Greenhouse gas Reduction Pathways in the UN-FCCC process up to 2025

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Dialogue on the Clean Development Mechanism
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Challenges for Post-Kyoto regimes

- Bring both US and (some) developing countries on board at the same time
- Develop a regime acceptable to all Parties
- Develop a regime for adaptation support and disaster relief
- Get a regime that has a long-term perspective (to meet Article 2 UNFCCC)
  - Incremental pledge based approach (like KP) is likely to put low stabilisation levels out of reach
  - Provisional LT targets can help to promote investments in technological solutions
Objectives GRP

- The need for further action: identify global emission pathways that could achieve the EU climate target of 2ºC
- Architecture: to review the main climate regimes (literature/negotiations), in order to design international quantitative emission targets systems.
- Assessment: the use of models for an initial quantification of emission allowances and costs

- Summary for Policy Makers report
- Technical background report

RIVM-background reports available at: [http://www.rivm.nl/iweb](http://www.rivm.nl/iweb)
- 2 Reports ‘Exploring options’ and ‘Indepth analysis’

Greenhouse gas Reduction Pathways in the UN-FCCC process up to 2025 (GRP)

Partners:
- CNRS-IEPE (coord.)
- RIVM-MNP
- ICCS-NTUA
- CES-KUL

Study performed for DG Environment
Two Phases GRP

First exploratory phase:
- baseline and global emission profiles for GHG concentration stabilisation
- exploration of implications of different approaches to differentiation of future commitments
- evaluation of approaches; selection of approaches to be further explored

Second in-dept analysis phase:
- exploration of technical and economic implications of selected approaches
- analysis of co-benefits (air pollution)
Structure presentation - GRP

1. Baseline and emission profiles
2a. Climate regimes - first phase: Options
2b. Climate regimes - detailed analysis
3. Mitigation costs and energy implications
4. Benefits and co-benefits
5. Conclusions

Assumptions:
- medium population
- medium economic growth

Results:
- emissions of 6 GHGs almost double compared to present levels
- concentrations reach 900 ppmv levels
- Exceeds temperature increase of 2 degrees Celsius
**Emission profiles: S550e & S650e (all GHGs)**

Allowed GHG emissions (in CO₂-eq.) for 550 & 650 CO₂-eq ppmv

- The profiles are innovative as they include all GHGs, not just CO₂.
- From our analysis it shows that 550 CO₂-eq. means about 450-500 ppmv CO₂ only; 650 CO₂-eq. is compatible with about 550 ppmv CO₂.
- For stabilising at 550 ppmv there are very limited pathways; for 650 eq there are actually various pathways still possible, peaking earlier or later.

**Meeting the EU target depends on the climate sensitivity**

- The S550e profile meets the EU target of 2 °C in 2100 for a low to medium climate sensitivity.
- The S650e profile only meets this target under a low climate sensitivity. After 2100 temperature increase continues.
1. Baseline and emission profiles

2a. Climate regimes - first phase: Options

2b. Climate regimes - detailed analysis

3. Mitigation costs and energy implications

4. Benefits and co-benefits

5. Conclusions

GRP: the possible architectures

- Emission reduction targets can be defined either:
  - on the basis of a *global emission profile* (top-down)
  - or *individual targets* for the different parties (bottom-up)

- Participation levels: *full participation*, or *increasing participation*

- The form of commitments can be *similar* for all Parties or *differentiated*

- The type of commitment can be defined in *absolute* or *dynamic* terms (intensity targets)

- Different equity principles can be used: *egalitarian*, *acquired rights*, *responsibility*, *capability*
GRP: the possible regimes

- Per Capita Convergence (GCI)
- Soft Landing in emission growth (IEPE)
- Global Preference Score (Muller)
- Historical Contribution (Brazilian proposal)
- Ability to Pay (MIT: Jacoby rule)
- Multi-Stage (RIVM)

Then, two approaches have been selected as sufficiently generic and robust based on calculation and qualitative multi-criteria analysis.

Structure presentation - GRP

1. Baseline and emission profiles
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GRP: The Per Capita Convergence scheme

The *Per Capita Convergence* is a “full-participation” scheme

A global emission profile is first defined (e.g. S550e or S650e)

Then a date is set for the convergence in per capita emissions

Two end-dates for convergence have been chosen: 2050 and 2100

GRP: the Multi-Stage scheme

*Multi-Stage* is an “increasing participation” scheme, with Parties gradually entering into different stages:

- in *Stage 1* Parties have no quantitative commitment
- in *Stage 2* they have to meet to dynamic “intensity targets”
- in *Stage 3* they share absolute emission targets, as resulting from the global emission profile

Three Multi-Stage schemes have been defined, according to the type of threshold in the transition from one stage to the other
GRP: The three Multi-Stage in GRP

Transition from Stage 1 to Stage 2 in all cases depends on a:

**Capability-Responsibility index**
(see Art. 3.1. of UN-FCCC)

This index is defined as the sum of per capita GDP and per capita emissions of each Party

<table>
<thead>
<tr>
<th>Country</th>
<th>pc GDP (1000€)</th>
<th>pc emiss. (tCO2e)</th>
<th>Cap-Resp index</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>32</td>
<td>26</td>
<td>58</td>
</tr>
<tr>
<td>EU (enl.)</td>
<td>19</td>
<td>10</td>
<td>29</td>
</tr>
<tr>
<td>China</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>India</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

GRP: The three Multi-Stage in GRP

Transition from Stage 2 to Stage 3 is defined either through:

- A threshold expressed as “average world per capita emissions” MS-1
- A threshold expressed again as a Capability-Responsibility index (about twice as high as the first CR threshold) MS-2
- A stabilisation period defined as the time necessary to bring emission growth to zero MS-3
**Annex I targets in 2025**

- **S550e:** for Multi-Stage 2 and PCC-2050, reductions from baseline levels amount to 35% in Europe and Japan, 40-50% in North America, except for PCC-2100.

- **S650e:** reductions are less stringent, about 20-30% below baseline levels in Multi-Stage 2 and PCC-2050, except for PCC-2100 with lower reductions.

**Non-Annex I targets in 2025**

- **S550e:** non Annex I regions have to reduce emissions, but to a limited degree for the low income regions Africa and South-Asia, except for PCC-2100. Middle-income regions have higher reductions.

- **S650e:** the low income regions either do not participate or benefit of “excess emissions”.

The reductions are limited to 10-20% in Latin America and South-East & East Asia.
GRP: Highlights from economic assessment - 1

- Economic assessment is performed under the assumption of *international emission trading* schemes
- that allow for *least-cost options* to be implemented in all parts of the world
- The resulting world emission trading volume varies considerably according to the profile and allocation scheme
Abatements costs

- With (perfect) trading: global costs and international permit price hardly depend on regime.
- Restricting emissions to S550e leads to much higher abatement costs than the S650e (equivalent to 1.0% versus 0.2% of world GDP in 2050).
- Costs are subject to considerable uncertainty.

Regional costs (S550e)

Four groups with similar effort rates can be identified:
1. Annex I (excl. FSU) regions: average costs.
2. FSU, Middle East, to al lesser extent LAM: high costs.
3. China show low costs.
4. Low-income non-Annex I regions (Africa, South-Asia) gains.

Group 1 and 2: buyers
Group 3 and 4: sellers.
**Regional costs (S650e)**

Costs as percentage of GDP

- Similar four groups
- High gains for Africa due to large excess emissions for Per Capita Convergence 2050

**Emission trading (S550e)**

Financial flows (bln Euro)

- The financial flows between these regions can become quite large, from 50 to 250 billion euro in 2025 to 600-700 billion euro in 2050.
- Buyers: Annex I regions, Middle East and Latin America
- Sellers: Africa, South Asia and rest Asia
- In S650e, financial flows lower: 0-20 billion in 2025; 0-100 billion in 2050.
- Lowest financial flows under PCC2100.
**GRP: Highlights from economic assessment**

- The General Equilibrium approach also allows to account for indirect macroeconomic costs.
- For each region, the impacts on welfare are strongly correlated to emission trading.
- Except for fossil fuel exporting regions, which are also affected by changes in their exports.
- In 2025, the total cost of achieving reductions are 0.7-0.9% of world GDP in S650e and 1.9-2.8% in S550e.

**Energy Implications: Contribution of Energy system CO₂ emission reductions**

- Major contribution from energy efficiency improvement – in particular from DCs.
- In the longer run changes in energy production become more important.
- Carbon capture and storage option could also become important.
Structure presentation - GRP

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Temperature change and risks

Temperature increase

IPCC Reasons for concern

- Risks to Unique and Threatened Systems
- Risks from Extreme Climate Events
- Distribution of Impacts
- Aggregate Impacts
- Risks from Future Large-Scale Discontinuities
Co-benefits - Reductions in global S and NOx emissions

Both climate policies for meeting S550e and S650e result in substantial reductions of sulphur and Nitrous oxide emissions: resp. 70% and 50% for S550e and 50% and 35% for S650e by 2050.

Co-benefits : Change in exceedance of critical loads for acidification in Asia

- The 550 ppmv-eq scenario can limit the 2030 exceedance of critical loads in the total region by on average 50%.

- The co-benefits of the 650 ppmv-eq scenario are smaller. Here, most co-benefits can be expected after 2030.
The GRP study is only a first step in a continuous effort that will have to combine climate studies, economic analyses and international debate.

It shows however that:

- Meeting the EU climate objective will require a peak in world emissions within 2 decades (if no overshoot profiles).
- Stabilising at 550 and 650 ppmv CO2-eq is found to be technically feasible.
- Stabilising at 550 is much more expensive than at 650 (abatement costs of 1% of world GDP in 2050 vs. 0.25%).
- But the 650 ppmv level is unlikely to stay below 2 degrees target.
Financial gains from emission trading and co-benefits may allow non-Annex I countries to take on commitments at net gains or low costs, while lowering the costs of climate policies at the world level. This requires a fully effective functioning of emission trading instruments.

Evaluating the fairness of regimes requires not only an assessment of the initial allocation but also an assessment of the distribution of abatement costs, impacts from emission trading and the impacts in energy trade changes. There is a need to account for national circumstances in design of regime.

Per Capita Convergence and Multi-Stage seem most generally acceptable approaches. But they need to better accommodate with national circumstances.

Combining top-down and bottom-up

Triptych approach

- includes target-time table, but bottom-up for definition of targets based on sectoral considerations
- sector and technology-oriented approach
- different differentiation rules applying to sectors
  - domestic emissions: convergence per capita domestic emission
  - power emissions: (1) growth of production; (2) improvement rates of carbon intensity on the basis of convergence to low carbon intensity level
  - industrial emissions: (1) growth of production; (2) improvement rates of energy efficiency on the basis of convergence of Energy Efficiency Index
Triptych approach: sectoral - and technological oriented approach

For example

Energy Efficiency Index (EEI)

- Reference-value EEI 1995: 1 (best current technology)
- 1995 values vary from 1.2 EU, 1.3 Japan till 1.8 US and 2 Russia
- Converge to final EEI level (for example: 0.5 in 2050)
- Improvement rates vary from 1.7-3.0 %/year.
Preliminary conclusions

- **Triptych:**
  - Triptych: less reductions for more efficient countries (Japan, Europe)
  - Global Triptych: good options for early DCs participation without hot air by substantiating emissions growth-limitations for non-Annex I regions

Combining top-down and bottom-up

**Triptych approach**

**Strengths**
- More certainty about environmental effectiveness
- Growth targets acceptable for DCs
- Accounting for different national circumstances
- Low risk of hot air
- More flexible than sectoral targets
- Allows for full IET

**Weaknesses**
- Uncertainty about costs remains complex methodology and data-intensive; therefore complex to negotiate
Characterising the Regime Proposals: Equity Principles

Egalitarian principle

Responsibility principle (polluter pays)

Brazilian proposal

Multi Stage

Global Preference Score

Per Capita Convergence

Sovereign / Acquired rights principle

Capability principle / basic needs

Rights based principles

Duty based principles

Emission profiles: S550e & S650e

Reduction efforts between profiles S650e

<table>
<thead>
<tr>
<th>Year</th>
<th>S550e</th>
<th>Anthropic GHG Emission gap for S650e</th>
</tr>
</thead>
<tbody>
<tr>
<td>2025</td>
<td></td>
<td></td>
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<tr>
<td>2050</td>
<td></td>
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<tr>
<td>2100</td>
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</tbody>
</table>

S550e: in 2025 emissions can increase to 20% above 1990 levels (-30% compared to baseline). In 2050 20% reduction compared to 1990 levels.

S650e: less stringent, but still a 35% reduction below baseline in 2050.
Characterising the Regime Proposals: Equity Principles

- Egalitarian principle
- Responsibility principle (polluter pays)
- Capability principle / basic needs
- Sovereign / Acquired rights principle
- Global Preference Score
- Per Capita Convergence

GRP: goals and corresponding scenarios

- The “S550e” scenario will meet the “less than plus 2°C” target for a low-to-median value of the climate sensitivity
- The “S650e” scenario will meet the target only if the climate sensitivity is low
Proposals for Climate Change Regimes - a selection

- Continuing Kyoto (pledge-based)
- Brazilian Proposal (Brazil / RIVM)*
- Multi-criteria (CICERO)*
- Multi-stage (RIVM)*
- Contraction & Convergence (Global Commons Institute)*
- Global Compromise - Preference Score (Benito Müller)*
- Multi-Sector Convergence (ECN/CICERO)
- (global) Triptych approach (UU)*
- Emission intensity targets*
- Growth cap index (Ellerman, MIT)
- Jacoby rule (MIT)*
- Soft landing (IEPE)
- Sectoral commitments / sectoral CDM (Figueres)
- (sectoral) Technology standards (Barrett)
- Sustainable Policies and Measures (University of Cape Town)

* = included in FAIR 2.0

GRP: a typology of architectures

<table>
<thead>
<tr>
<th>Form of Commitment</th>
<th>Same</th>
<th>Differing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of Commitment</td>
<td>Fixed</td>
<td>Dynamic</td>
</tr>
<tr>
<td>No Participation Threshold</td>
<td>Per Capita Convergence</td>
<td>Global Preference Score</td>
</tr>
</tbody>
</table>

NB: Same or Differing Types = according to different country categories (fixed or dynamic)

Fixed Targets or Dynamic Targets = independent or dependent of baseline
Brazilian Proposal (Brazil/RIVM)

- Distribute emission reductions Annex I based on regional contribution to temperature increase due to their historical emissions (from 1890)

- Global application with participation threshold

- Reference case (S550e):
  - 40% '90 Annex I per capita PPP income
  - World average per capita emissions

- Timely participation is needed to avoid disproportional burdens

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Multi-Stage approach (RIVM)

- A gradual increase in the number of Parties involved and their level of commitment according to participation and differentiation rules

- Four stages (for non-Annex I):
  - Stage 1. No constraint
  - Stage 2. Intensity targets (threshold 1)
  - Stage 3. Stabilisation emissions (threshold 2)
  - Stage 4. Emission reduction targets

- Annex I enter stage 4 after Kyoto

- Reference case (S550e):
  - Threshold 1: 20% '90 Annex I per capita income
  - Threshold 2: 40% '90 Annex I per capita income
  - 10-year stabilisation emissions
  - Contribution to reductions using burden-sharing key p.c. emissions
Middle- & high income NA I regions enter stage 4 before 2025 after stabilization;
Most low-income NA-I regions enter stage 2 before 2025 (except for West- & East Africa)

Emission Intensity Targets

General features:
- Global application of Bush Plan approach
- Stringency intensity targets related to income:
- Catching up with EU/Japan
- Threshold for participation
- Bottom-up approach

Parameter settings for cases:

<table>
<thead>
<tr>
<th>Participation threshold</th>
<th>Income-dependent intensity targets*</th>
</tr>
</thead>
<tbody>
<tr>
<td>To match S550e profile</td>
<td>20% of 1990 Annex I PPP-income</td>
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<td></td>
<td>Maximum rate linearly increases from</td>
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<td></td>
<td>3.5%/yr (2012) to 5.0%/yr in 2050</td>
</tr>
<tr>
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<td>40% of 1990 Annex I PPP-income</td>
</tr>
<tr>
<td></td>
<td>Maximum rate linearly increases from</td>
</tr>
<tr>
<td></td>
<td>2.0%/yr (2012) to 3.0%/yr in 2050</td>
</tr>
</tbody>
</table>

* with maximum de-carbonization rate at 50% of 1990 Annex I PPP-income
Comparison climate regimes

- GC is particularly unattractive for Annex I and Middle East.
- BP is unattractive for Europe and Latin America.
- MS is most attractive for middle- and high-income non-Annex I regions. Small differences with CC.
- CC is attractive for Europe, Japan and Africa, but less attractive for China.
- JR (not shown) attractive for FSU, unattractive for LAM, China.

Annex I targets in 2050

- S550e: for Multi-Stage 2 and PCC-2050, reductions from 1990 levels from 70-85%.
- S650e: for Multi-Stage 2 and PCC-2050 the reductions from 1990 levels are 40-70%, for PCC-2100 lower reductions.
**Non-Annex I targets in 2050**

- **S550e**: Same differences in reductions between low-income and middle-income non-Annex I regions. High reductions for low-income regions for PCC-2100.
- **S650e**: low income regions either have small reductions or “excess emissions”, except PCC 2100.
- **FAIR 2.0**: The reductions are 30-60% in Latin America and South-East & East Asia.

**Allowed Emissions up to 2050 for S550e profile**

- **US/CAN**: Efforts from baseline differ significantly (e.g. USA versus EU)
- **“India”**: Some regions more sensitive for regime choice than others
- **“China”**: Outcomes will differ more on country level
- **Overall**: Short-term implications may differ from long-term (PCC)
- **Source**: FAIR 2.0 model
Influence of profile larger than choice of regime

Range of reductions for S550e in 2025: 20-50% below 1990 level

Reductions in 2050: 40-90% (BP even 80-100%)

Outcomes PCC and MS comparable (except USA); BP largest reductions (EU/Japan/FSU); EIT generally smaller reductions for Annex I targets in 2025

Source: FAIR 2.0 model

FAIR 2.0 model overview:
- Global emission profile
- DATASETS: Historical emissions, Baseline scenario, Emissions profile, MACs
- CLIMATE MODEL: Climate assessment model
- FUTURE COMMITMENT MODEL: Multi-stage approach, Brazilian Proposal, Per capita Convergence, emission intensity system, Triptych approach
- EMISSION TRADE & COST MODEL: Mitigation costs & Emissions trade
S550e requires substantial reductions from baseline by middle income non-Annex I regions by 2025 already.
By 2050 Middle income non-Annex I Regions allowances near 1990 levels.
Differences between outcomes approaches limited on short term, but large on long term (2050).

Non-Annex I targets in 2025

Multi-criteria evaluation of regimes

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Regime</th>
<th>Environmental criteria</th>
<th>Environmental effectiveness</th>
<th>Incentives for developing country action</th>
<th>Political criteria</th>
<th>Comprehensiveness equity principles</th>
<th>Acceptability for key countries</th>
<th>Room for negotiation</th>
<th>Supportive to trust building</th>
<th>Economic criteria</th>
<th>Cost-effectiveness</th>
<th>Certainty about costs</th>
<th>Accounting for different national circumstances</th>
<th>Technical and institutional criteria</th>
<th>Compatibility with the KP and UNFCCC</th>
<th>Simplicity of the negotiation process</th>
<th>Ease of implementation</th>
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<tr>
<td></td>
<td>Brazilian Proposal</td>
<td>+</td>
<td>+</td>
<td>0/+</td>
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<td></td>
<td>Multi-Stage Convergence</td>
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<tr>
<td></td>
<td>Emission intensity</td>
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<td>- / -</td>
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</table>

Source: FAIR 2.0 model
### Top-down approaches explored

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
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<tbody>
<tr>
<td><strong>Multi-stage</strong></td>
<td></td>
</tr>
<tr>
<td>- Covers different equity principles</td>
<td>- Intensity targets reduce certainty about environmental effect</td>
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<td>- Flexible concept with transparent rules</td>
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<td>- Certainty about DC participation</td>
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### Strengths and weaknesses

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<tr>
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### Strengths and Weaknesses regime approaches

**Brazilian Proposal**
- Originates from DC

**Multi-stage**
- Covers different equity principles
- Flexible concept
- Compatible with UNFCCC/KP

**Per Capita Convergence**
- Certainty about DC participation
- Certainty about envir. effect.
- Simple concept
- Allows for full ET

**Emission Intensity Targets**
- Reduces uncertainty about costs (if clauses for econ. recession)

**Weaknesses**
- Focus on responsibility only
- Technical concept
- Extreme results for some Annex I
- Inflexible (in original form)

- Intensity targets reduce certainty about environmental effect
- Per capita BS key hits some of Annex I strongly
- Hits some of Annex I strongly
- Extra costs / large financial flows due to excess emissions
- Large Impl. Problems in LDCs

- Uncertainty about environmental effect.
- Lack of clear criteria for differentiation of targets
- Complicates KMs

### Prospects for regime options

Parties have different perspectives on weight of various criteria / strengths and weaknesses, e.g:
- EU: priority for environmental effectiveness (2 degree target)
- US+FSU: priority for economic implications
- DC: priority for economic development and equity

Our assessment:

<table>
<thead>
<tr>
<th></th>
<th>Brazilian Proposal</th>
<th>Multi-stage</th>
<th>Per Capita Convergence</th>
<th>Emission Intensity Targets</th>
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<td>EU</td>
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<td>+/-</td>
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Prospects for regime options

- Parties have different perspectives on weight of various criteria / strengths and weaknesses, e.g:
  - EU: priority for environmental effectiveness (2 degree target)
  - US+FSU: priority for economic implications
  - DC: priority for economic development and equity

- Our assessment:

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<th>Brazilian Proposal</th>
<th>Multi-Stage</th>
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<td>EU</td>
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<td>FSU</td>
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<td>Middle-Income Dev. Countries</td>
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<td>Least Developed countries</td>
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Methodology

- FAIR costs model used to calculate regional abatement action on the basis of Marginal Abatement Cost curves (MAC): 6 GHGs, 11 sectors and 17 world regions;

- Assumption is made of international emission trading: full trading in case regions participate; limited trading for non-participants (CDM)

- FAIR is linked to the global energy model TIMER to also describe changes in energy use and fuel trade
**Methodology**

Marginal reduction costs

- Marginal abatement curves

- CO₂: TIMER energy model
- CH₄/N₂O: EU project 2002
- Sinks: IMAGE model

**MAC curves only represent direct costs, there is no direct feedback to GDP development;**

- Assumption of relatively ideal markets and converging discount rates in different parts of the world

- MAC curves change in time (technological improvements and inertia in energy system)

**Emission trading (S550e)**

Reductions from baseline (%)

- OECD, Middle East, Latin America buyers of emission permits.
- Percentage domestic reductions increases rapidly in time to 80% and more.
- S650e: higher share of reductions achieved through trading.
Regional costs

Several sensitivity analyses have been performed, among which comparison of results of different models.

Robustness of results

International market price (Euro/tCO₂)

- The choice of the baseline emissions scenario has a large influence on both the permit price and global costs.
- The influence of the non-CO₂ costs curves (EMF MAC curves) on the permit price is very small, but other MAC CO₂ curves (such as MAC POLES) can have a large effect.
- Assuming no sinks leads to higher prices and global costs.
The ratio of direct (sectoral) abatement costs to GDP provides a good indication of the “rate of effort” for each region.

In most Annex I regions and in 2025, this rate of effort represents 0.5 to 1% of GDP in S550e and 0.1 to 0.2% of GDP in S650e.

Low-income regions receive a net benefit from emission trading …

while intermediate income or high per capita emission developing regions incur net costs.

Climate policies induce significant changes from baseline for sulphur and nitrogen oxydes emissions.

They may thus bring substantial co-benefits in terms of reduced regional air pollution and improved human health.

The positive impacts are particularly noticeable for the “low-income but rapidly growing” regions of the world, i.e. mainly Asia.

GHG abatement policies may for instance significantly reduce the probability of exceeding NOx standards in Asia in 2050.
Regional costs (S550e)

Costs as percentage of GDP

‘Four groups’ regarding costs levels:
- High emissions/high income: average costs (most OECD regions).
- High emissions/medium income: relatively high costs (CIS, ME, Lat. America?)
- Medium emission/low-medium income: average to low costs (SE & E Asia)
- Low emissions/low income: low costs or net gains (Africa, South Asia)

Contribution in mitigation

550 CO₂-eq. 650 CO₂-eq.

In short terms, large contributions from sinks and non-CO₂ GHGs (up to 80%) due to low costs.

Longer term, contribution of different options more according to their share in emissions (more CO₂).

Contribution from sinks uncertain: here 0.35 GtCO₂ but estimates vary between 0.2-2 GtC depending on land availability - but also implementation barriers.
GHG stabilisation level strongly affects energy demand.

Stabilisation level strongly affects energy mix: strong reduction in coal.

Under S650e in short-term natural gas use could increase under S650e.

Temperature change 550 vs. 650 CO2-eq. stabilisation

Global temp. 2100: +1.6 (1990)  
Global temp. 2100: +1.9 (1990)

Temperature increase above 1990 levels