GHG emission reduction due to energy efficiency measures under climate policy

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Outline

1. Background

2. TIAM-ECN model description

3. Results

4. Conclusion

Background of this study

- Initiated and funded by UNEP Risø Centre

- Support to UN GAP report 2014

- Involved partners:
  - Energy modelling: ECN (TIAM-ECN model) and Enerdata (POLES model)
  - Macro-economic modelling: Cambridge Econometrics (E3ME model)

- Focus: G20 member countries, time horizon 2030

- This presentation highlights the findings derived from TIAM-ECN.

TIAM-ECN model characterisation

ECN

- Global, technology rich, long-term energy system model
- Economic optimisation: determination of cost optimal configuration of the energy system
- 20 world regions with trade of energy, emission certificates and captured CO_2
- All energy supply and demand sectors (from resource extraction to the final end use of energy)
- Comprehensive energy technology portfolio, e.g. hydrogen and synfuel production, CCS in power, industry and upstream sector, renewables for heat and power
- Emissions: CO_2, CH_4, N_2O

Energy efficiency measures in TIAM-ECN

ECN

- Different power plant technologies

- Energy technology for industrial applications

- Energy conversion technology in residential and commercial sectors

- Energy savings in the demand sectors

- Transport technologies

Example Gasoline cars

| Technology	Reduction of fuel consumption compared to standard technology	Additional invest costs compared to standard technology
Gasoline cars		
Advanced car with improvements up to 25 US$ per %-point of fuel reduction, including low rolling resistance tyres, low friction design and material, improvement of aerodynamics	8 %	168 US$
Advanced car with improvements up to 35 US$ per %-point of fuel reduction, including additionally lightweight components and variable valve actuation and lift	20 %	619 US$
Advanced car with improvements up to 50 US$ per %-point of fuel reduction, including additionally start and stop technology and direct injection	33 %	1350 US$
Advanced car with improvements up to 100 US$ per %-point of fuel reduction, including additionally starter-alternator, lightweight steel components, auxiliary systems improvements and dual clutch transmission	44 %	2765 US$
Advanced car with improvements up to 170 US$ per %-point of fuel reduction, including additionally lightweight aluminium	46 %	3344 US$

Scenario definition & assumptions

ECN

- **BAU plus 3 carbon tax scenarios:**

| scenario	2010	2020	2030	2040	2050
carbon tax 40 US$ (ct40)	0	13	40	40	40
carbon tax 70 US$ (ct70)	0	23	70	70	70
carbon tax 100 US$ (ct100)	0	33	100	100	100

- Model input data harmonization with POLES & model linkage with E3ME
- Population growth according to UN projection (medium fertility rate)
- GDP(PPP) growth by more than factor 4 (2010-2050)

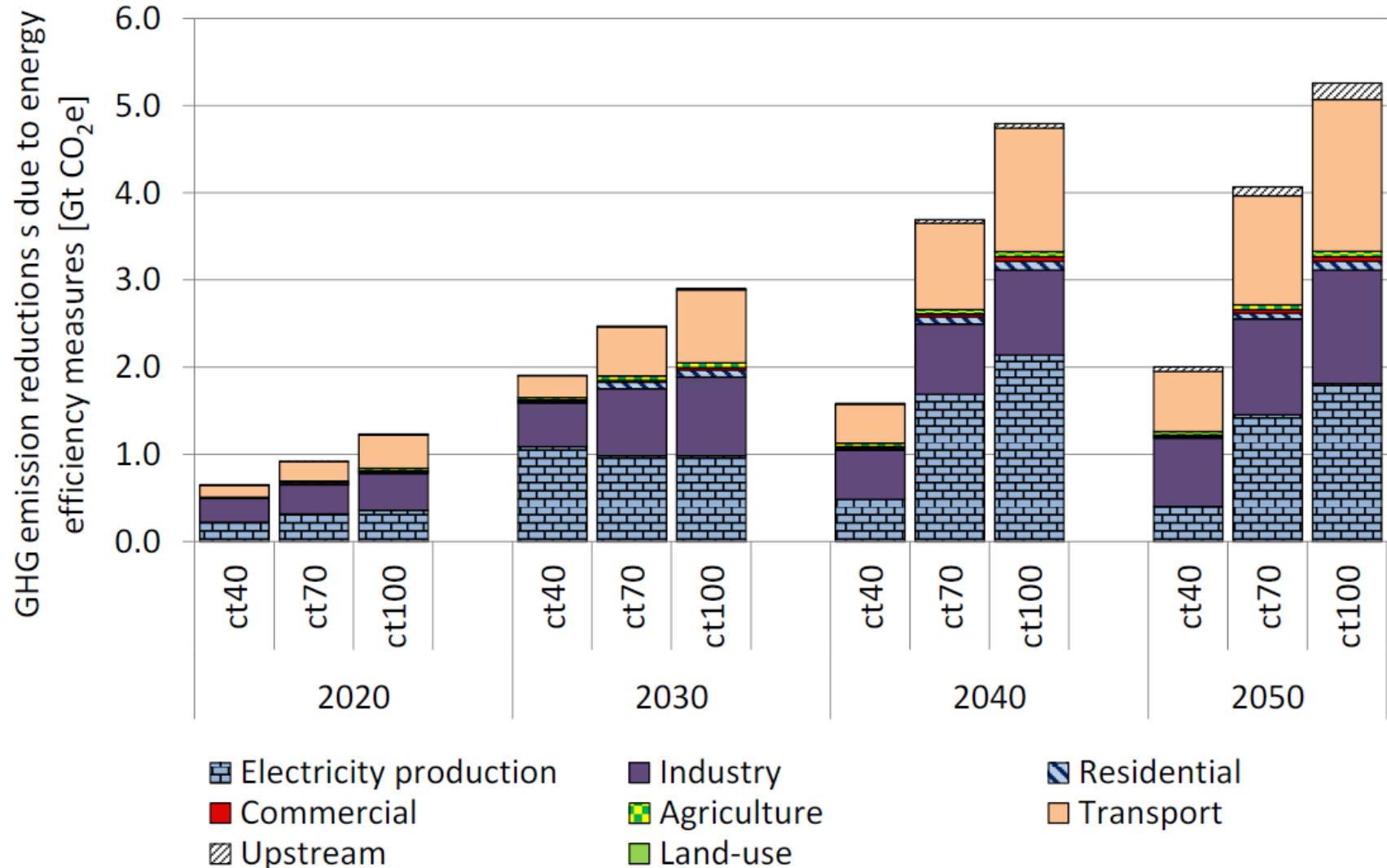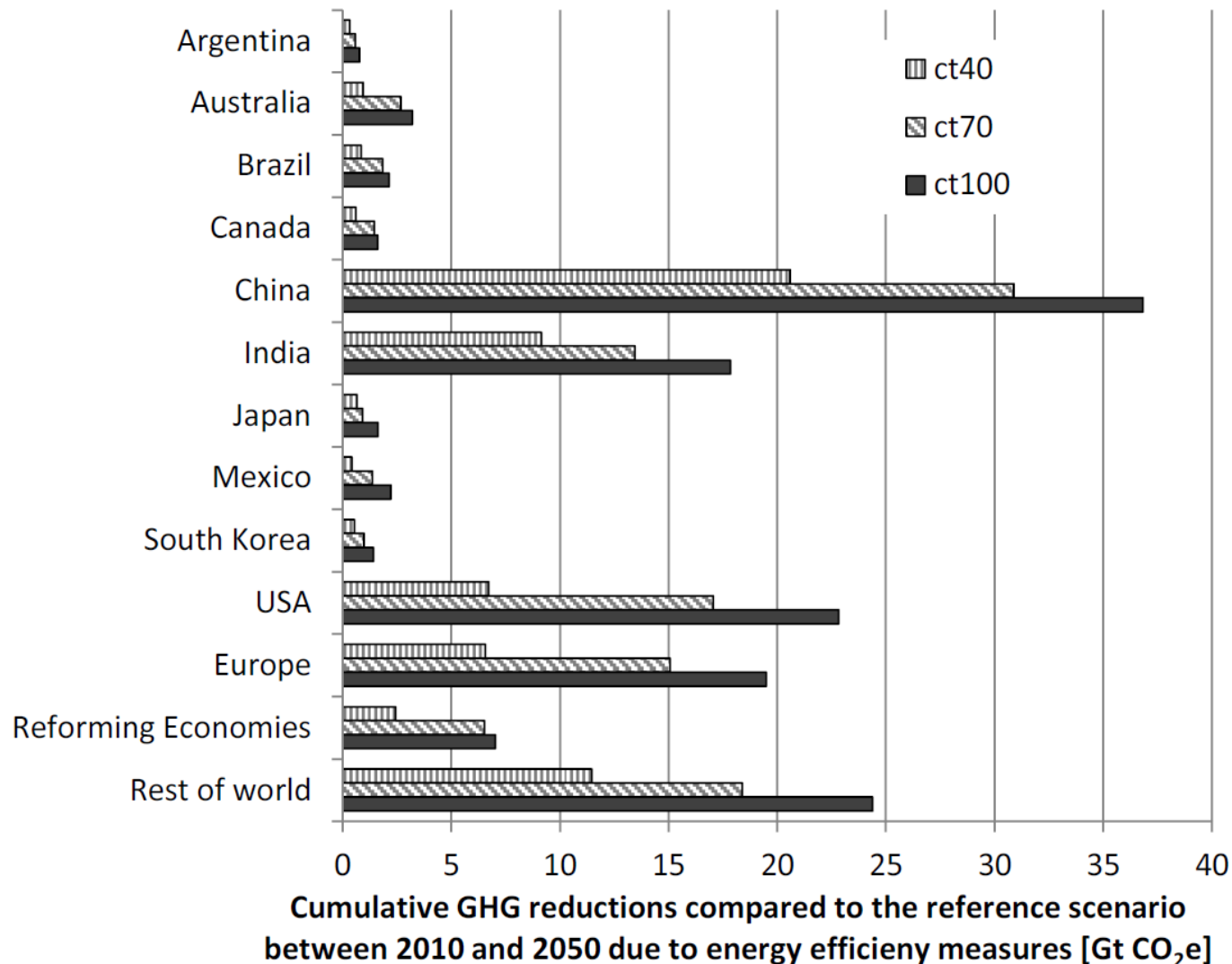| billion US$2005	2010	2020	2030	2040	2050
World	66755	102981	152792	215480	295082

Global GHG emissions
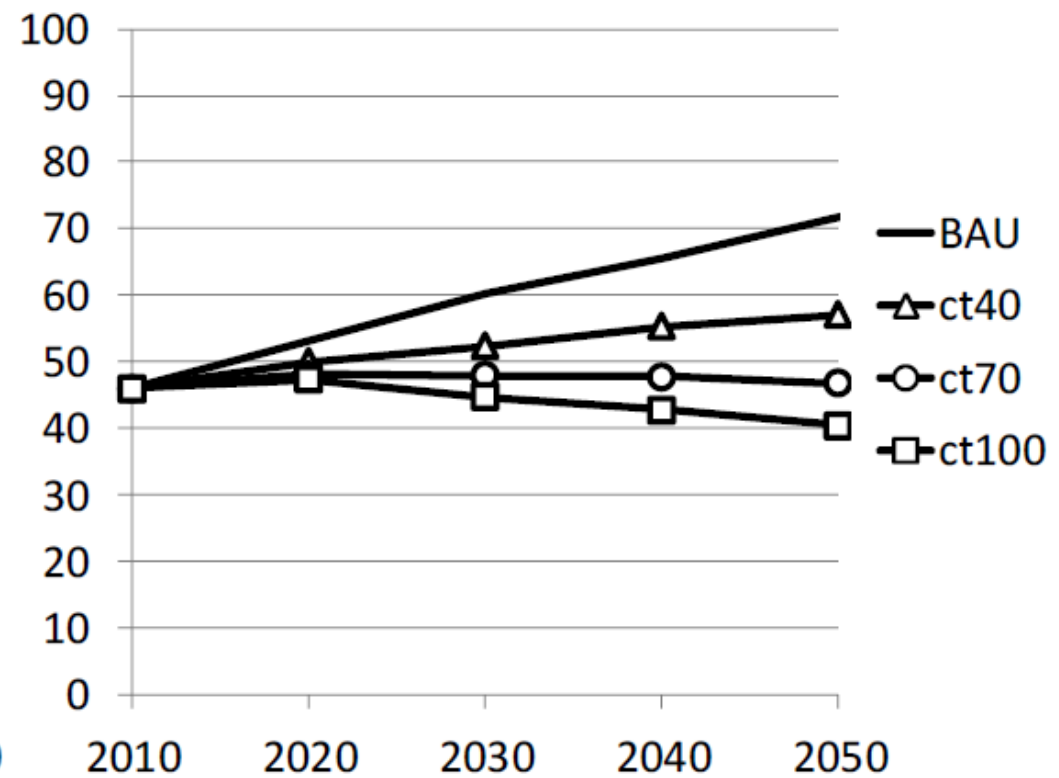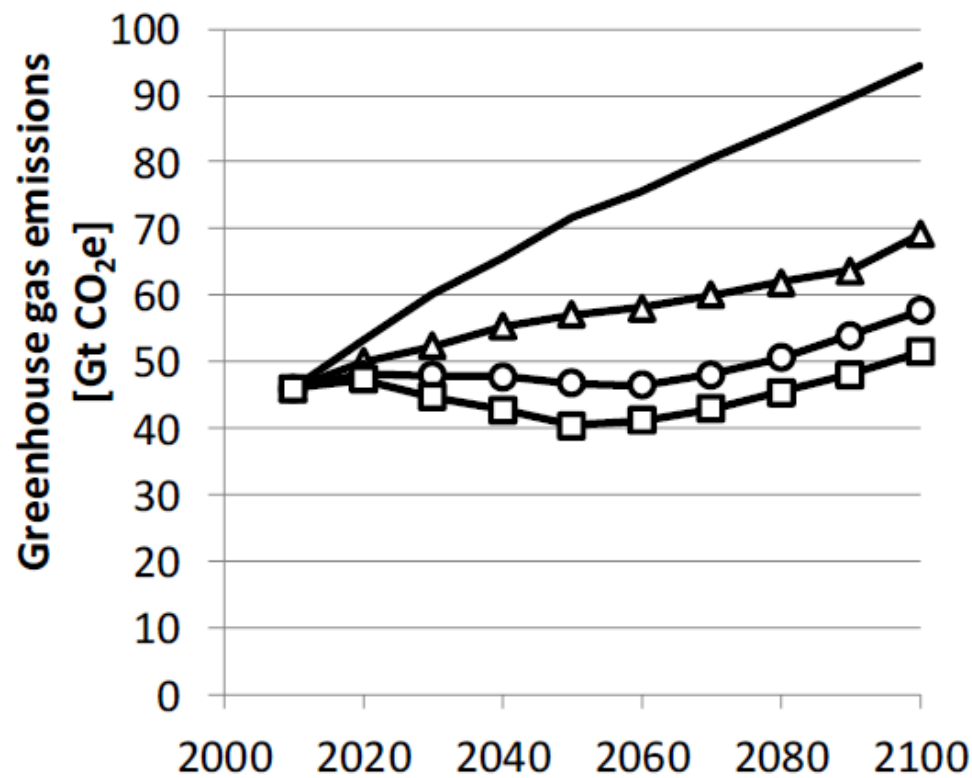
GHG emission in the BAU and reductions under carbon taxes
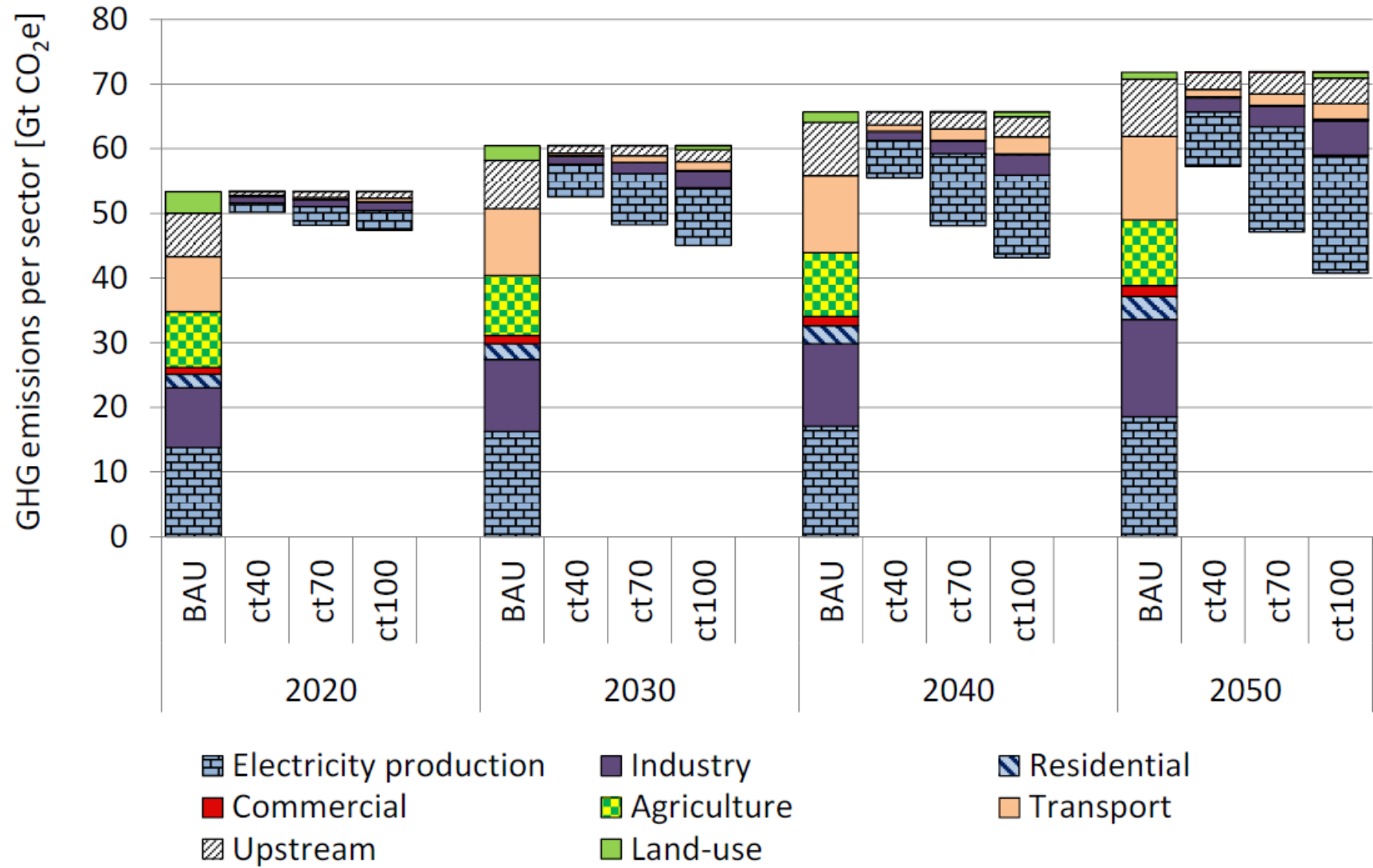
GHG emission reduction due to energy efficiency measures

Impact of energy efficiency measures on regional level

ECN

Cumulative GHG reductions compared to the reference scenario between 2010 and 2050 due to energy efficieny measures [Gt CO_2e]

Share of energy efficiency of total GHG emission reduction

Scenario	Share of emission reductions due to energy efficiency measures of total cumulative GHG emission reductions between 2010 and 2050				
	0 - 9 %	10 - 14 %	15 - 19 %	20 - 24 %	25 - 29 %
ct40	Ref. Econ.	Argentina Australia Brazil Canada Mexico South Korea USA	Japan Europe Rest of world		China India
ct70		Japan South Korea	Argentina Brazil Canada China Mexico USA Ref. Econ. Rest of world	Australia India	Europe
ct100		Brazil Canada South Korea Ref. Econ.	Argentina Japan Mexico Rest of world	Australia China India USA	Europe

N. B.: Ref. Econ. refers to Reforming Economies

TIAM-ECN and POLES broadly agree on regional effects

ECN

Cumulative emission reductions (2015-2030) due to energy efficiency improvements (units in MtCO2e)	carbon tax 40 $		carbon tax 70 $		carbon tax 100 $	
	POLES	TIAM-ECN	POLES	TIAM-ECN	POLES	TIAM-ECN
World	15252	16069	24067	21612	31071	26884
Europe[1]	298	1763	740	2758	1136	4654
China	6939	6715	10707	8435	13101	9499
India	1466	2388	2214	2486	2720	2721
USA	1294	1092	2159	1825	2932	2228
Canada	191	53	310	249	418	280
Brazil	128	59	213	264	294	296
Australia/New Zealand	173	157	294	142	389	170
Mexico	123	94	209	144	293	240
Russia[2]	1041	288	1602	1101	2050	1360
Japan	249	215	404	271	551	328
Middle East[3]	404	716	666	1348	1035	1557
South Korea	137	167	228	277	303	316

[1] For POLES *Europe* refers to EU-28, for TIAM-ECN to the two native model regions Eastern and Western Europe.

[2] In TIAM-ECN this region represents the countries which belonged to the former Soviet Union.

[3] Here included the Middle East indicative for Saudi Arabia as G20 member.

Conclusions on energy efficiency measures

- Partly cost-effective even under absence of carbon tax policy

- Responsible for 15-25 % of global GHG emission reductions until 2050

- Higher GHG mitigation contribution in the near and midterm (2020/2030) than in the long-run (2050)

- Offset by 2030 about 2 to 3 $GtCO_2e$ for a price of carbon between 40 $ and 100 $ per ton of CO_2

- GHG reductions in the power sector & in industry and transport

- China, India and the USA offer prime opportunities

Acknowledgements

Further results and documentation are provided in the ECN report
ECN-E–14-038 which is soon available under
www.ecn.nl/publications,
and in a synthesized publication comprising all participating models
of this project, which will be published by the
UNEP Risø Centre early 2015.

Thank you!

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