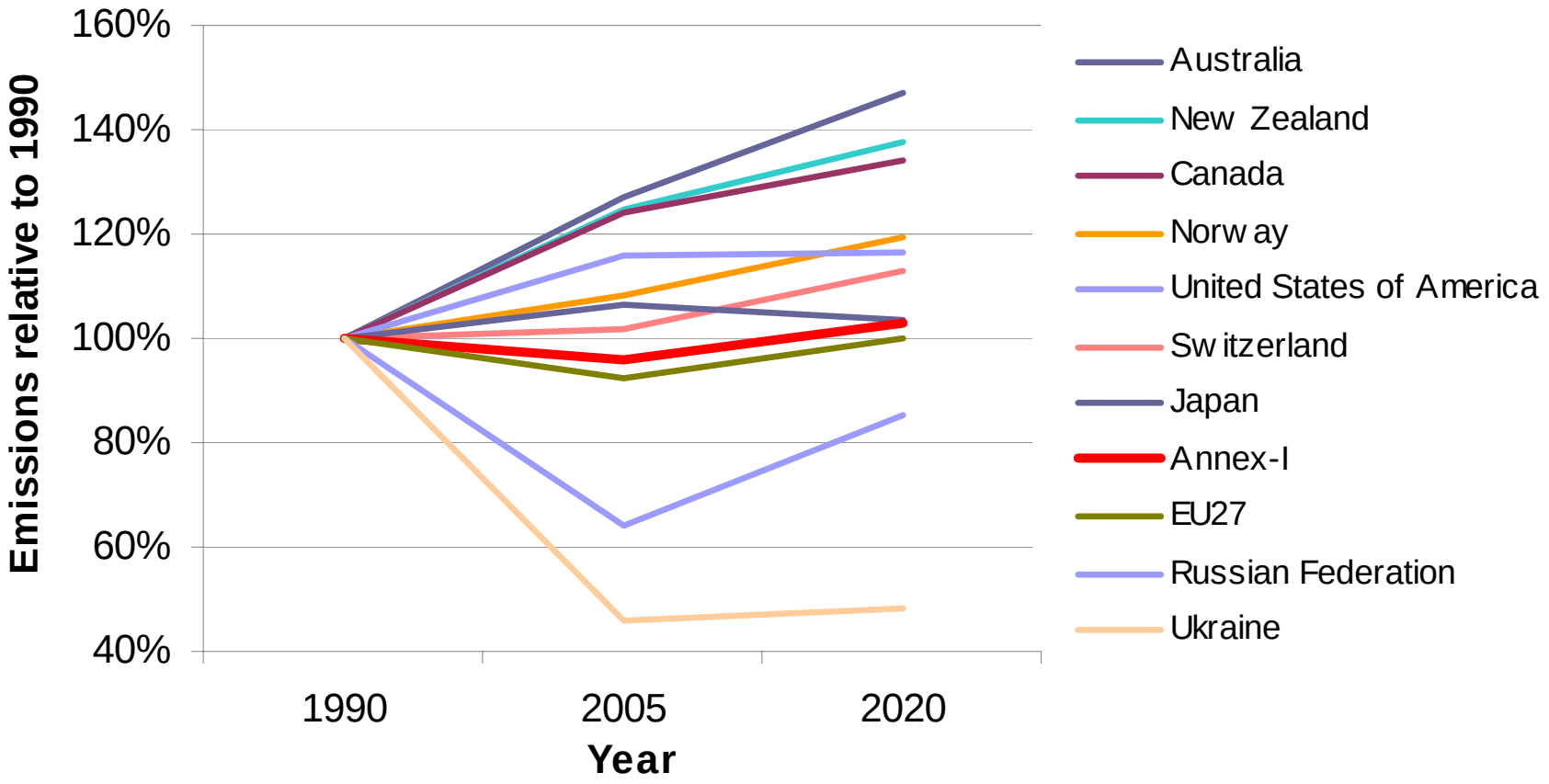


- Key assumptions:
  - Only currently available technologies
  - Natural turnover of capital stock, no premature scrapping
  - No behavioural changes
  - Before trading
  - LULUCF excluded for now

- Initial analysis based on publicly available information, received only limited review by national experts

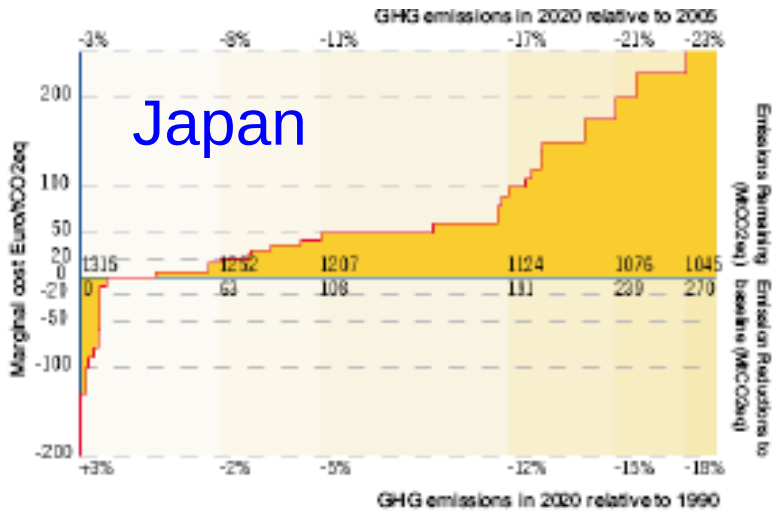
Baseline GHG emissions projections

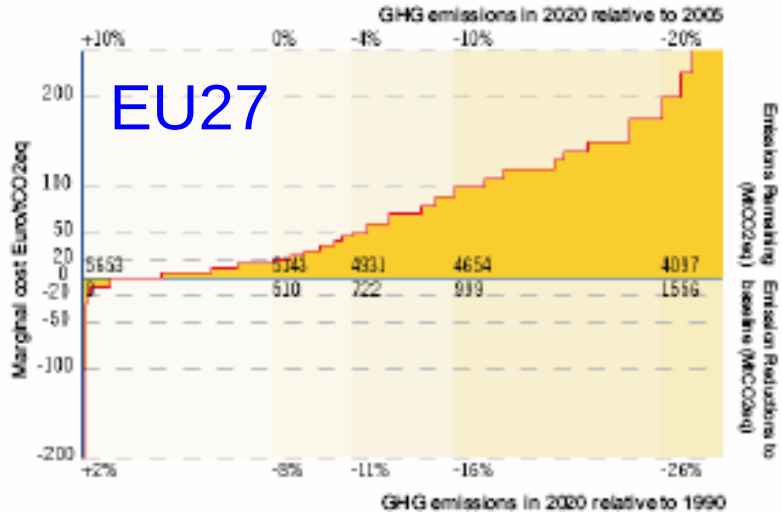
for IEA WEO2008 projection

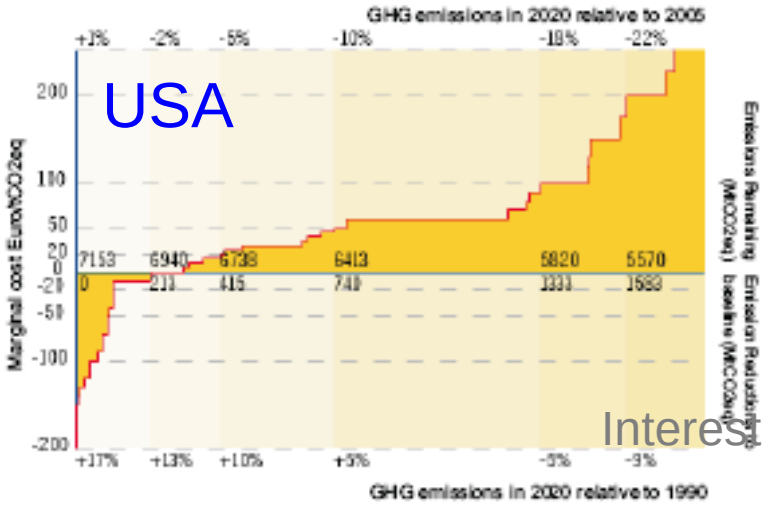


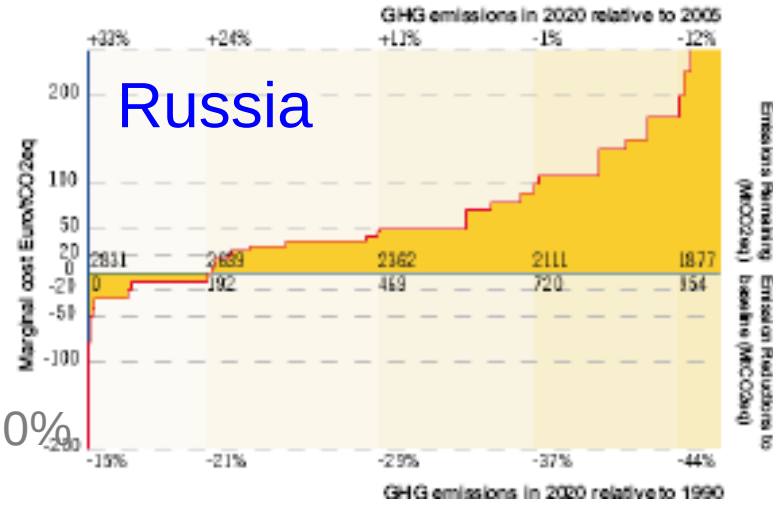
Analysis not completed yet for: Belarus, Croatia, Turkey, Cyprus, Malta

Marginal cost curves for individual Parties





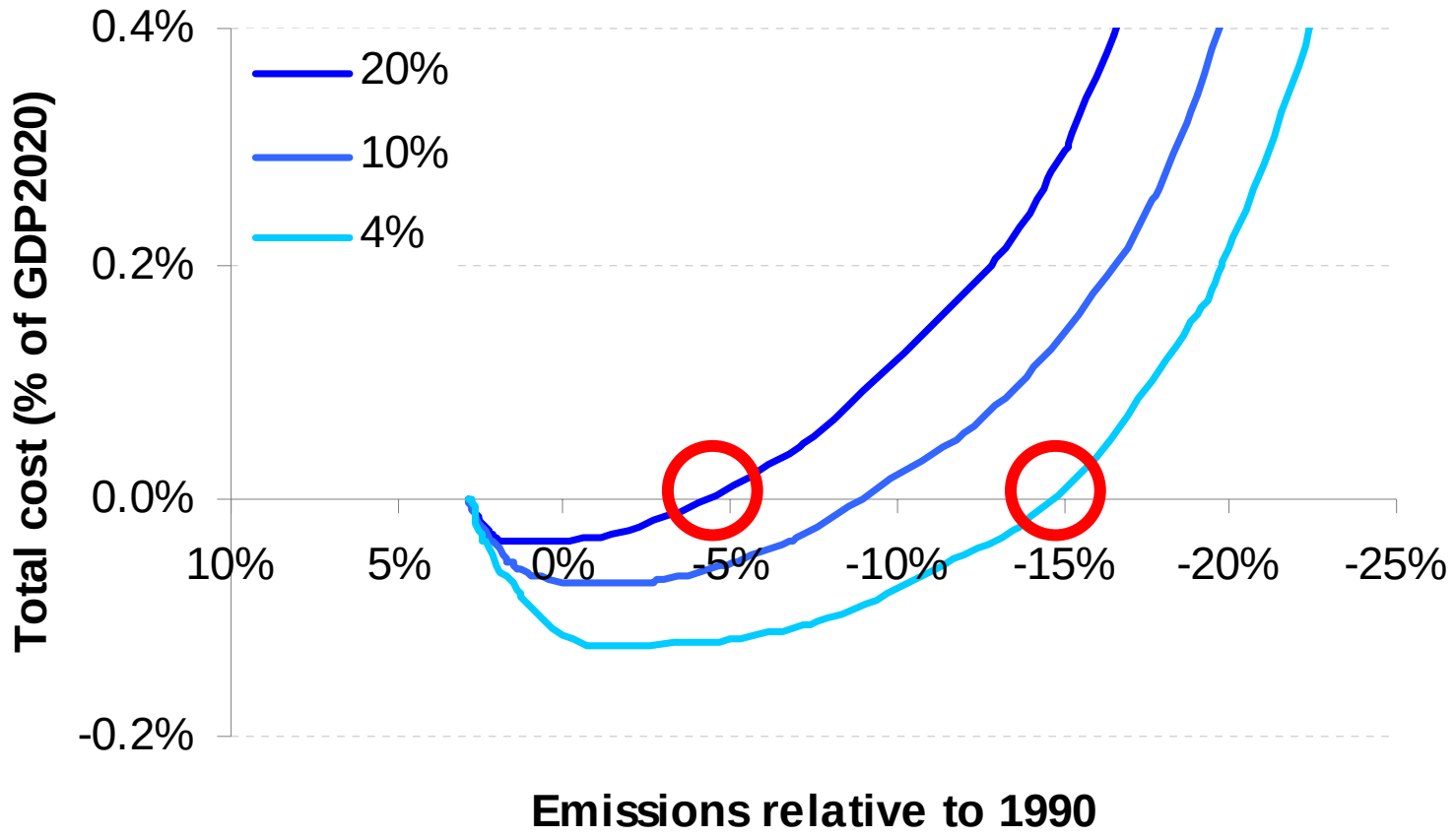




Interest rate: 20%

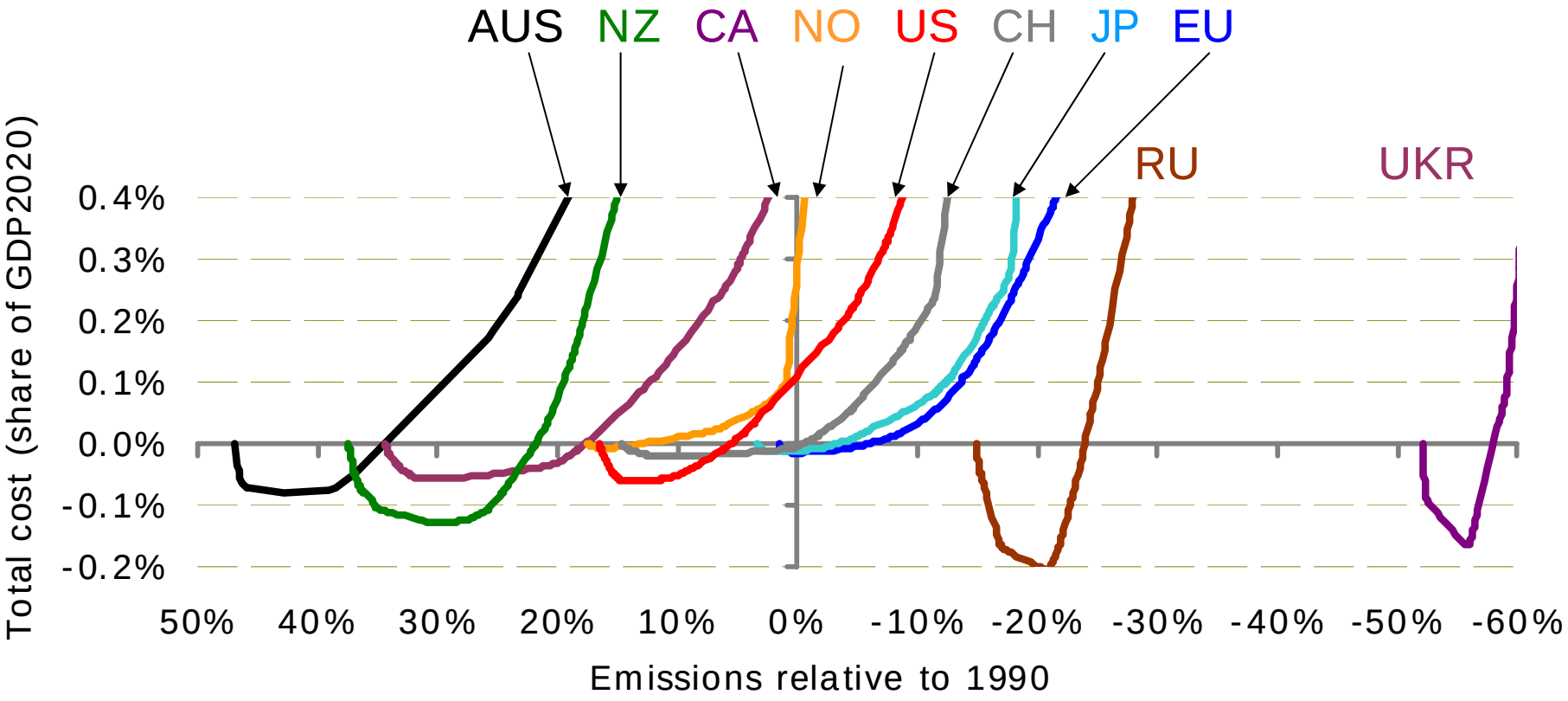
Total costs for different interest rates

Annex 1, 2020, excl. LULUCF



Total cost curves (% of GDP)

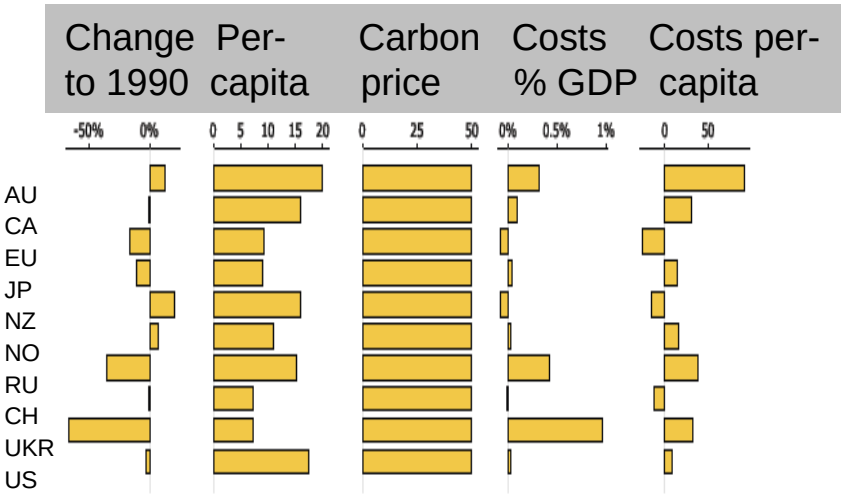
(10% interest rate)

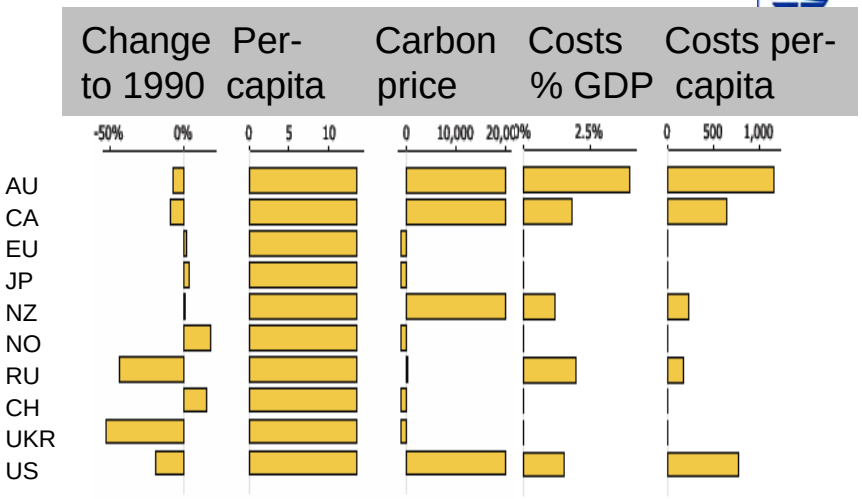


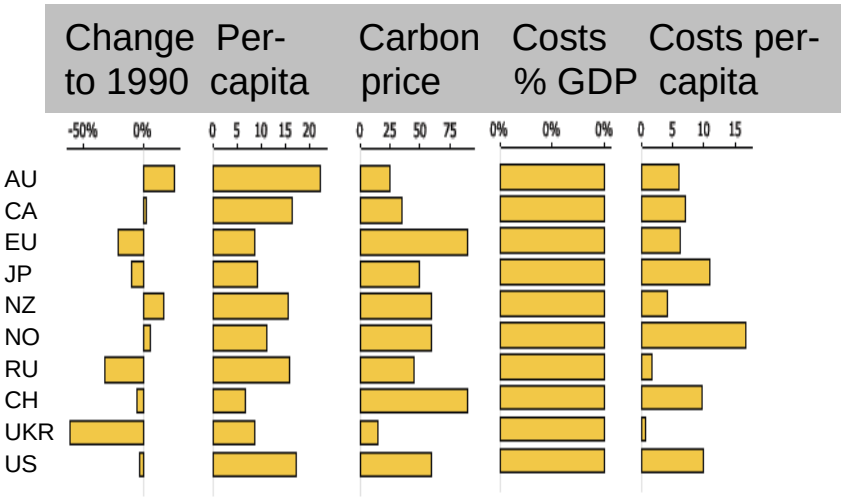
Comparison of mitigation efforts

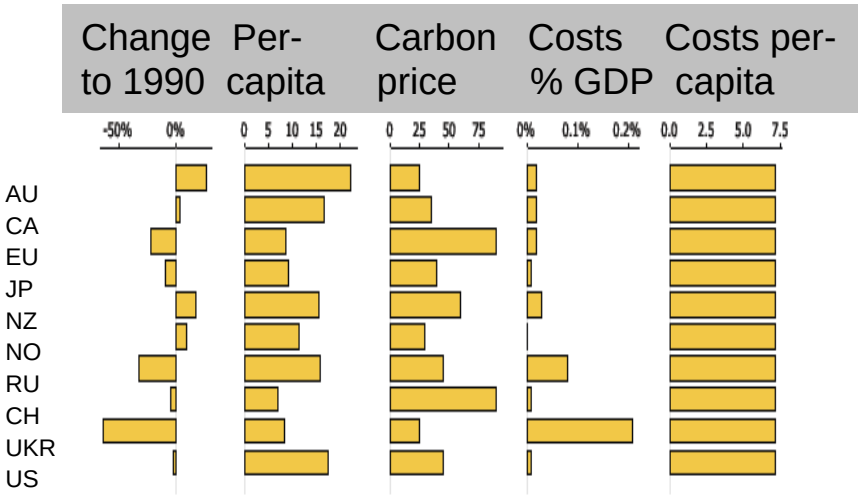
for a 16.5% reduction of total Annex 1 emissions

Efficiency vs. equity

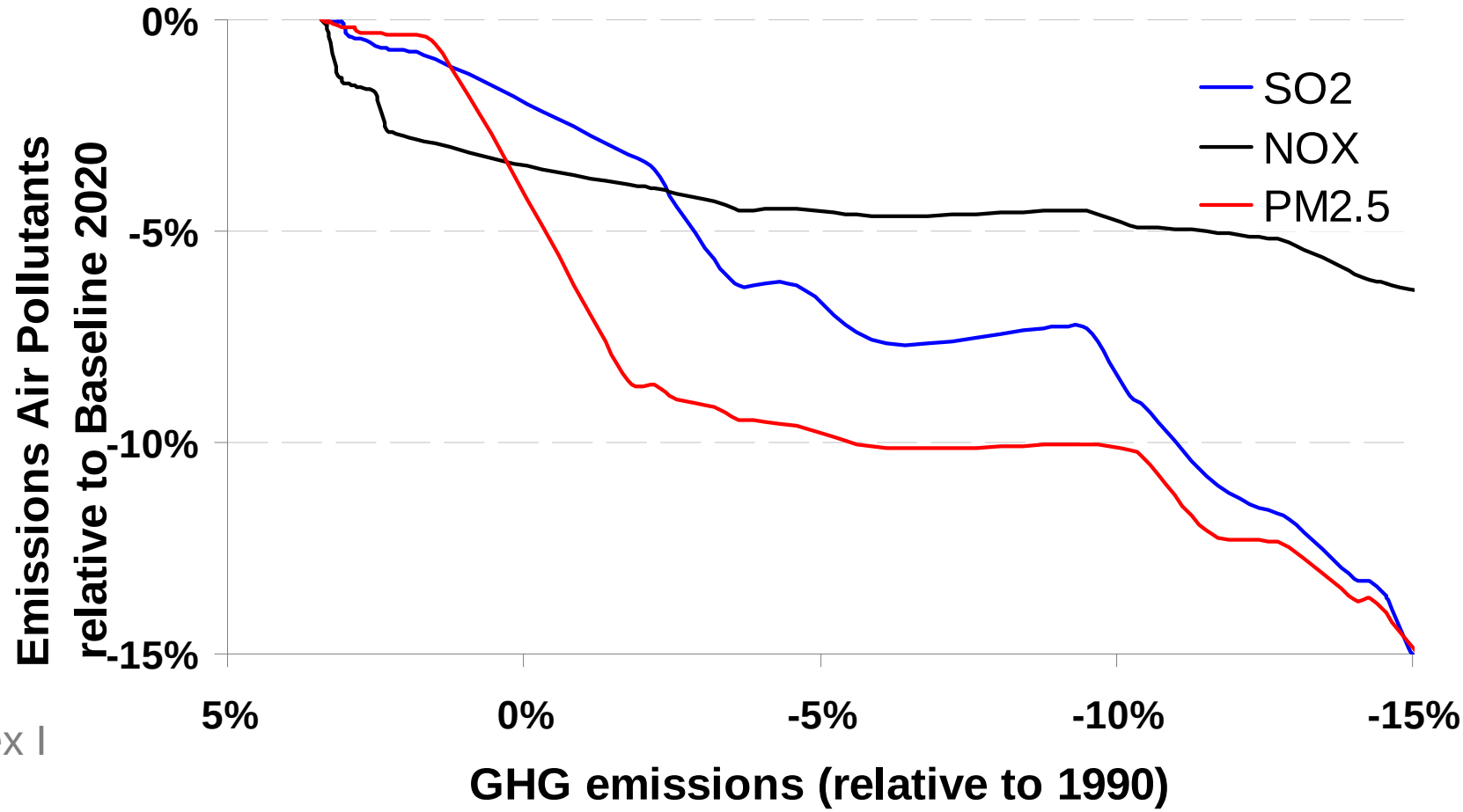








Co-benefits on air pollutant emissions

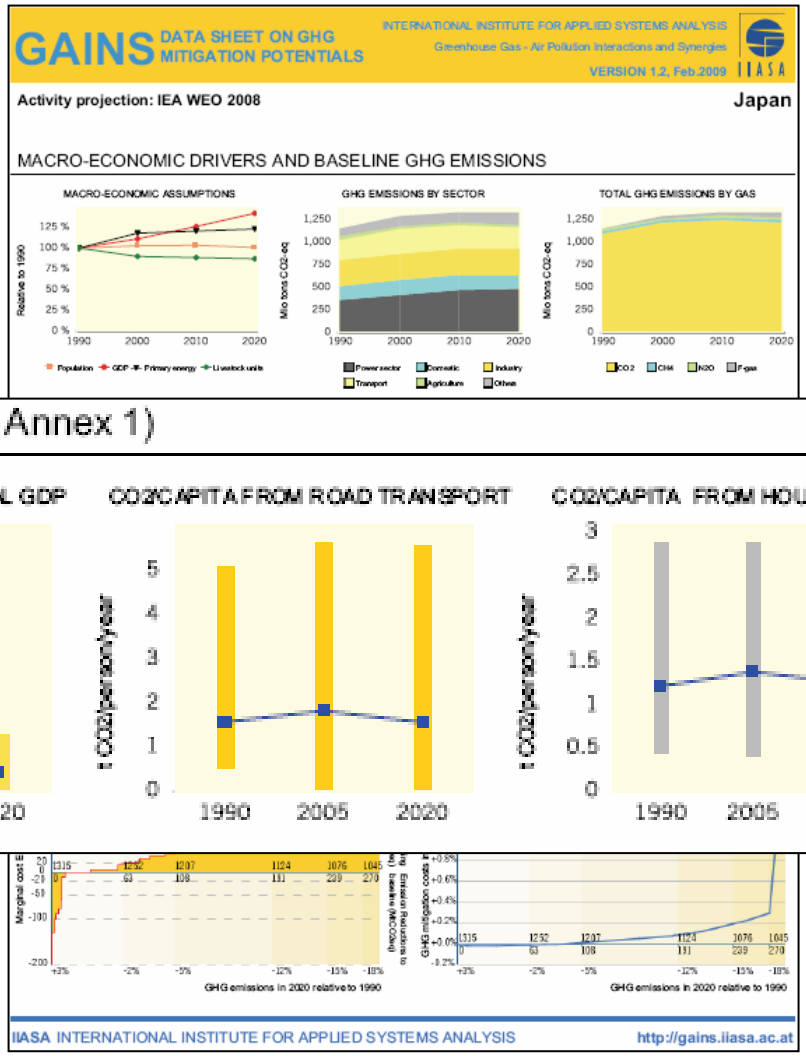


Annex I
2020
Interest rate: 20%

Access to more information (1)

http://gains.iiasa.ac.at

- Data sheets on GHG mitigation potentials for all Annex 1 Parties



Access to more information (2)

http://gains.iiasa.ac.at

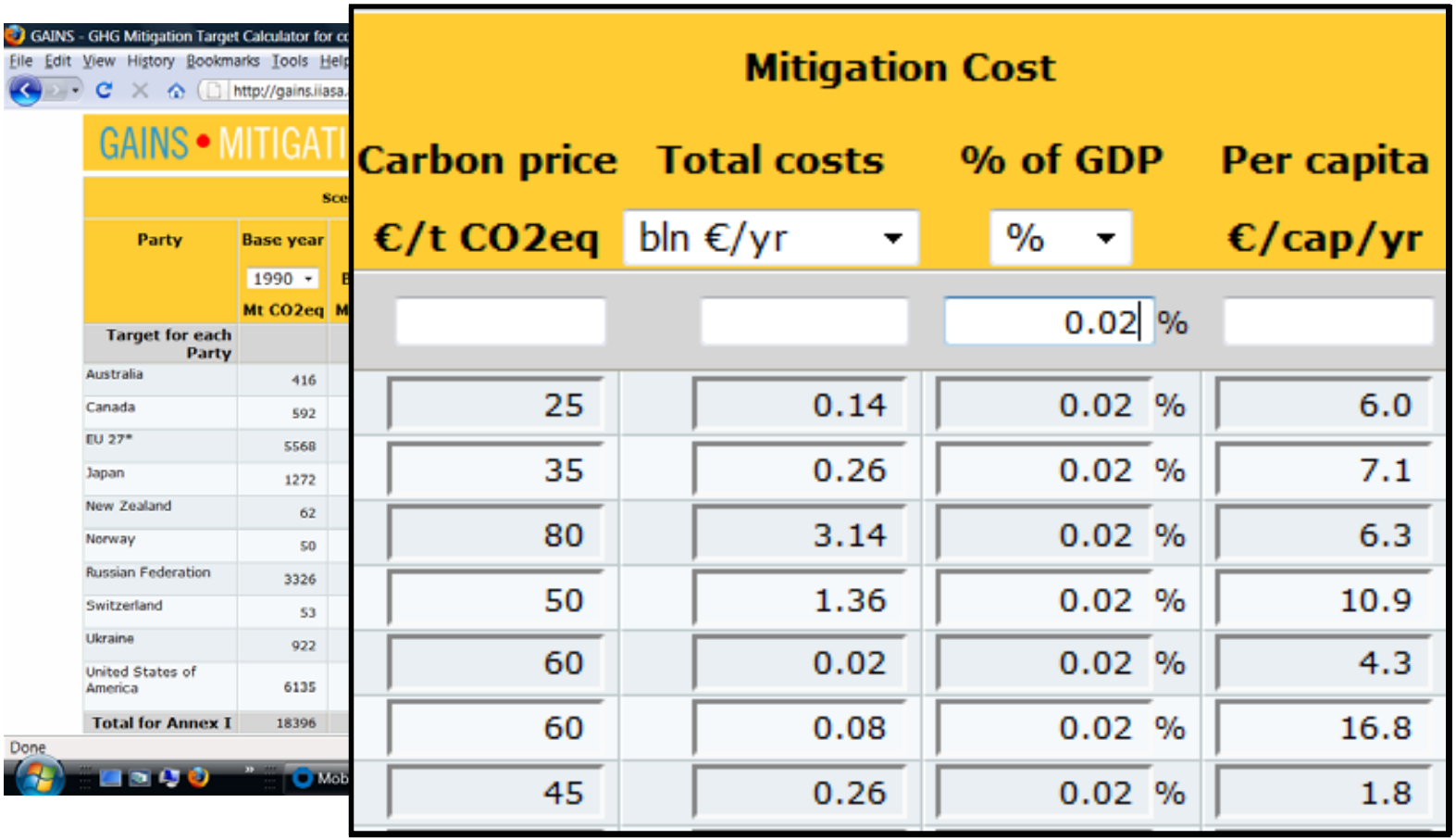
Documentation of methodology:

- Basic GAINS methodology (M. Amann et al., 2008)
- Mitigation potentials from energy use and industry (J. Cofala et al., 2008)
- Mitigation potentials from transportation (J. Borken-Kleefeld et al., 2008)
- Mitigation potentials for non-CO_2 gases (L. Höglund-Isaksson et al., 2008)
- Mitigation potentials from LULUCF (H. Böttcher et al., 2008)

Access to more information (3)

http://gains.iiasa.ac.at

- On-line calculator on the Internet:



Access to more information (4)

http://gains.iiasa.ac.at

Review workshop:

March 16-18, 2009 at IIASA

Registration:

http://gains.iiasa.ac.at

Conclusions

- IIASA's GAINS analysis:
  - Coherent impartial comparison of mitigation efforts
  - Analysis based on publicly available data
  - Transparency: Open access to results and all input data:

    http://gains.iiasa.ac.at

- There are objective reasons for differences in mitigation efforts.
- Different equity criteria deliver different rankings of countries.
- Political agreement on the meaning of comparability of efforts is required.
- The GAINS analysis provides a quantitative tool for such negotiations.