Limiting Global Climate Change to 2° Celsius

The way ahead for 2020 and beyond

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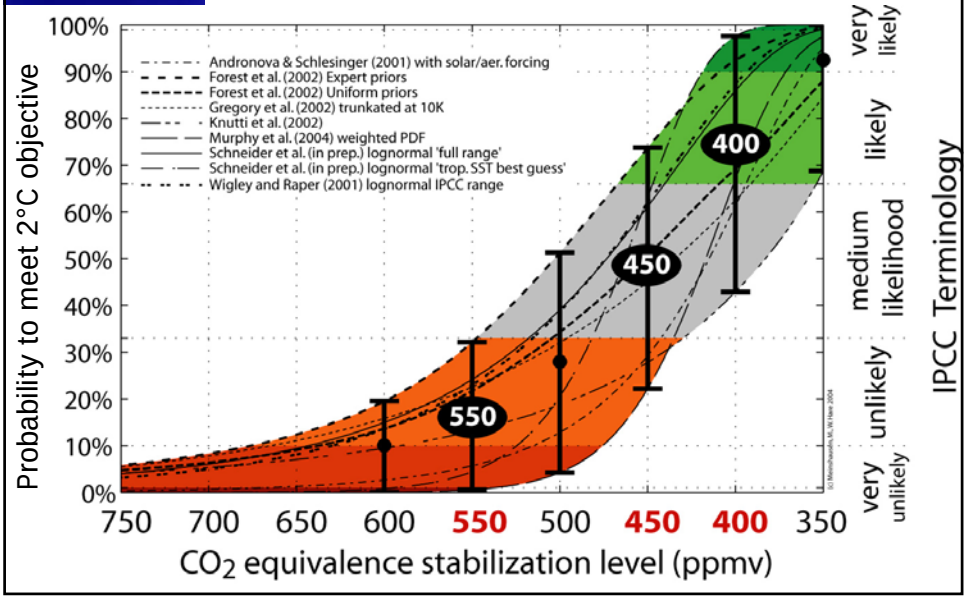
Overview

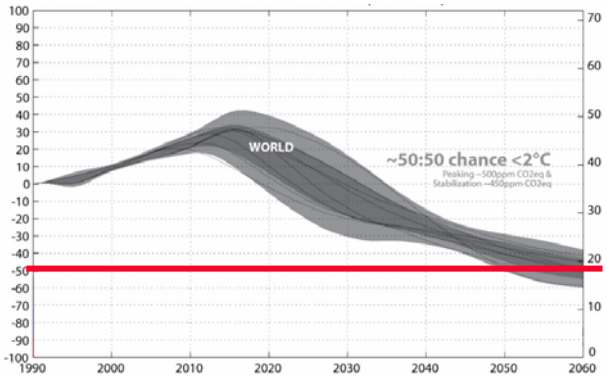
- Global emissions pathways
  - Objectives of the modelling exercise
- The POLES model
  - Assumptions and Outcome
- The GEM –E3 model
  - Assumptions and Outcome
- The LULUCF sector
- Other developments and ongoing work

Meeting the 2°C objective



Global emissions path to meet the 2°C objective

- 450 ppm CO_2 equivalent emission path with limited overshooting gives 50% chance meeting the 2°C objective.
- Peak before 2025
- Reduce up to 50% by 2050 compared to 1990
- Annual reduction rates increase by 5% for each 5 year delay



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Source graph: Meinshausen

The POLES Modelling system

- partial equilibrium model of the world energy system
- recursive dynamic simulation up to the year 2050
- endogenous energy demand and prices
- explicit technology modelling for many sectors
- 47 world regions / countries
- 30 power generation technologies
- 8 industry sectors + transport sector + residential and services + agriculture

The POLES Modelling system (2)

- energy supply modelling
  - oil reserves by region (64 regions)
  - drilling and extraction
  - world and regional markets
- hydrogen options included
- emissions of CO_2 and other GHG ("Kyoto gases") from energy use and industrial processes
- CCS included
  - capture from coal and gas
  - storage potential by region

Assessing the mitigation potential: objectives

- Technically feasible vision on how to reach an ambitious emission development, for the EU and rest of the world
- Global cost/technology estimates for mitigation scenarios until 2030
- Options for viable long-term technology paths identified beyond 2030 up to 2050
- Realistic role of the carbon market and the use of flexible mechanisms defined.
- Identify options for policy instruments that engage all key players on the basis of their responsibilities and capabilities

POLES Model: Scenario assumptions

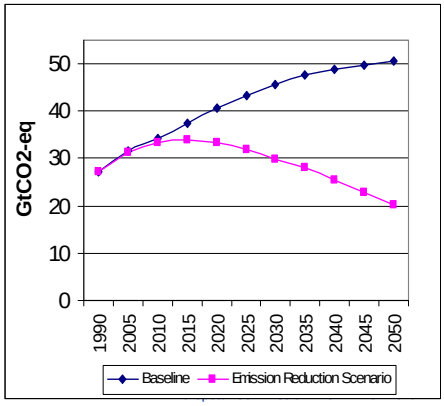
• Global GHG emissions peak before 2020, i.e. 2015, and reduce to 10% above 1990 levels by 2030. Economic assessment up to 2030

• Global GHG emissions continue to decrease up to 2050 to allow for a technology assessment up to 2050

• Multi-gas and introduction of Carbon Capture and Storage

• Global emissions trading market develops gradually in power and energy intensive sectors.

• Non-trading sectors are subject to policies that lead to comparable emission reductions.



POLES MODEL: Assumptions on how to broaden participation

- All countries, also DCs, implement Energy Efficiency policies, specifically in transport and residential sectors. Includes:
  - Better foresight and information.
  - Increased Technology Development
  - Additional Energy Efficiency Standards
- In order to meet the 2°C objective, developed countries take the lead, gradually increasing participation from developing countries.
- Answer the question to what extent the guidance from the 2005 EU Spring Council can translate into a 2°C emission scenario:

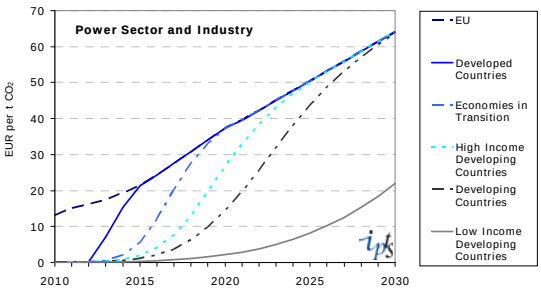
> *the EU looks forward to exploring with other parties strategies for achieving necessary emission reductions and believes that, in this context, reduction pathways for the group of developed countries in the order of 15-30% by 2020, should be considered*

POLES model: assumptions on the evolving global carbon market

- Markets develop at different speeds and companies experience different carbon prices in different countries, i.e. a carbon price in the EU of € 25 does not automatically translate into a global price of € 25.

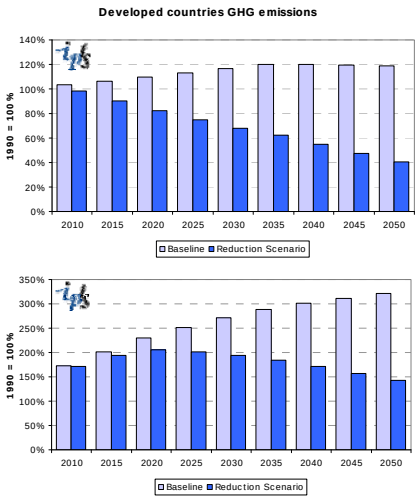
- Carbon price developing countries gradually increases to the level of that in the EU and other developed countries

-By 2030 all industries experience same carbon price except in low income DCs



Results: Global Participation

- Emissions in developed countries on a continuously descending path.
- Internal emissions should be reduced by 20% by 2020 and 60% by 2050 compared to 1990
- Developing countries emissions may grow but at lower rate than baseline.
- Also need to peak between 2020 and 2025



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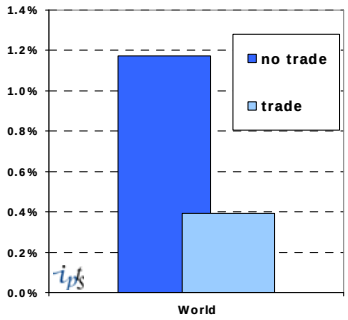
Cost of action: role of the global carbon market (1)

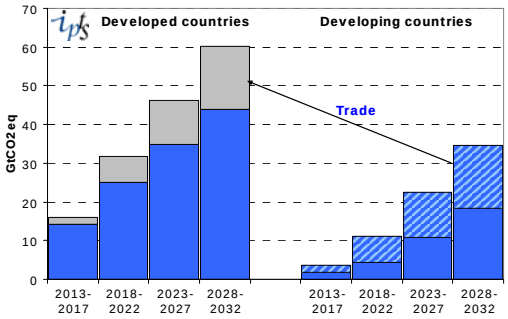
- Carbon market decreases investment costs by a factor of 3.
- Carbon price is substantial but evolves gradual

Carbon Price Trading Sectors € / t CO_2 eq.	
2010	14
2015	21
2020	37

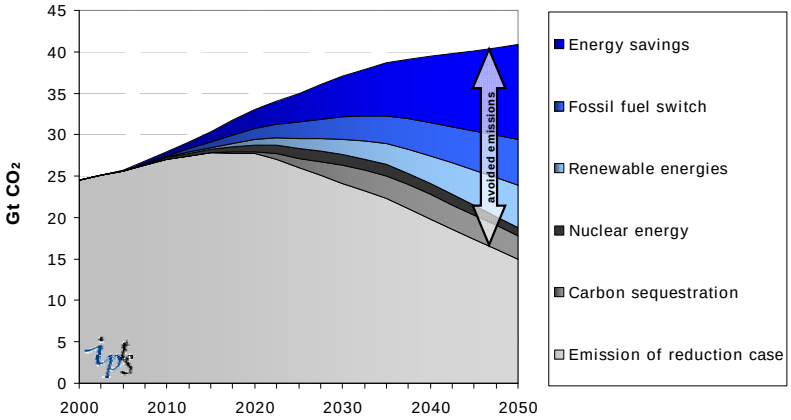


Cost of action: role of the global carbon market (2)

- Developed countries emissions targets need to be at -30% by 2020 to see sufficient global reductions (± 2/3 domestic, ± 1/3 trade).
- Developing country emissions need to grow at a much lower pace compared to business as usual.



Technologies: there is no silver bullet



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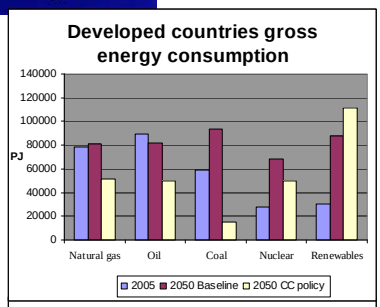
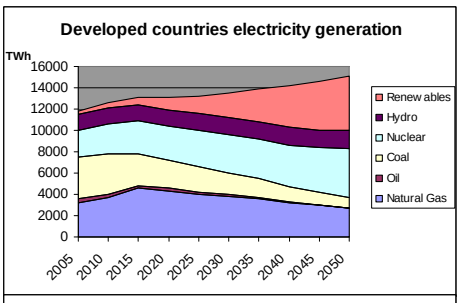
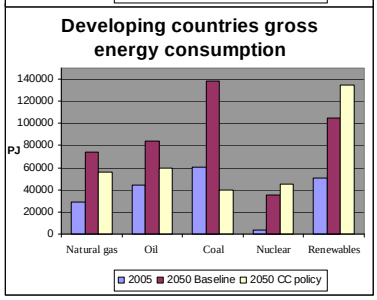
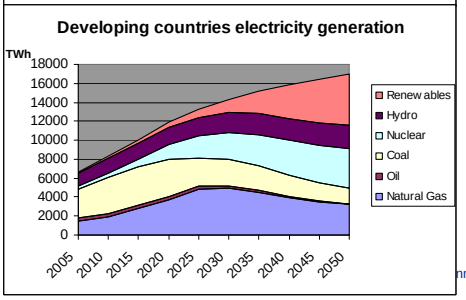
A post-2030 glimpse: technology deployment on a 2°C trajectory









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The role of energy efficiency by 2020

- EE reduces emissions most in transport, residential and commercial sectors.
- EE achieves 1/3 of the necessary global reductions by 2020.
- Energy standards key to deliver real reductions
- "Trickle through" effect into developing countries' product markets

2020 **Share of emission reductions due to EE scenario**	
Annex I	35%
China	31%
Non - Annex I	27%

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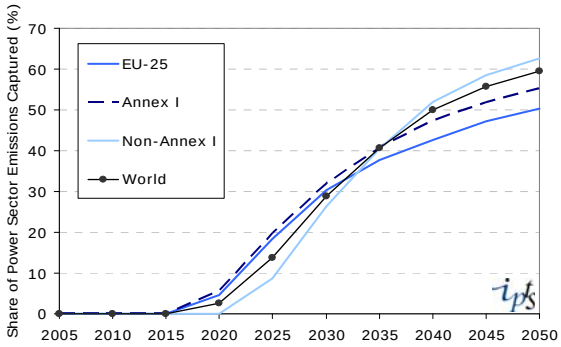
Carbon Capture and Storage (CCS)

- Deployment of CCS needs to start in developed countries, but developing countries to catch up quickly after 2020
- By 2020 full deployment of technology in EU power sector



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The GEM-E3 World Model

- GEM-E3 World is a computable general equilibrium (CGE) model:
  - demand and supply functions derived from microeconomic behaviour of economic agents (optimisation of their objective)
  - markets clear through prices
  - covers the entire economic activity within a region
- simultaneously multinational and specific for each region, markets clear at regional or World level, where appropriate
- extensive environmental dimension (GHG and local pollutants, incl. abatement)
- wide variety of policy instruments (standards, taxes, permits, at World and regional level, different allowance scheme)
- follows a time forward path (dynamic recursive over time)

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The GEM-E3 World model (2)

- 18 World regions: EU27, Other European countries, Former Soviet Union, Mediterranean countries, USA, Canada, Australia and New Zealand, Japan, China, India, rapid growing Asian countries, Rest of Asia, Mexico and Venezuela, Brazil, Rest of Latin America, Middle East, South Africa, Rest of the World)
- 18 sectors: agriculture, 4 energy branches, 9 industrial branches, 4 market and non market services

- Business as usual scenario calibrated with POLES BAU scenario
  - GDP growth 2005-2050: 2.5% per year on average
  - GHG emission growth 2005-2050: 1.5% per year 112% above the 1990 level in 2050

GEM E3 scenario assumptions

Grouping of the countries/regions:

- Developed countries:
  - AUZ, JPN, CAN, USA, EU27, Other EUR, FSU
- High income developing countries:
  - Mexico and Venezuela, Mediterranean and middle east, Rapid growing Asian Countries
- Developing countries

GEM E3 scenario assumptions

- Targets calibrated to ensure similar emission trajectory as in POLES model runs:
  - 2020: -22.5% versus 1990 for Group 1 + Group 2
  - 2025: -25% versus 1990 for Group 1 + Group 2
  - 2030: +7% versus 1990 at World level
    - -38% versus 1990 for Group 1 + Group 2
    - +135% versus 1990 for Group3

GEM E3 scenario assumptions

- Allocation of the target:
  - Allocation within a group by grandfathering
- Policy instrument: emissions trading
  - Energy intensive sectors: a World ETS, i.e. an international emission trading system for these sectors between all groups contributing to the target
  - Other sectors: a domestic trading system for household and sectors not included in the World ETS
  - Use of flexible mechanisms is possible depending on the scenarios but limited to the energy intensive sectors
- The Kyoto targets are respected for participating countries

Scenarios to imitate gradual development of the global carbon market

- In the POLES model the carbon market only gradually developed with differentiated carbon price.
- In GEM E3 it is not possible to have different carbon prices between trading countries. The gradual development of the carbon market is simulated through gradual participation:
  - From the developing countries only Brazil, other Latin America, South Africa and China are fully participating in the World ETS from 2020;
  - In 2020 and 2025 they have no reduction target but receive an endowment equal to the reference emissions
  - Other countries join the World ETS only in 2030
  - No domestic target in the other sectors before having a national reduction target

Developed countries : GEM-E3 results

	2020		2030	
	Emission targets (compared to 1990)	**Domestic emissions (compared to 1990)**	**Emission targets (compared to 1990)**	**Domestic emissions (compared to 1990)**
USA	-23 %	-4 %	-39 %	-21 %
EU27	-31 %	-21 %	-46 %	-35 %
FSU	-42 %	-39 %	-54 %	-51 %
Japan	-26 %	-24 %	-41 %	-37 %

Developing countries : GEM-E3 results

	2020			2030	
	Participation global carbon market?	Baseline emissions (compared to 1990)	Domestic emissions (compared to 1990)	Emission targets (compared to 1990)	Domestic emissions (compared to 1990)
Brazil	Yes	31 %	32 %	34 %	31 %
China	Yes	140 %	85 %	150 %	103 %
India	No	165 %	165 %	218 %	179 %

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Results: Cost of action is consistent with global economic development

	Impact on GDP					
	2020			2030		
	GDP 2005=100 baseline	GDP 2005=100 reduction	Annualised change from 2005	GDP 2005=100 baseline	GDP 2005=100 reduction	Annualised change from 2005
USA	156.8	154.6	-0.15%	194.9	190.1	-0.20%
EU27	135.1	129.9	-0.19%	158.1	146.9	-0.24%
FSU	214.1	213.4	-0.37%	298.8	287.6	-0.47%
Japan	130.4	129.3	-0.08%	162.6	160.0	-0.11%
Brazil	165.4	164.8	-0.04%	244.6	242.3	-0.09%
India	205.6	204.3	-0.10%	331.6	328.9	-0.11%
China	213.1	212.4	-0.05%	317.2	314.5	-0.11%
World	155.3	153.2	-0.14%	200.8	196.2	-0.19%

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Cost of action is consistent with IPCC results

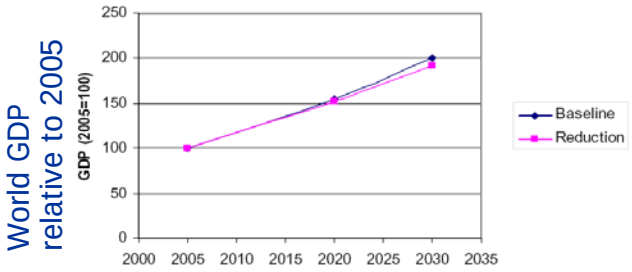

Table SPM.4: Estimated global macro-economic costs in 2030[16] for least-cost trajectories towards different long-term stabilization levels.[17, 18]

Stabilization levels (ppm CO_2-eq)	Median GDP reduction[19](%)	Range of GDP reduction [19, 20](%)	Reduction of average annual GDP growth rates (percentage points) [19, 21]
590-710	0.2	-0.6 – 1.2	< 0.06
535-590	0.6	0.2 – 2.5	<0.1
445-535[22]	Not available	< 3	< 0.12

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Benefits from the global carbon market

- The global carbon market reduces overall global costs substantially.
- Countries that do not participate in the carbon market and do not have reduction targets still experience an impact through trading effects.
- When the carbon market would be limited to the Annex I countries, then the cost is higher for those countries but it is also higher for the developing countries.
- Countries that participate in the global carbon market actually perform economically better.

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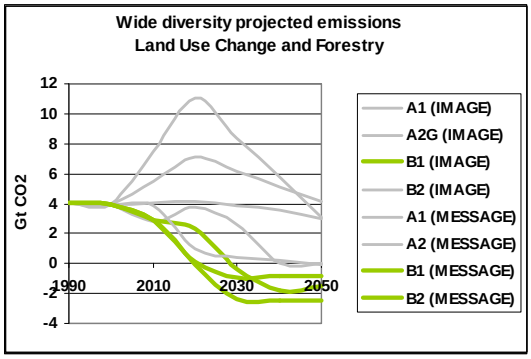
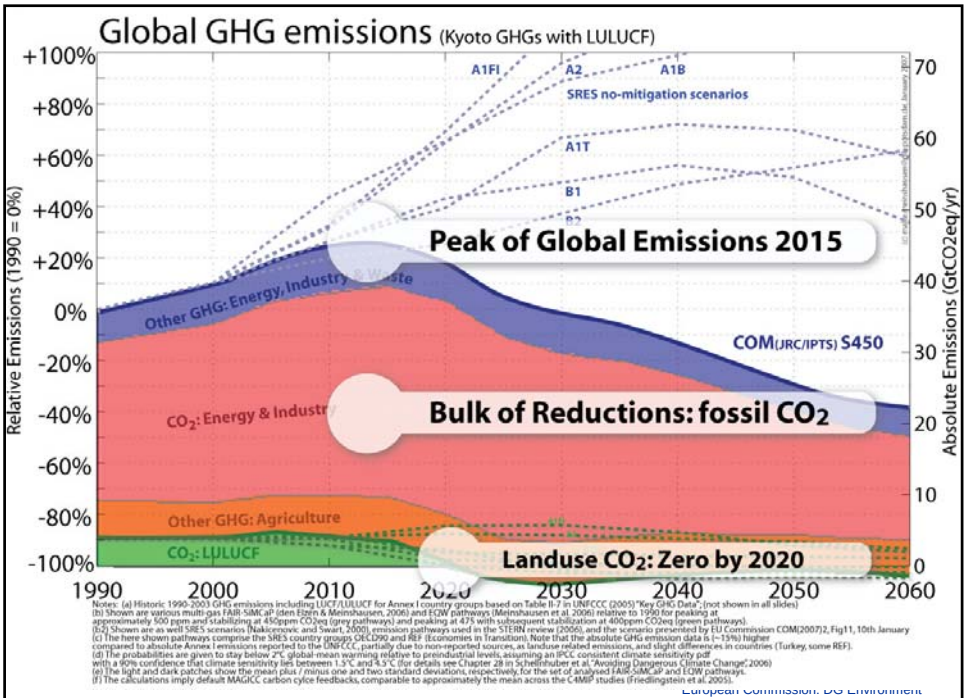
Global emissions from land use, land use change and forestry

- At present, net emissions from land use change and forestry are estimated to be around 4 Gt CO_2
- This needs to be reversed around 2020 or otherwise targets in other sectors have to be more stringent.
- Note large differences in projected baseline emissions depending on different models.





Co-benefits: Reducing GHG emissions reduces emissions of other air pollutants

Costs of air pollution policies in the EU would decrease significantly due to climate policies, estimates using the GAINS model:

Co-benefits from Climate Change Policies		
	Reduction compared to 2020 baseline emissions	
CO2	-9.31%	-22.75%
SO2	-5.90%	-12.11%
NOx	-2.30%	-6.08%
PM2.5	-3.15%	-5.94%

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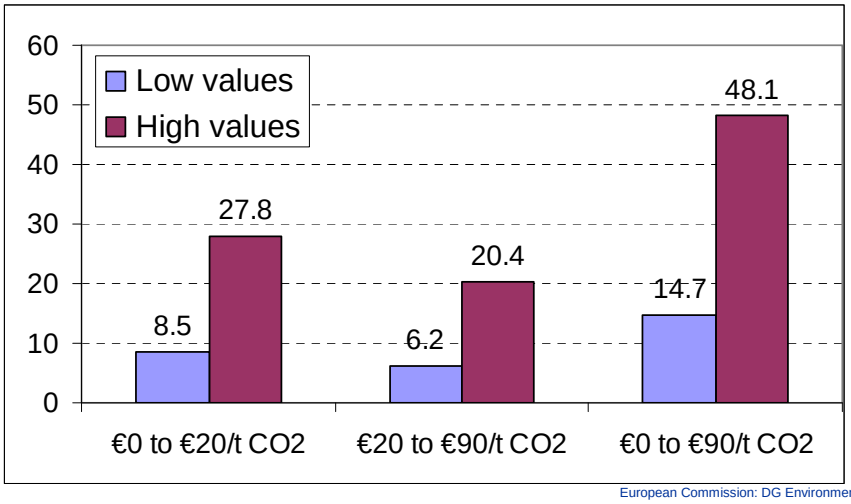
Health benefits from reduced air pollution



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Ongoing work

- GEM-E3 and POLES are continuously updated. Planning to present updated runs at future side events
- Linking POLES with a LULUCF model
- Integrate more realistic assumptions on how gradual development carbon market in GEM E3
- Link GHG mitigation models with air pollution models, e.g. GAINS.

All documents in the climate and energy package:
http://europa.eu/press_room/presspacks/energy/index_en.htm
http://ec.europa.eu/environment/climat/future_action.htm