Markus Amann
International Institute for Applied Systems Analysis (IIASA)

Progress in integrated assessment modelling

35th Session of the Task Force on Integrated Assessment Modelling, Bilthoven, June 8-10, 2009

Contents

- National baseline projections
- GAINS review
- EC4MACS
- Estimates of GHG mitigation potentials and costs in Annex I

State of new national baseline projections

Projections received	Projections promised	Contacts, but no data
Czech Republic	Denmark	Austria
Finland	Greece	Belarus
Ireland	Netherlands	Croatia
Italy	Norway	France
	Portugal	Hungary
	Spain	Moldova
	Sweden	Romania
	Switzerland	Slovakia
	UK	

GAINS review

- Methodology reports for all EC4MACS models available on the Internet
- Internet consultation, deadline June 15, 2009 http://www.ec4macs.eu/home/review.html
- EC4MACS review meeting Oct 5-7, 2009 at IIASA
- GAINS methodology for GHG reviewed at IIASA workshop on 'Comparison of GHG mitigation potentials and costs', May 28-29, 2009

EC4MACS
State of progress

- Focus extended to urban air quality, INERIS has joined EC4MACS team

- Model review:
  - Ongoing Internet consultation
  - Review meeting (October 5-7, 2009)

- EC4MACS Interim Assessment
  - New baseline projection (Integration of PRIMES 2009, TREMOVE, CAPRI), new critical loads, etc.
  - Will include economic crisis, Climate & Energy package, milk quota reform, etc.
  - Resulting air quality fields will be provided to WGE for full assessment of impacts
  - Delivery postponed to November 2009

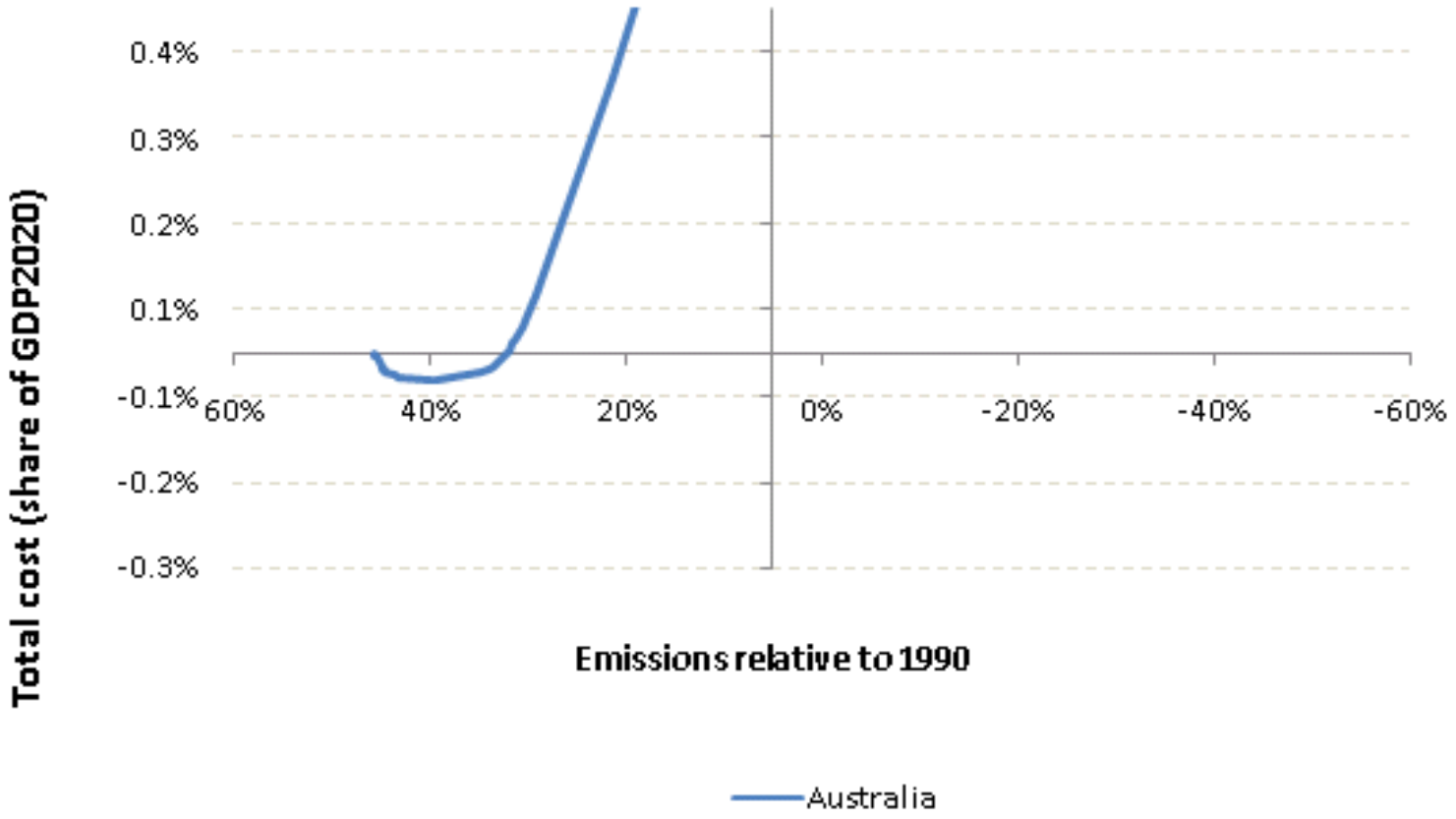
Fabian Wagner
International Institute for Applied Systems Analysis (IIASA)

The GAINS model analysis of GHG mitigation potentials and costs in Annex I countries

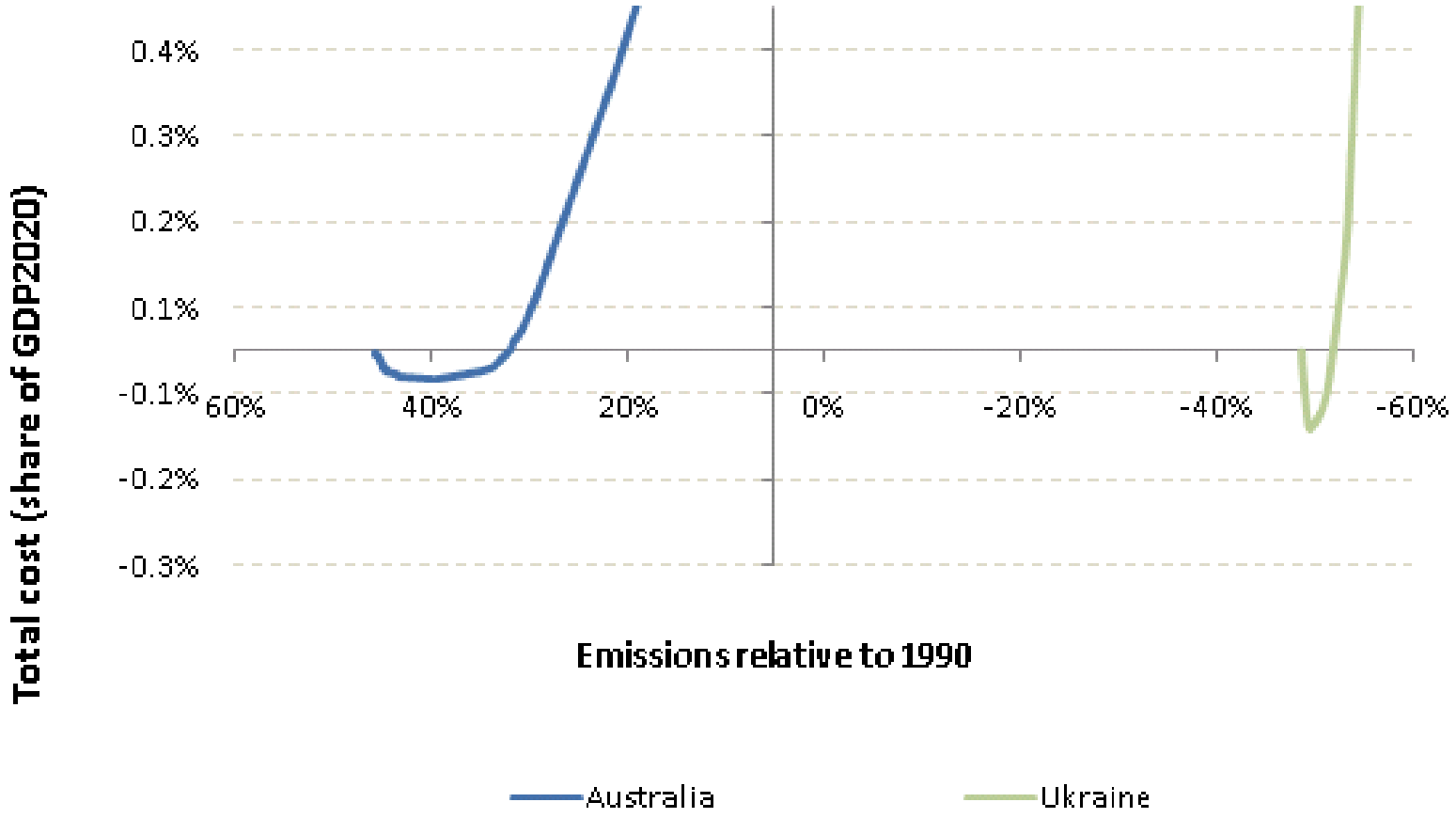
The GAINS Approach

- Impartial, coherent and transparent comparison of GHG mitigation potentials and costs in Annex I countries
  - Independent assessment, financed through IIASA's core funds (IIASA is funded by scientific organizations of 17 member countries in Asia, Europe, North America, Africa),
  - based on publicly available data (IEA, FAO, UNFCCC)
- Results, input data and an interactive calculator freely available in the public domain
- Bottom-up approach
  - Full technology detail (more than 300 measures)
  - Systems approach

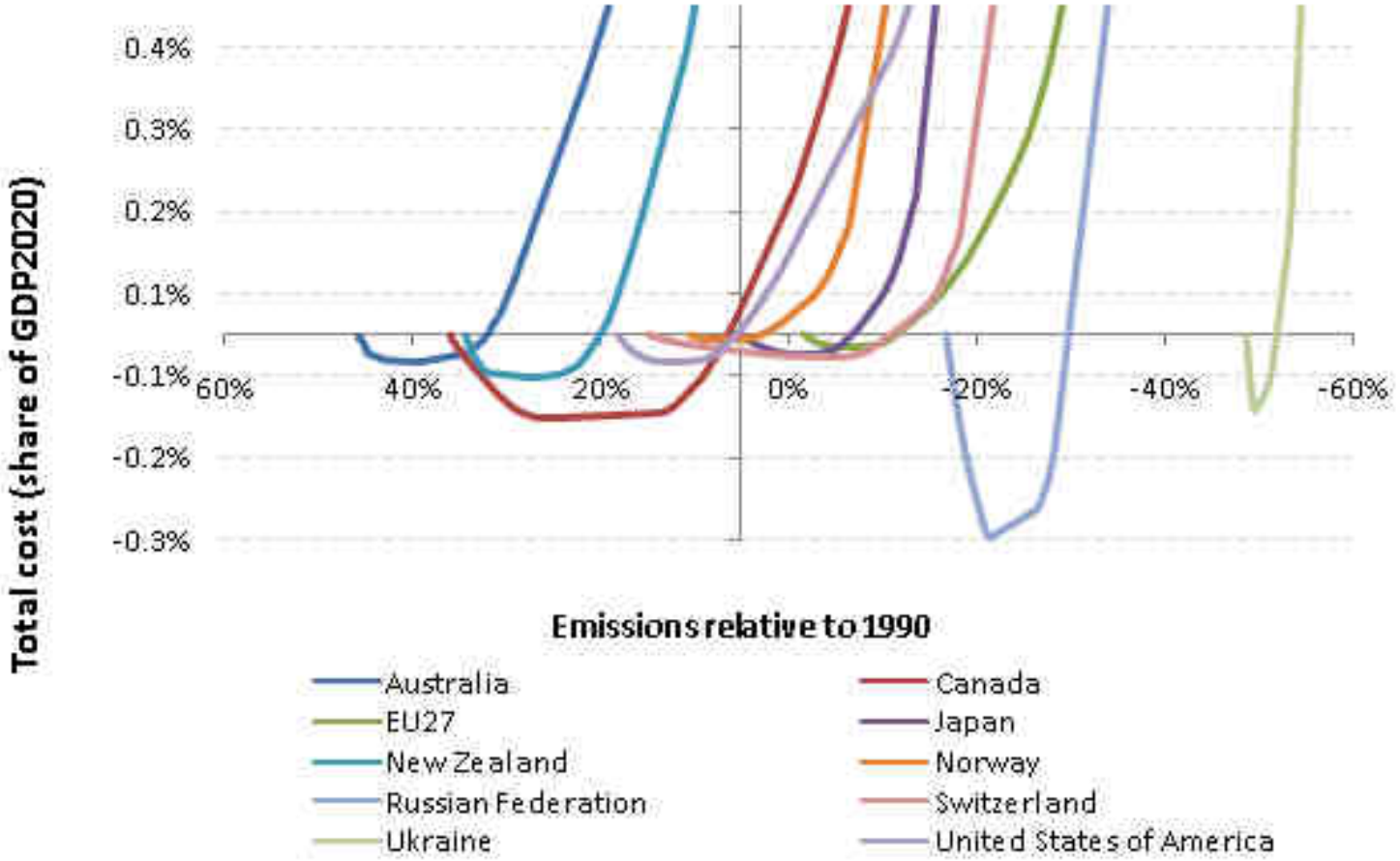
Total cost curves for individual Parties



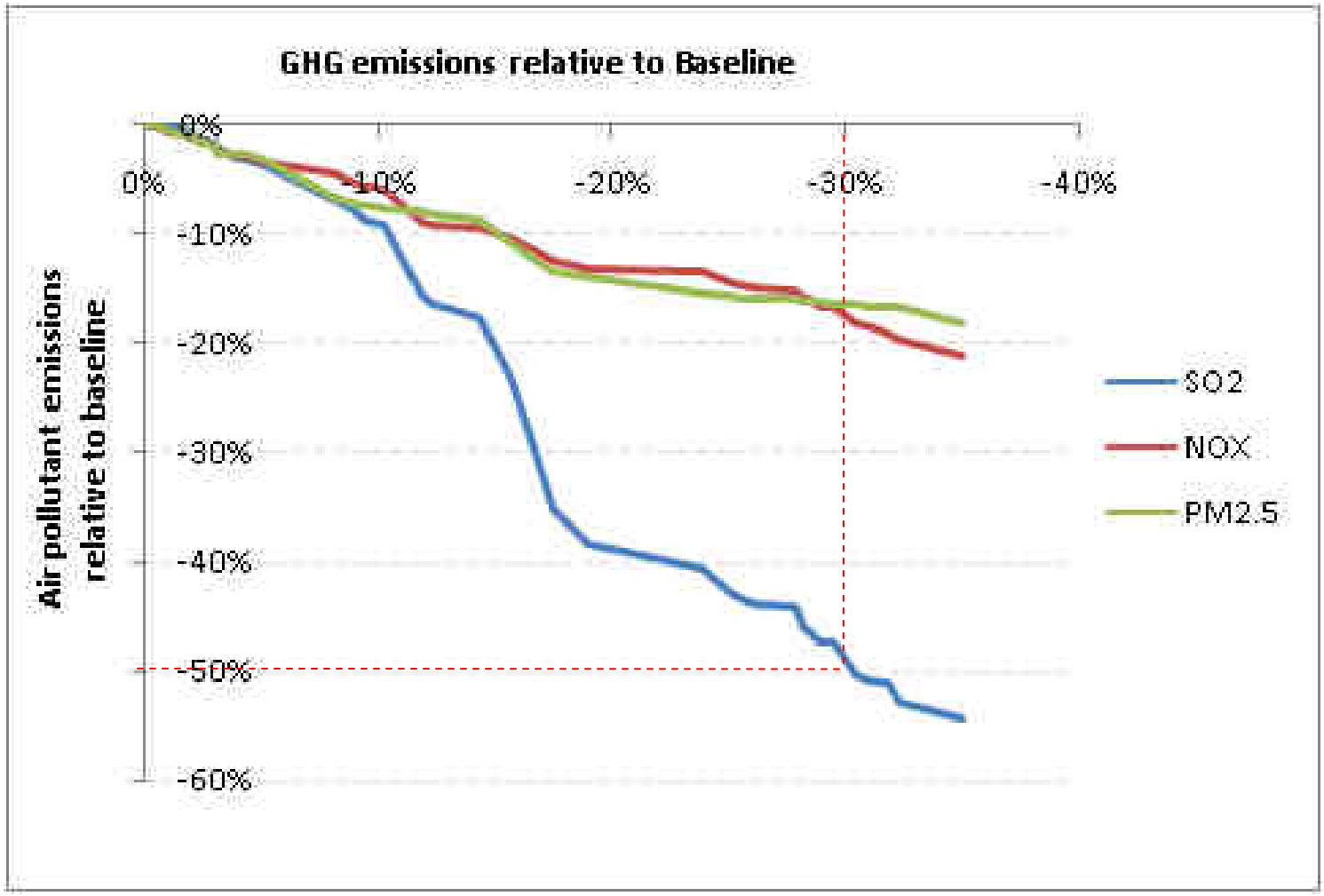
Total cost curves for individual Parties



Total cost curves for individual Parties



Co-benefits of air pollutant emissions
Example: Annex 1 in 2020



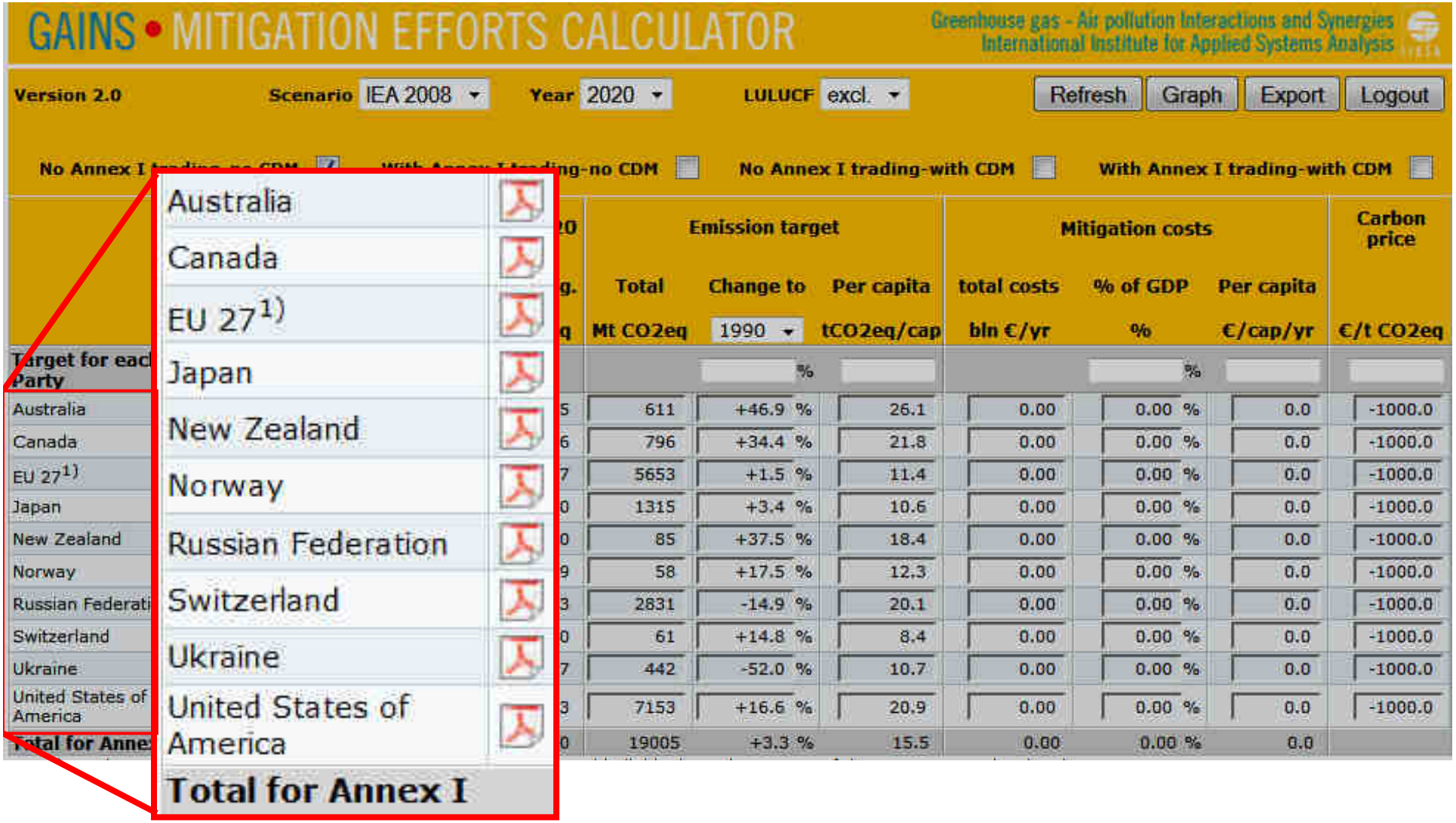
GAINS • MITIGATION EFFORTS CALCULATOR

Greenhouse gas - Air pollution Interactions and Synergies
International Institute for Applied Systems Analysis

Version 2.0 | Scenario: IEA 2008 | Year: 2020 | LULUCF: excl. | Refresh | Graph | Export | Logout

No Annex I trading-no CDM ☑ | With Annex I trading-no CDM ☐ | No Annex I trading-with CDM ☐ | With Annex I trading-with CDM ☐

	Base year	Emission range in 2020		Emission target			Mitigation costs			Carbon price
	1990	Baseline	max. mitig.	Total	Change to 1990	Per capita	total costs	% of GDP	Per capita	
	Mt CO2eq	Mt CO2eq	Mt CO2eq	Mt CO2eq	%	tCO2eq/cap	bln €/yr	%	€/cap/yr	€/t CO2eq
Target for each Party										
Australia	416	611	385	611	+46.9 %	26.1	0.00	0.00 %	0.0	-1000.0
Canada	592	796	536	796	+34.4 %	21.8	0.00	0.00 %	0.0	-1000.0
EU 27[1)]	5568	5653	3757	5653	+1.5 %	11.4	0.00	0.00 %	0.0	-1000.0
Japan	1272	1315	970	1315	+3.4 %	10.6	0.00	0.00 %	0.0	-1000.0
New Zealand	62	85	60	85	+37.5 %	18.4	0.00	0.00 %	0.0	-1000.0
Norway	50	58	49	58	+17.5 %	12.3	0.00	0.00 %	0.0	-1000.0
Russian Federation	3326	2831	1743	2831	-14.9 %	20.1	0.00	0.00 %	0.0	-1000.0
Switzerland	53	61	40	61	+14.8 %	8.4	0.00	0.00 %	0.0	-1000.0
Ukraine	922	442	237	442	-52.0 %	10.7	0.00	0.00 %	0.0	-1000.0
United States of America	6135	7153	4953	7153	+16.6 %	20.9	0.00	0.00 %	0.0	-1000.0
Total for Annex I	18396	19005	12730	19005	+3.3 %	15.5	0.00	0.00 %	0.0	


GAINS • MITIGATION EFFORTS CALCULATOR
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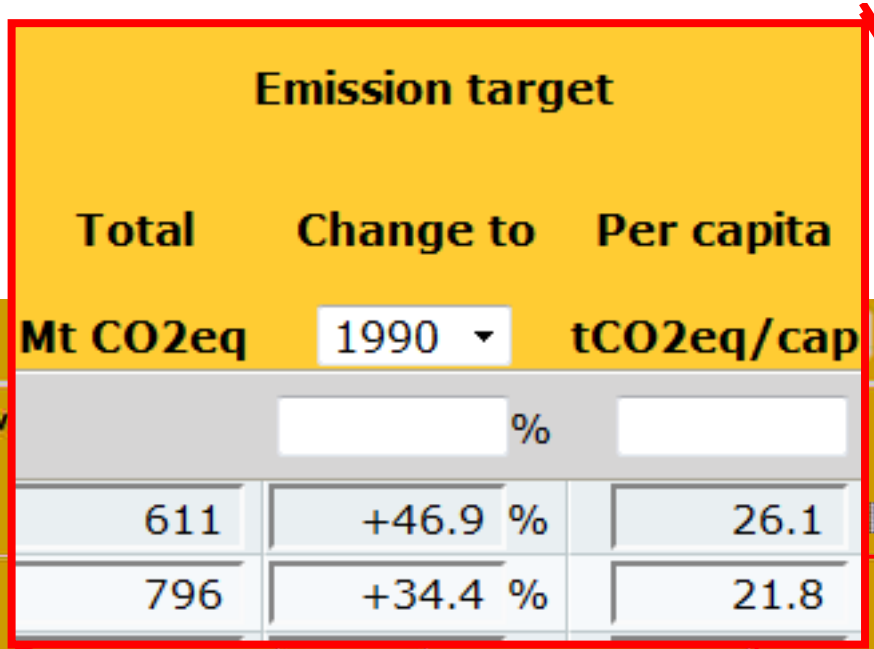
No Annex I trading-no CDM
With Annex I trading-no CDM
No Annex I trading-with CDM
With Annex I trading-with CDM
Emission target
Mitigation costs
Carbon price
Total
Change to
Per capita
total costs
% of GDP
Per capita
Mt CO2eq
1990
tCO2eq/cap
bln €/yr
%
€/cap/yr
€/t CO2eq
Target for each Party
Australia
Canada
EU 27 1)
Japan
New Zealand
Norway
Russian Federation
Switzerland
Ukraine
United States of America
Total for Annex I
611 +46.9 % 26.1 0.00 0.00 % 0.0 -1000.0
796 +34.4 % 21.8 0.00 0.00 % 0.0 -1000.0
5653 +1.5 % 11.4 0.00 0.00 % 0.0 -1000.0
1315 +3.4 % 10.6 0.00 0.00 % 0.0 -1000.0
85 +37.5 % 18.4 0.00 0.00 % 0.0 -1000.0
58 +17.5 % 12.3 0.00 0.00 % 0.0 -1000.0
2831 -14.9 % 20.1 0.00 0.00 % 0.0 -1000.0
61 +14.8 % 8.4 0.00 0.00 % 0.0 -1000.0
442 -52.0 % 10.7 0.00 0.00 % 0.0 -1000.0
7153 +16.6 % 20.9 0.00 0.00 % 0.0 -1000.0
19005 +3.3 % 15.5 0.00 0.00 % 0.0



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Greenhouse gas - Air pollution Interactions and Synergies
International Institute for Applied Systems Analysis

LULUCF excl

Refresh | Graph | Export | Logout

No Annex I trading-with CDM | With Annex I trading-with CDM

		Emission target			Mitigation costs			Carbon price
	1990 Mt CO2eq	Baseline Mt CO2eq	max. mitig. Mt CO2eq	Total Mt CO2eq	Change to 1990 %	Per capita tCO2eq/cap	total costs bln €/yr	% of GDP %	Per capita €/cap/yr	€/t CO2eq
Target for each Party										
Australia	416	611	385	611	+46.9 %	26.1	0.00	0.00 %	0.0	-1000.0
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Japan	1272	1315	970	1315	+3.4 %	10.6	0.00	0.00 %	0.0	-1000.0
New Zealand	62	85	60	85	+37.5 %	18.4	0.00	0.00 %	0.0	-1000.0
Norway	50	58	49	58	+17.5 %	12.3	0.00	0.00 %	0.0	-1000.0
Russian Federation	3326	2831	1743	2831	-14.9 %	20.1	0.00	0.00 %	0.0	-1000.0
Switzerland	53	61	40	61	+14.8 %	8.4	0.00	0.00 %	0.0	-1000.0
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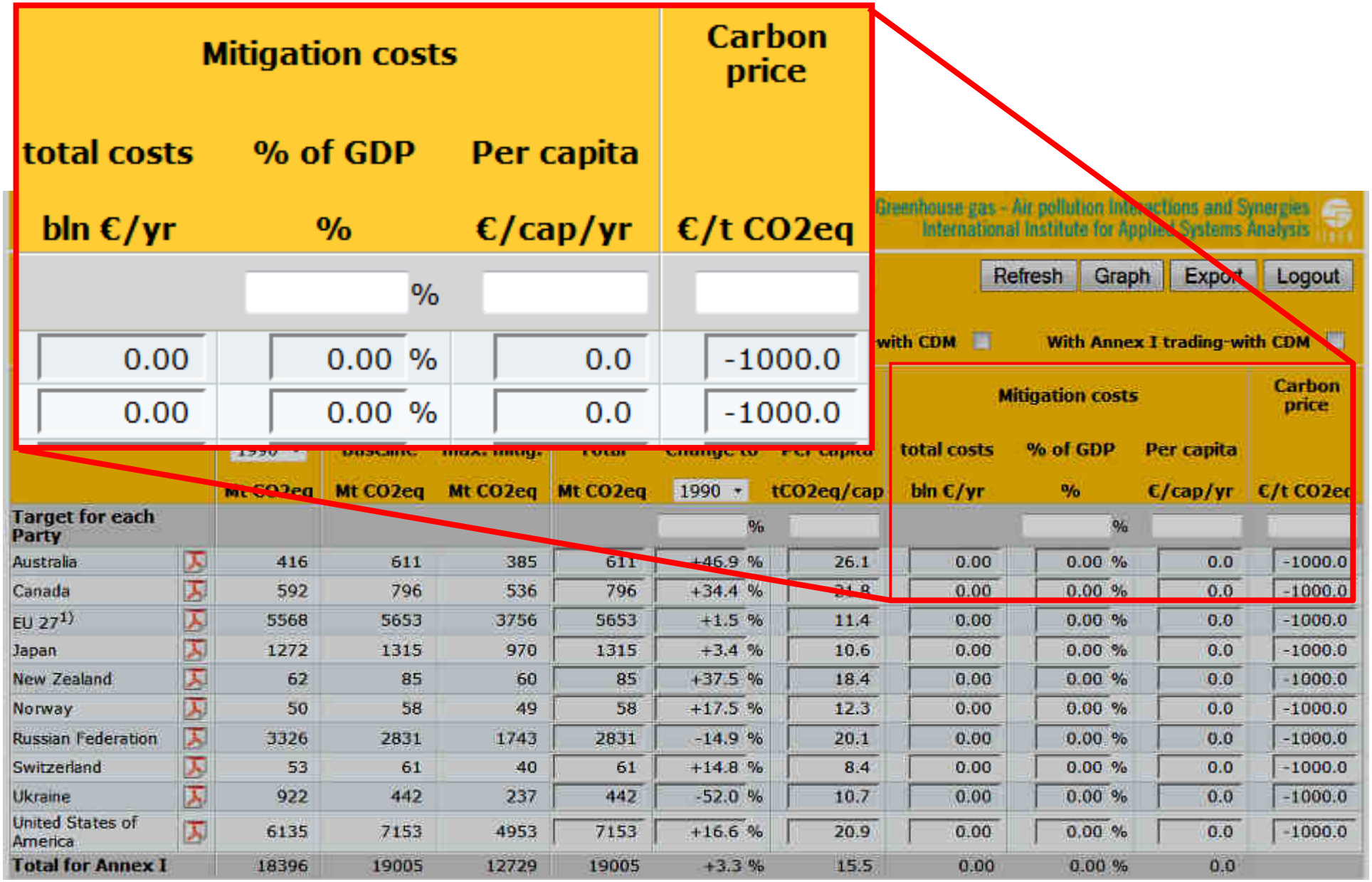

	Mitigation costs			Carbon price
	total costs	% of GDP	Per capita	
	bln €/yr	%	€/cap/yr	€/t CO2eq
		%		
	0.00	0.00 %	0.0	-1000.0
	0.00	0.00 %	0.0	-1000.0

Greenhouse gas - Air pollution Interactions and Synergies
International Institute for Applied Systems Analysis

Refresh | Graph | Export | Logout

with CDM | With Annex I trading-with CDM

							Mitigation costs			Carbon price
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	Mt CO2eq	Mt CO2eq	Mt CO2eq	Mt CO2eq	1990	tCO2eq/cap	bln €/yr	%	€/cap/yr	€/t CO2eq
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Russian Federation	3326	2831	1743	2831	-14.9 %	20.1	0.00	0.00 %	0.0	-1000.0
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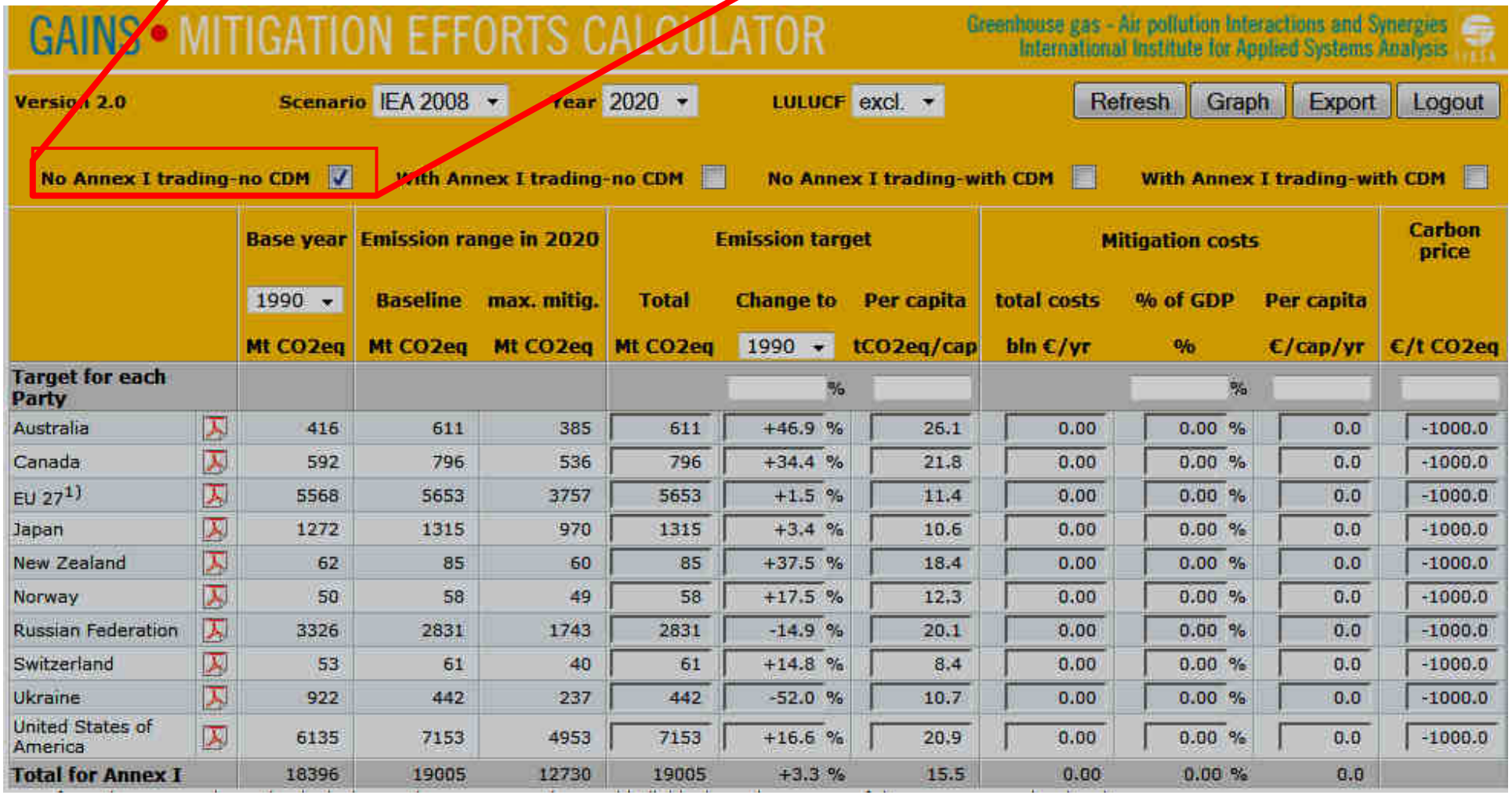

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GAINS MITIGATION EFFORTS CALCULATOR

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
Greenhouse Gas - Air Pollution Interactions and Synergies
VERSION 2.0, May 2009

IIASA

Scenario: IEA 2008 Year: 2020 excl. LULUCF

No Annex I trading-no CDM

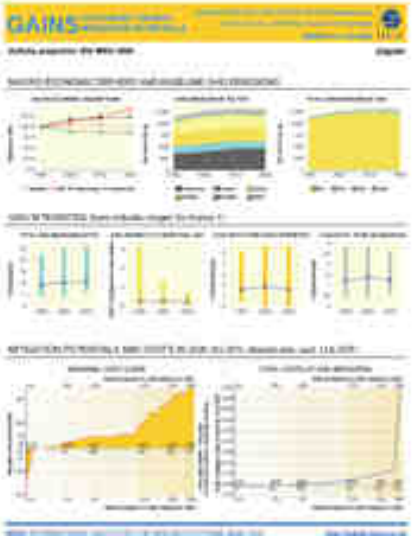
Party	Emission target: Total Mt CO2eq	Emission target: Change to 1990	Emission target: Per capita tCO2eq/cap	Mitigation costs: Total costs bln €/yr	Mitigation costs: % of GDP	Mitigation costs: Per capita €/cap/yr	Carbon price €/t CO2eq
		-50% 0%	0 5 10 15 20	-30 -20 -10 0	0%	-50 0 50	0 25 50
Australia	458						
Canada	585						
EU 27	4,477						
Japan	1,114						
New Zealand	68						
Norway	53						
Russian Federation	2,041						
Switzerland	54						
Ukraine	283						
USA	5,817						

More information
http://gains.iiasa.ac.at/

Methodology reports

Model Input data

Data sheets



Mitigation Efforts Calculator (MEC)

Markus Amann, Peter Rafaj (IIASA)
Niklas Höhne (Ecofys)

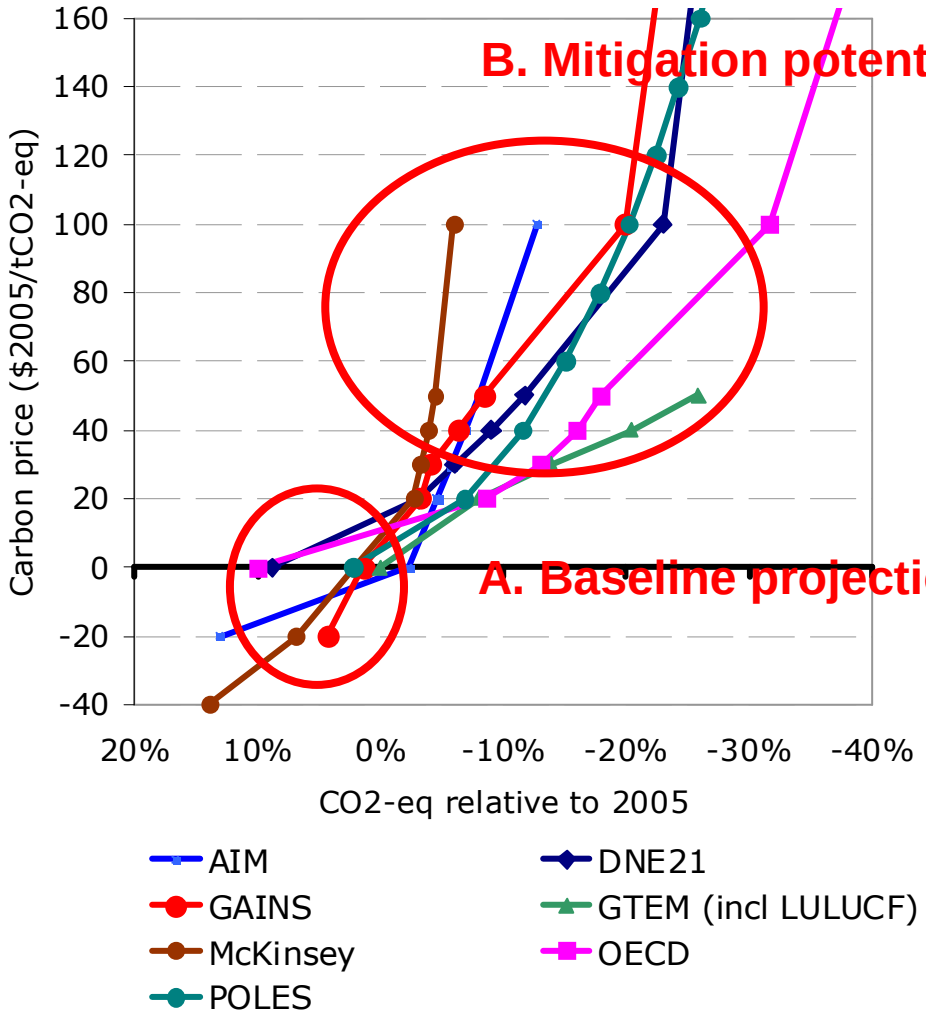
Comparison of estimates of GHG mitigation potentials and costs in Annex I countries

Findings from the workshop
May 28-29, 2009
International Institute for Applied Systems Analysis (IIASA)

Method

- Questionnaire sent out to modelling teams
  - Basic assumptions (GDP, discount rates, oil prices, etc.)
  - Baseline energy projections
  - GHG emissions for baseline and 0/20/50/100/300 US-$/t $CO2_{eq}$
- Responses received from
  - AIM (NIES, Japan)
  - DNE21+ (RITE, Japan)
  - ENV-LINKAGES (OECD)
  - GAINS (IIASA, Austria)
  - GTEM & MMRF (Treasury, Australia)
  - McKinsey
  - POLES (JRC, Spain)

Marginal mitigation costs,
Comparison of raw data, Annex I, 2020



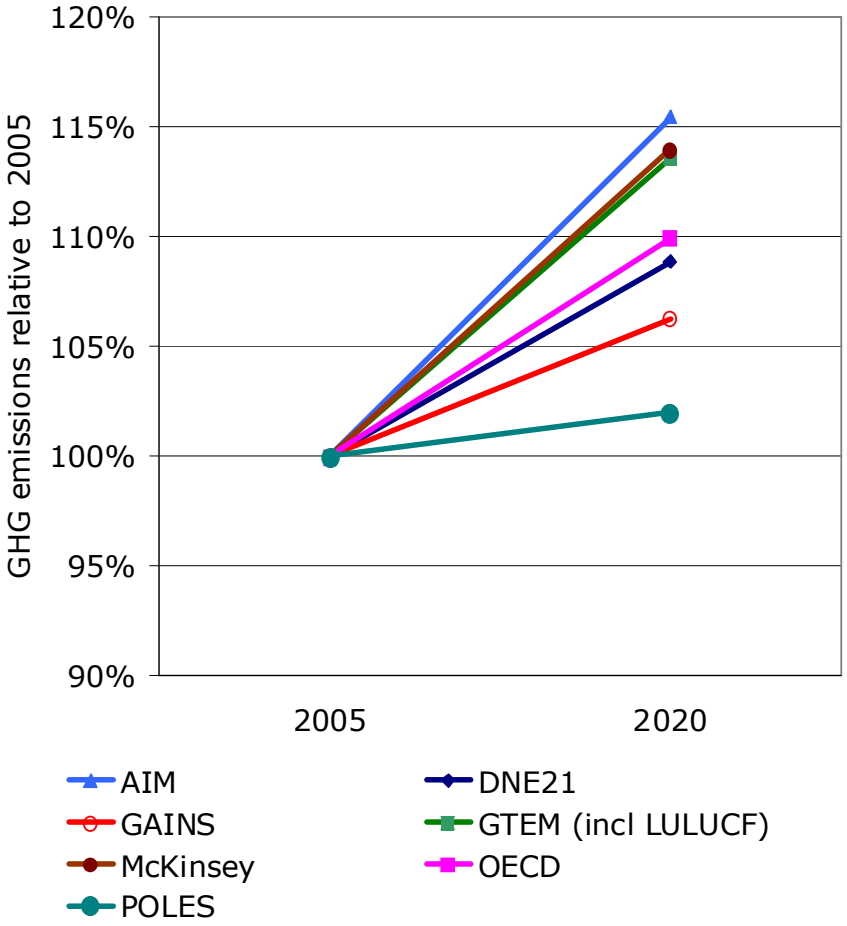
\+ All models suggest significant mitigation potential (10-30% below 1990 at 50$)

\+ Better agreement than revealed in earlier studies

– However, spread remains considerable in absolute terms

– Difficulties for comparing mitigation efforts

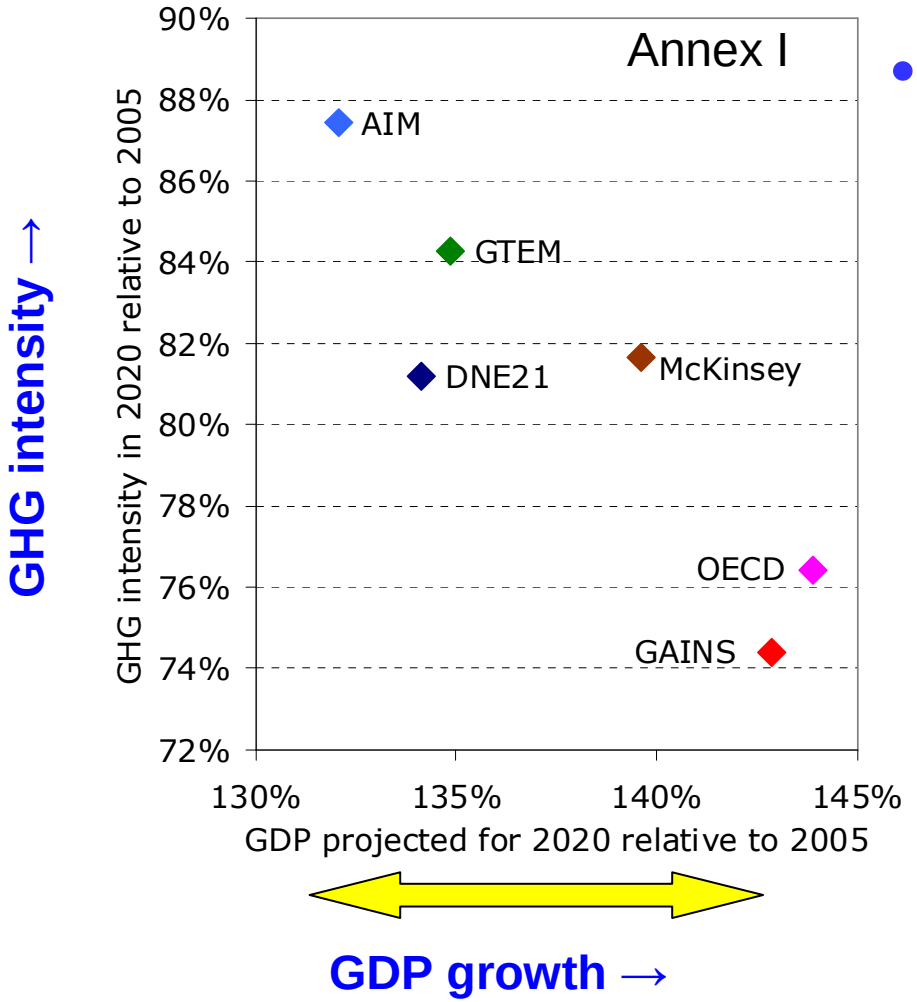
A. Baseline GHG emissions
Annex I, 2005 and 2020



- Baseline projections of Annex I GHG emissions range from +6% to +16% in 2020 relative to 2005

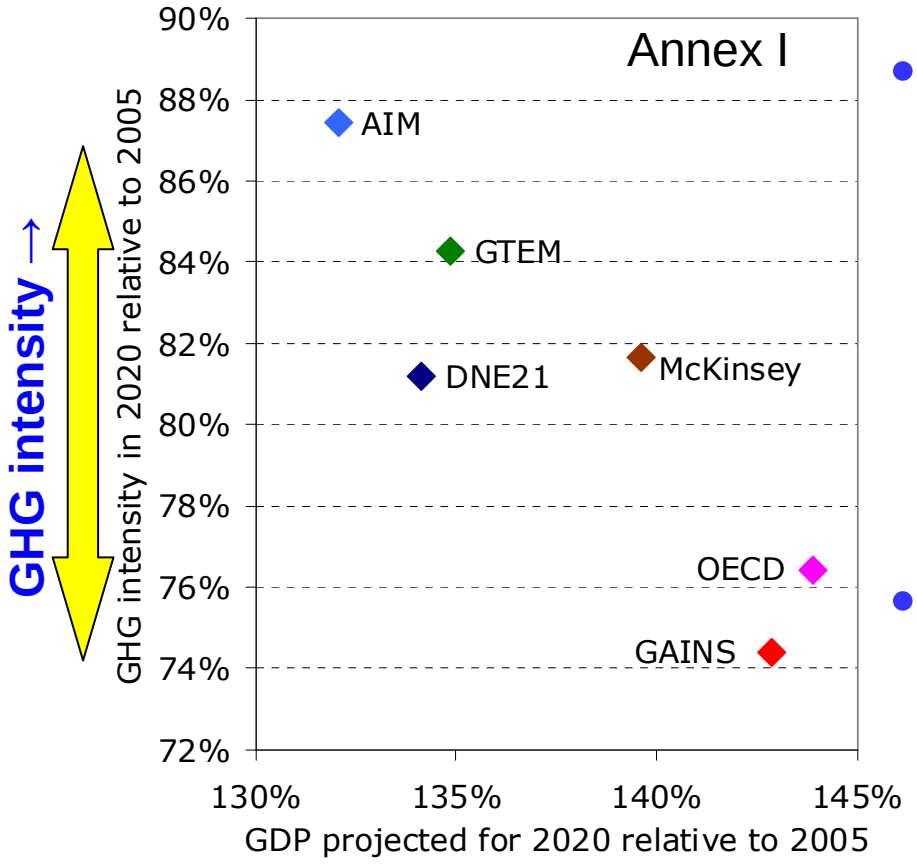
- Major reasons:
  - Assumptions on GDP growth
  - Assumptions on autonomous energy efficiency improvements
  - Definition of baseline case with regard to climate policy measures

Differences in projected baseline GDP growth and GHG intensities



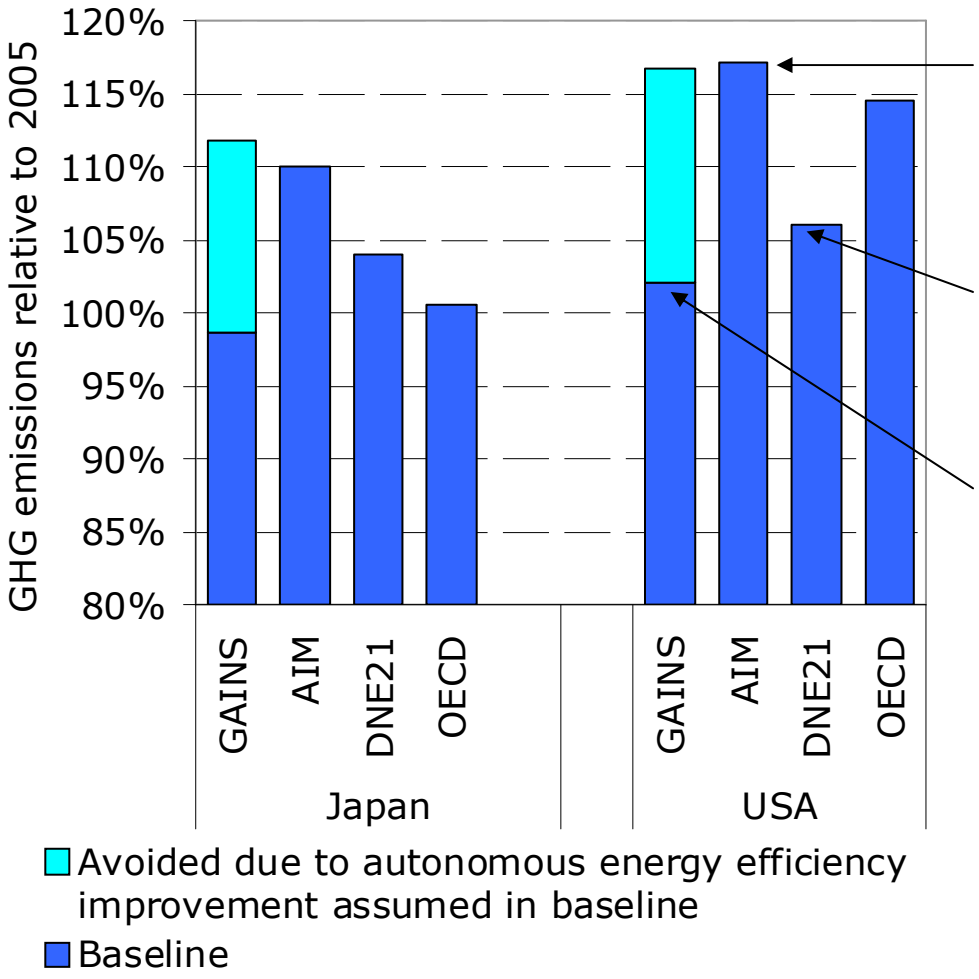
- GDP projections for 2020 range between +32% and +44% relative to 2005
  - Difficult to predict accurately, especially in the current crisis

Differences in projected baseline GDP growth and GHG intensities



- GDP projections for 2020 range between +32% and +44% relative to 2005
  - Difficult to predict accurately, especially in the current crisis
- Assumed baseline improvements in GHG intensities range between 13% and 26% relative to 2005
  - Models apply different definitions of baselines

Baseline emissions projections depend i.a. on assumed autonomous energy efficiency improvements



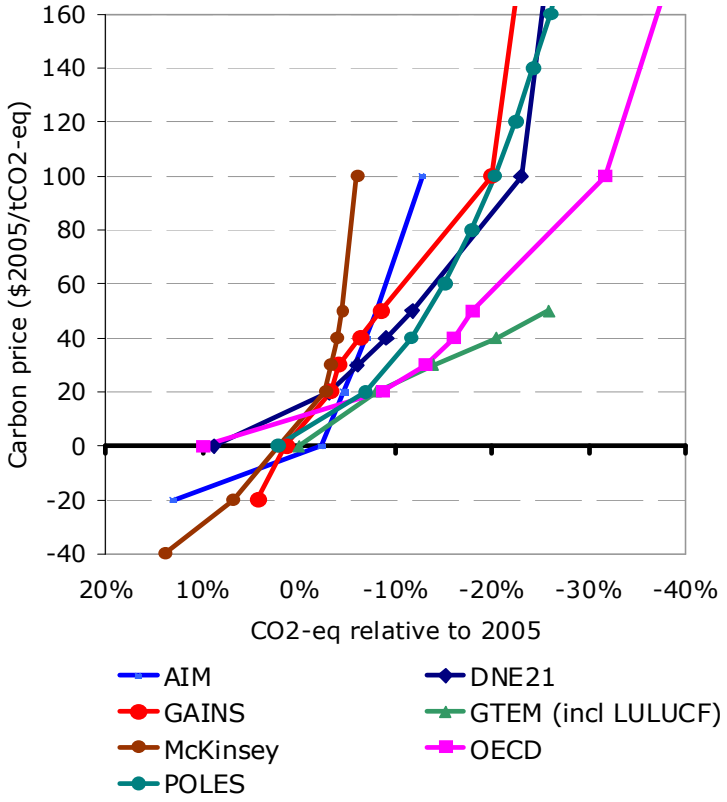
AIM: Frozen technology baseline

DNE21:Baseline includes measures at zero-$ carbon price

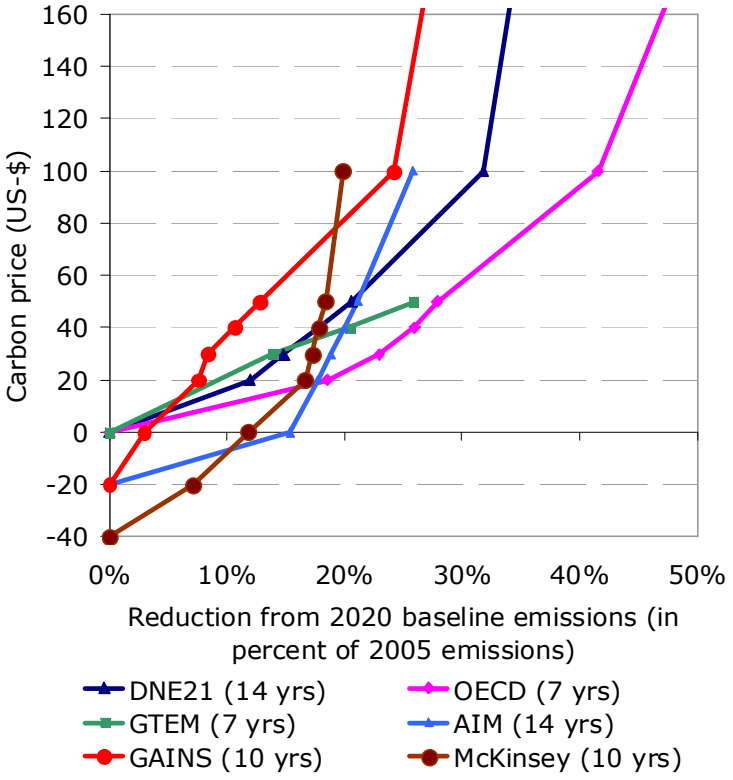
GAINS: Autonomous energy efficiency improvements as in IEA World Energy Outlook 2008

Differences in baseline definitions are critical for determining costs associated with GHG mitigation!

B. Differences in mitigation potentials
(1) Impacts of baseline projections

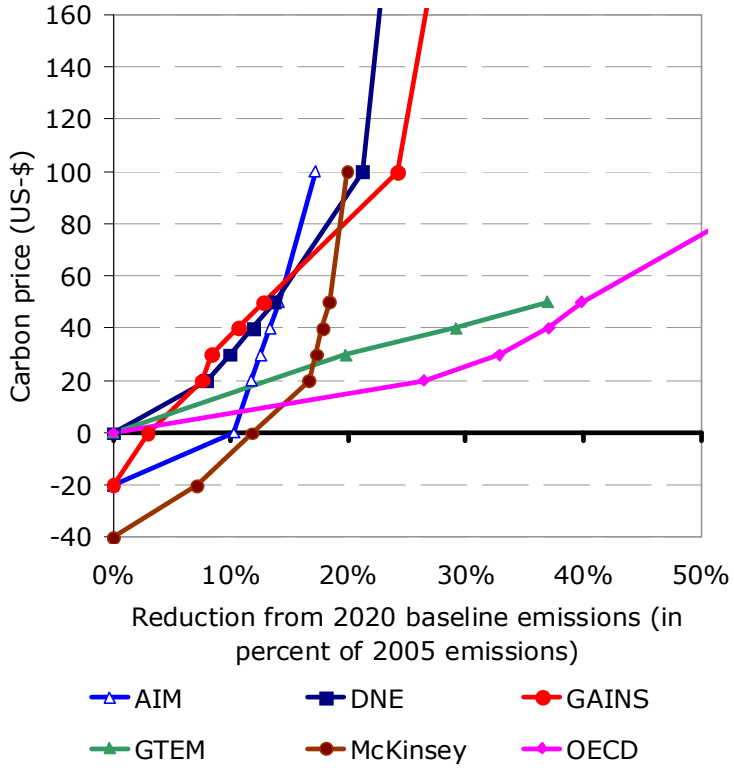


MACs relative to 2005 emissions



MACs relative to projected baseline emissions

B. Differences in mitigation potentials: (2) Assumed implementation periods differ



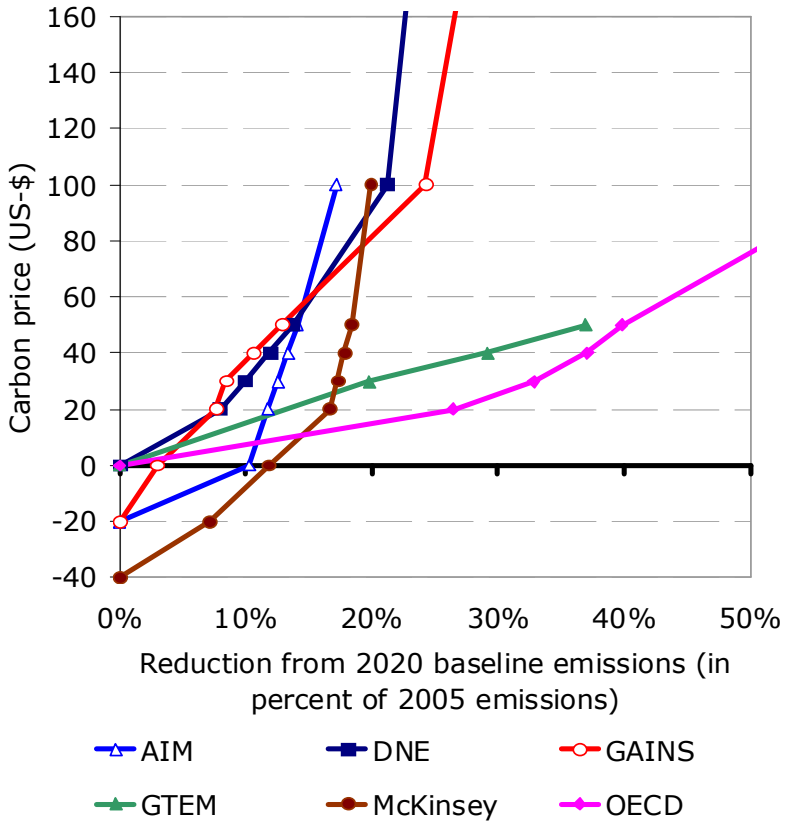
MACs relative to baseline emissions, **with 10 yrs implementation time**

For 2020, models have assumed different implementation times for mitigation measures:

- AIM: 15 yrs (>2005)
- DNE21: 14 yrs (>2006)
- GAINS: 10 yrs (>2010)
- GTEM: 7 yrs (>2013)
- McKinsey: 10 yrs (>2010)
- OECD: 7 yrs (>2013)

Model estimates converge with harmonized implementation periods!

Two clusters of estimates for 2020



MACs relative to baseline emissions,
for 10 yrs implementation period

Top-down models:

-40% below baseline for 50 US-$

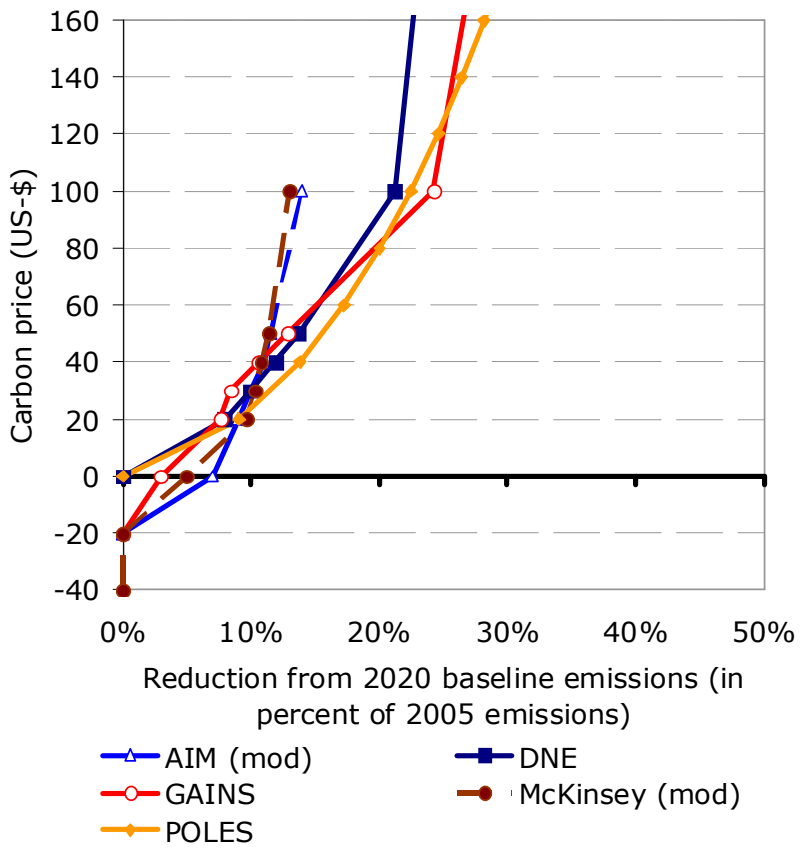
- include demand adjustments and macro-economic feedbacks

Bottom-up models:

-20% below baseline for 100 US-$

- GAINS and DNE21: similar
- McKinsey: lower costs – does not include transaction costs
- AIM: baseline does not include autonomous efficiency improvements at negative costs

Harmonization of baseline projections, implementation periods and cost concepts



Back-of-the-envelope adjustments:

- McKinsey:
  some transaction costs added
- AIM:
  1/3 of negative cost measures assumed as part of baseline

With harmonized

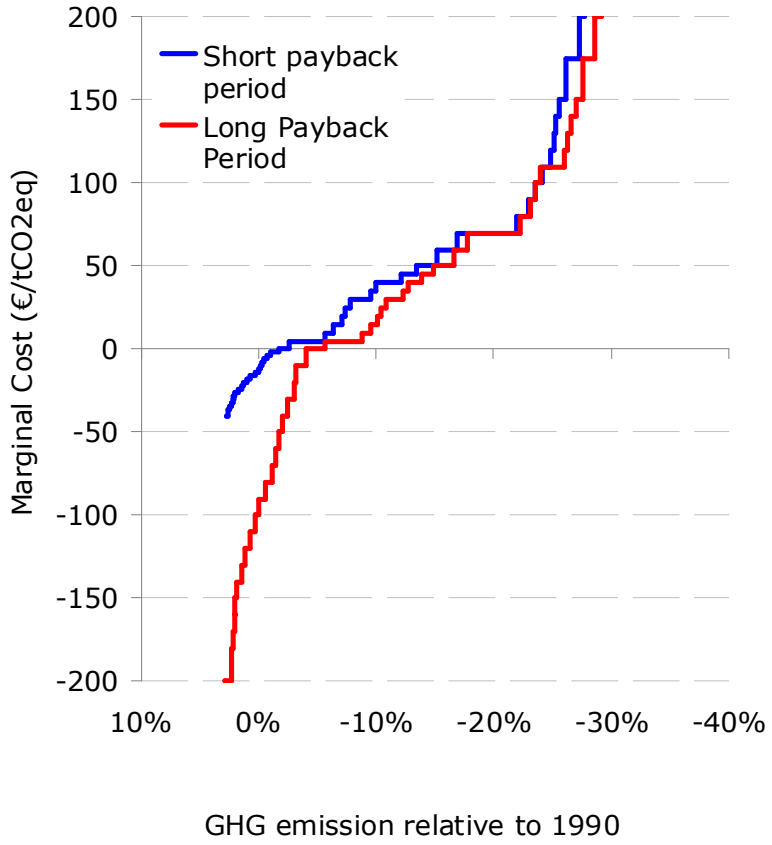
1. **baseline assumptions,**
2. **implementation periods**,
3. and **transaction costs,**

bottom-up models produce similar results!

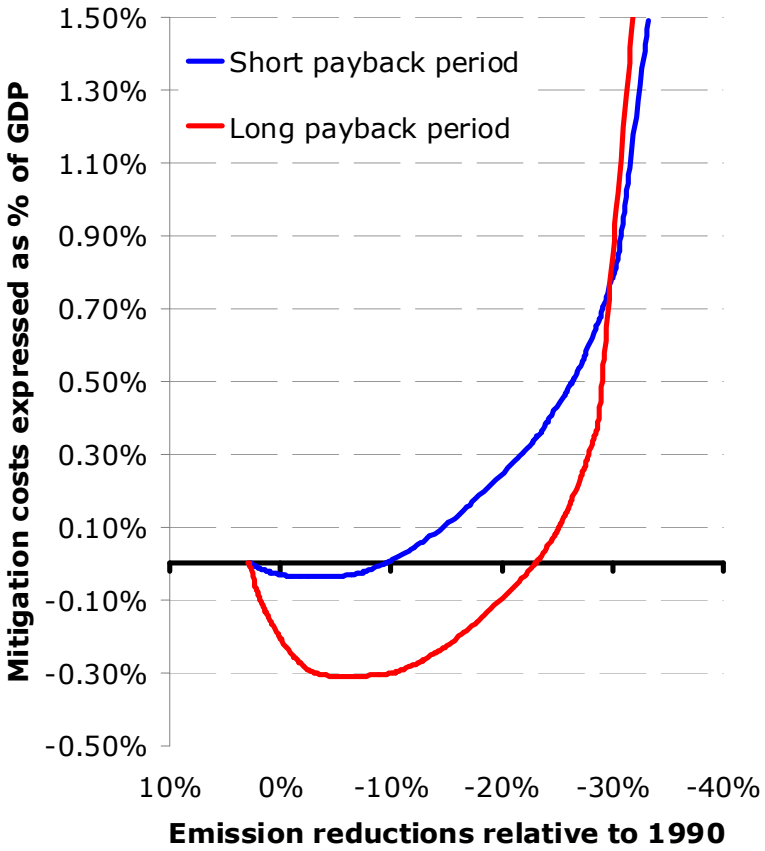
Implications of different pay-back periods

GAINS results, Annex I, 2020

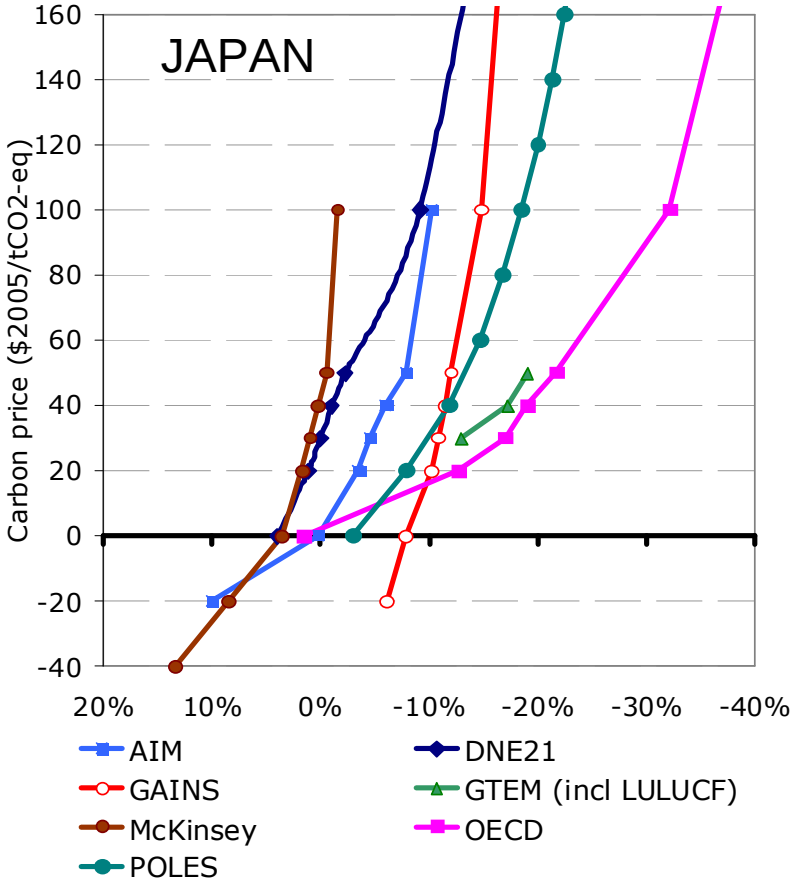
Marginal costs

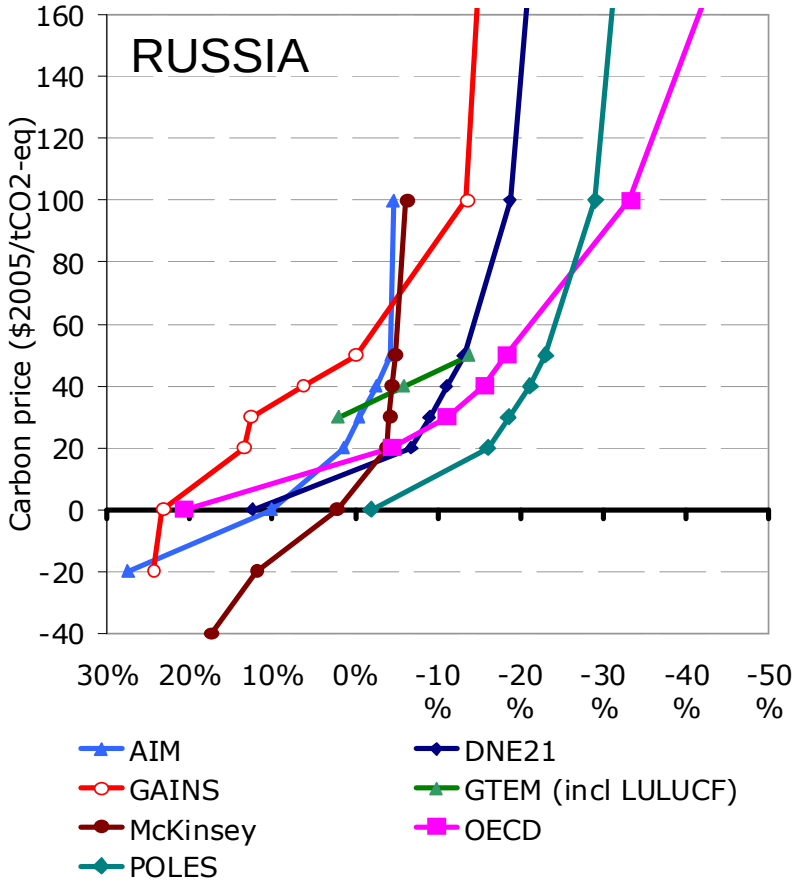


Total costs



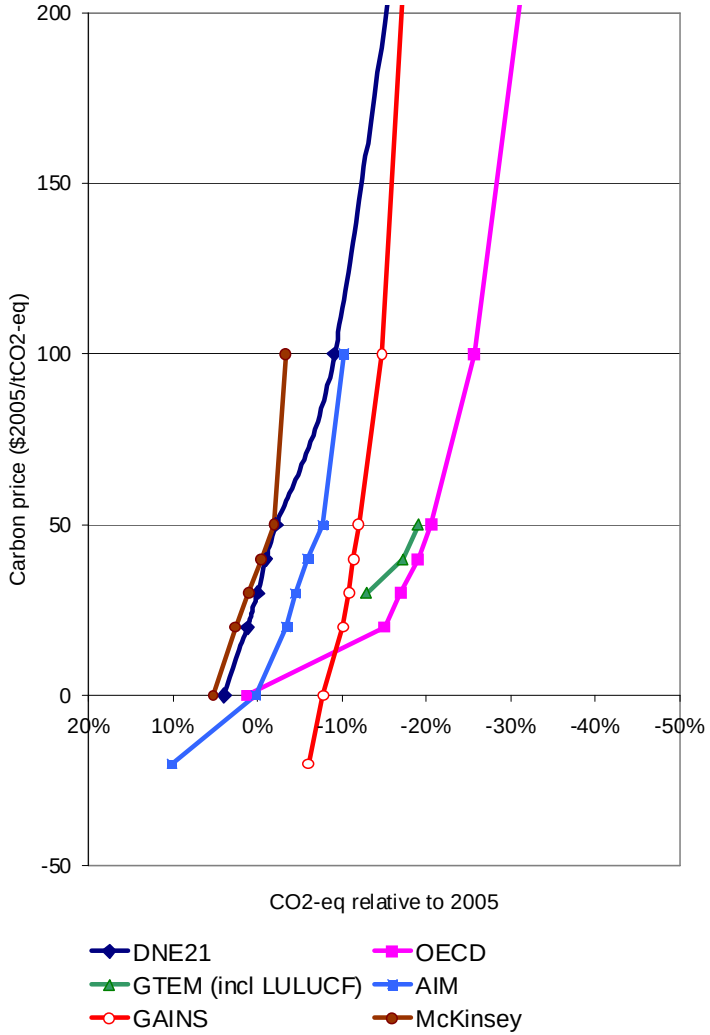
Similar considerations apply to country results
Validation with national experts necessary

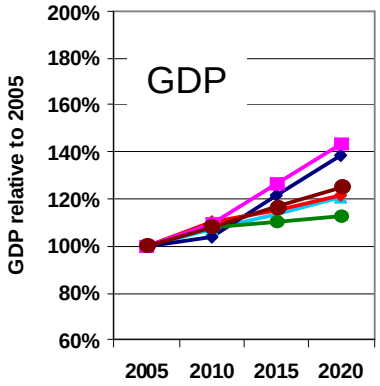


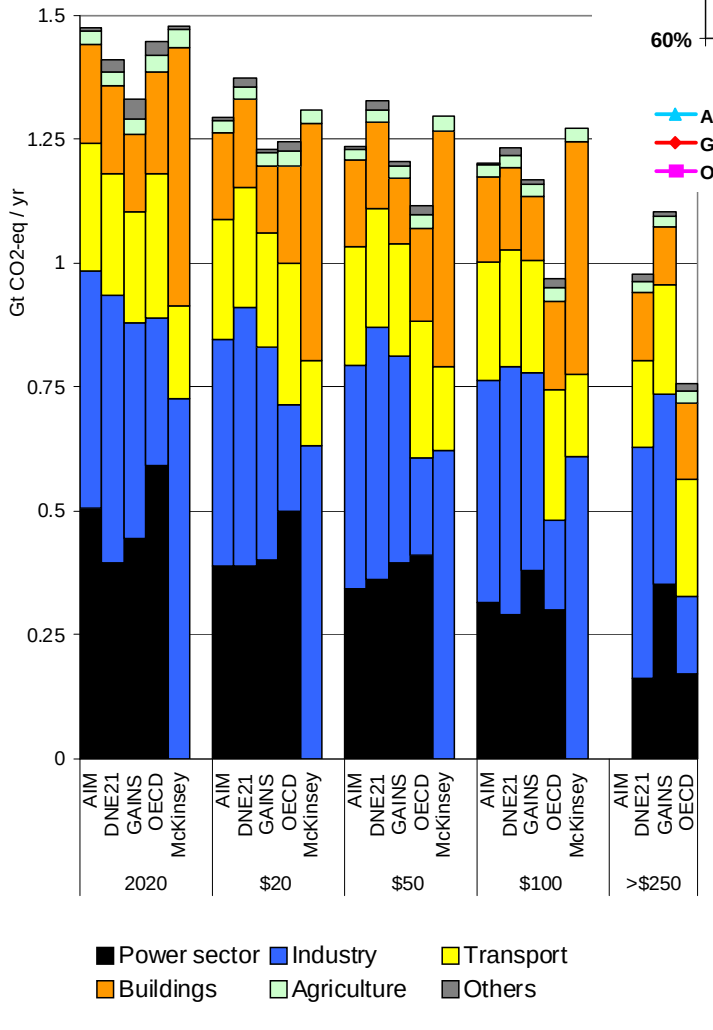


Japan

Marginal mitigation costs and sectoral emissions for different carbon prices, 2020







Conclusions
on the model intercomparison

- Top-down models - with consumer's demand changes - suggest a considerable potential leading up to a -40% reduction of Annex I emissions in 2020

- Bottom-up models show only half of this potential; however, there is striking agreement on mitigation potentials once results are harmonized for
  - baseline projections (definition and growth assumptions),
  - implementation periods,
  - transaction costs and pay-back periods.

- Assumptions for individual countries need to be confirmed with national experts.

Policy-relevant conclusions

- All models show for Annex I countries significant potential for GHG mitigation in 2020 at moderate costs.

- Baseline projections matter for feasibility and costs of absolute caps on GHG emissions.
  - Key uncertainty from current economic crisis

- Time matters!
  - Each delay in implementation decreases the potential achievable in 2020 and increases costs.
  - Mitigation potential in 2030 will be much larger than in 2020 due to more time for implementation and ongoing turnover of capital stock.

- Depending on the applied cost concept, total societal mitigation costs might be rather low.