

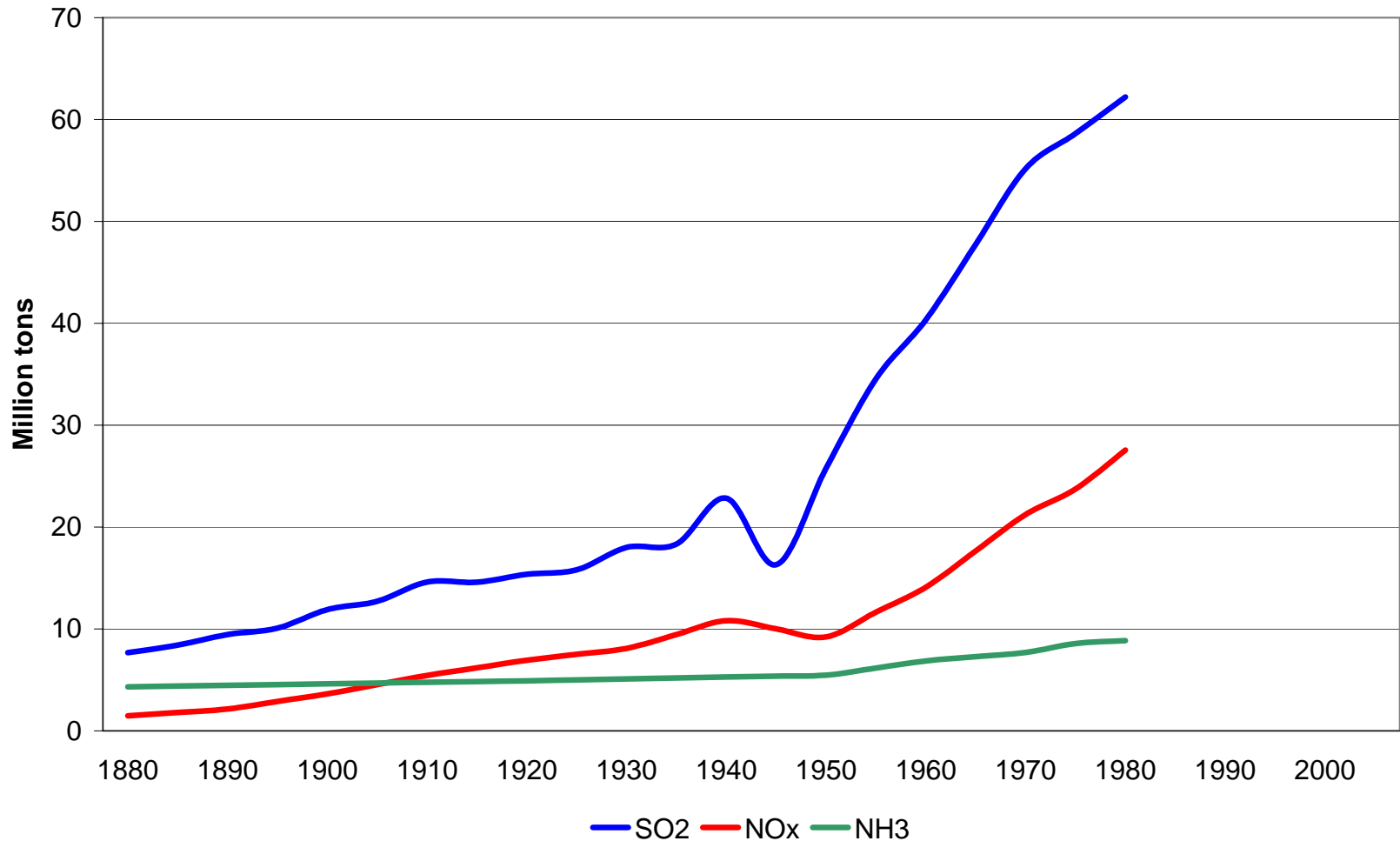
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Future challenges for
integrated assessment modelling

Historic SO₂, NO_x and NH₃ emissions 1880-1980, EU-25



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International Institute for Applied Systems Analysis (IIASA)

RAINS 1.1 (1984)

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RRRR		AA		III	NN	N	SSSS
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Please treat all results with caution!

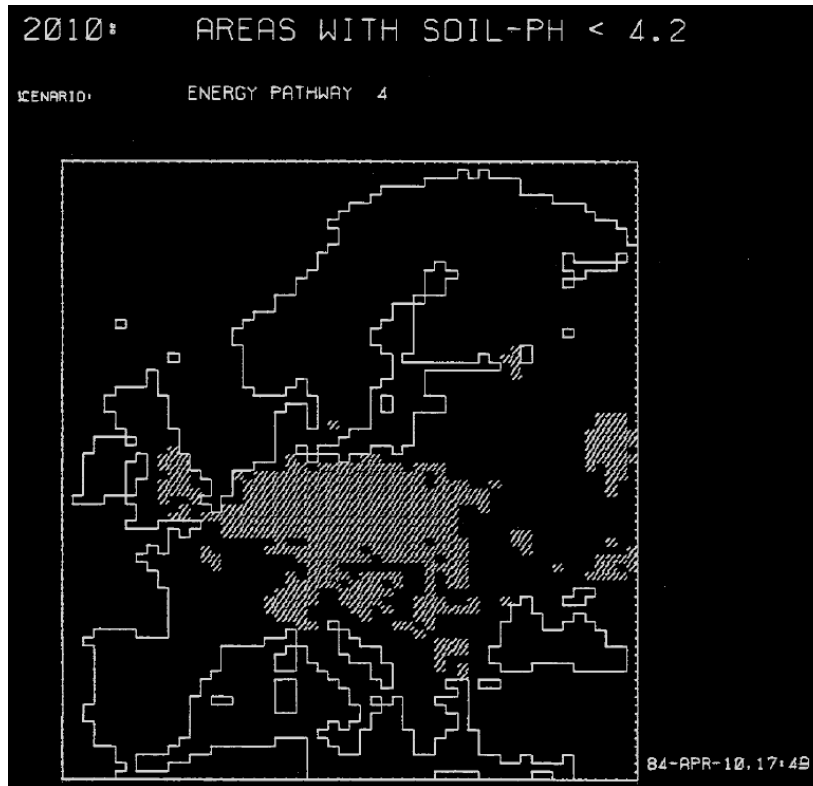
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Features of integrated assessment models



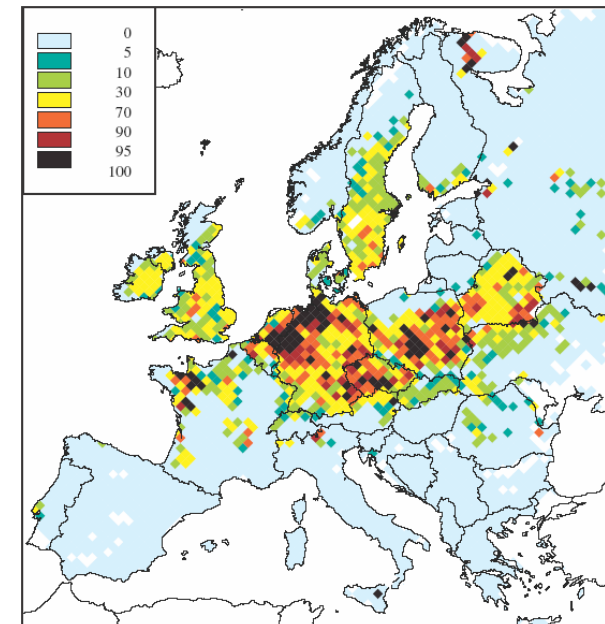
- Integration over cause-effects chain
 - Multi-disciplinary approach (since RAINS 1.1)

20 years assessment of forest soil acidification 1984 and 2004



1984: RAINS 1.1 assessment for 2010

Percentage of forest area
with acid deposition
above critical loads



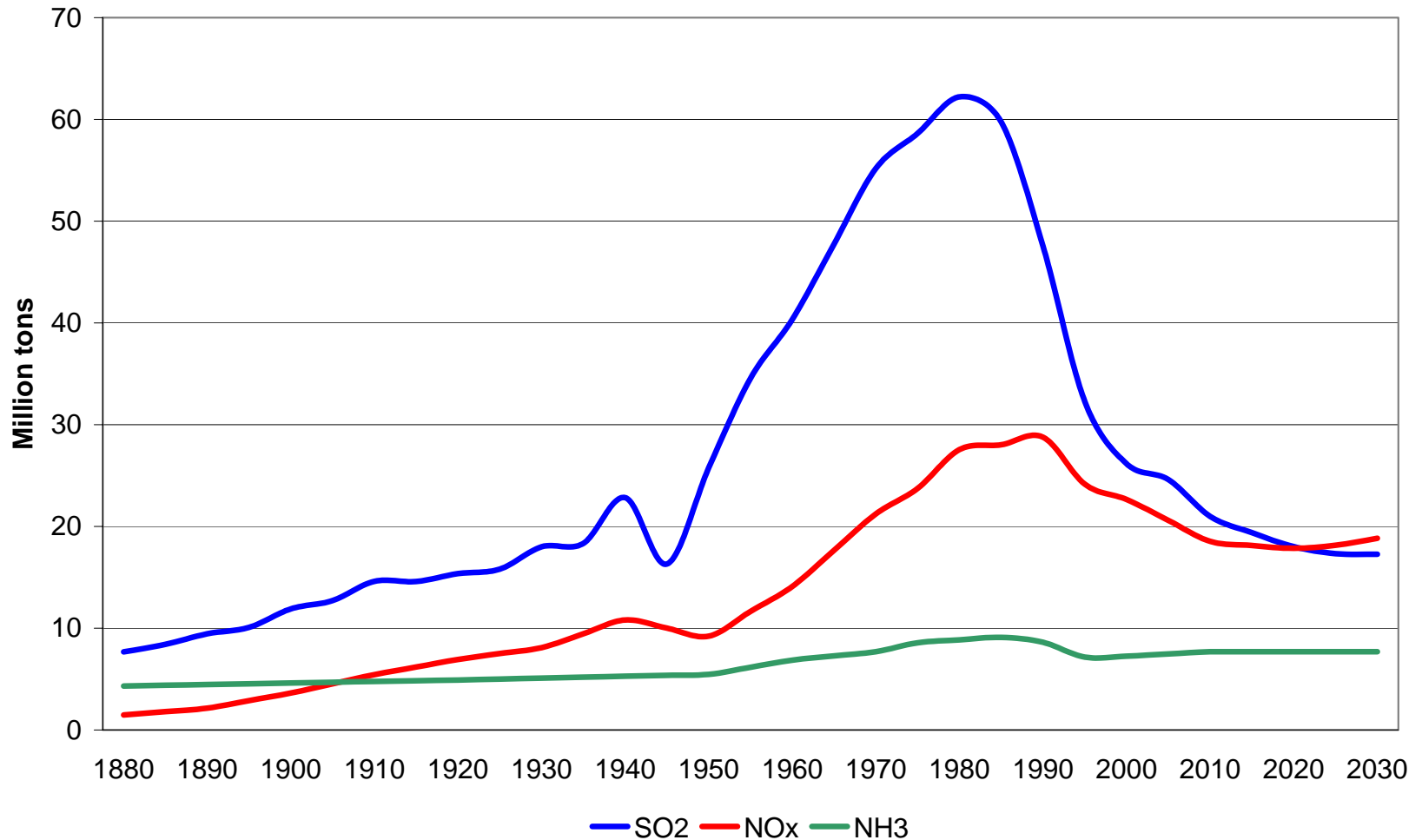
2004: CAFE assessment for 2010

Features of integrated assessment models



- Integration over cause-effects chain
 - Multi-disciplinary approach (since RAINS 1.1)
- Integrated view on mitigation potentials
 - Cost-effectiveness optimization (since 2nd Sulphur Protocol)
- Integration over multiple benefits
 - Multi-effect approach (since Gothenburg Protocol)
- Integration over scales
 - Inclusion of health impacts (since CAFE)

Historic SO₂, NO_x and NH₃ emissions 1880-2005, EU-25



What's next for IAM?



Environmental long-term objectives will not be met.

Integration over multiple policy areas

- Link to climate policy:
 - Co-benefits
 - Cost savings from co-control
 - Highlighting second-best measures

Multi-pollutant measures (1)

Trade-offs shown in red, GHGs are underlined



- Structural measures:
 - Energy savings, efficiency improvements, bans: all pollutants ↓
 - Increased use of natural gas: CO₂, SO₂, VOC, NO_x, PM ↓ CH₄ ↑
 - Biomass: CO₂ ↓ VOC, PM, CH₄ ↑
- Stationary sources:
 - SCR, SNCR: NO_x, CO ↓, NH₃, N₂O, CO₂ ↑
 - Fluidized bed combustion: SO₂, NO_x ↓, N₂O ↑
 - Advanced residential combustion: VOC, PM, CO, CH₄ ↓
 - FGD: SO₂, PM ↓ CO₂ ↑
 - IGCC: CO₂, SO₂, NO_x, PM ↓
 - CHP: all pollutants ↓
- Mobile sources:
 - Euro-standards: NO_x, VOC, PM, CO ↓ NH₃, N₂O ↑
 - Low sulfur fuels: SO₂, PM ↓
 - Diesel: CO₂, VOC ↓, PM, NO_x, SO₂ ↑

Multi-pollutant measures (2)

Trade-offs shown in red, GHGs are underlined

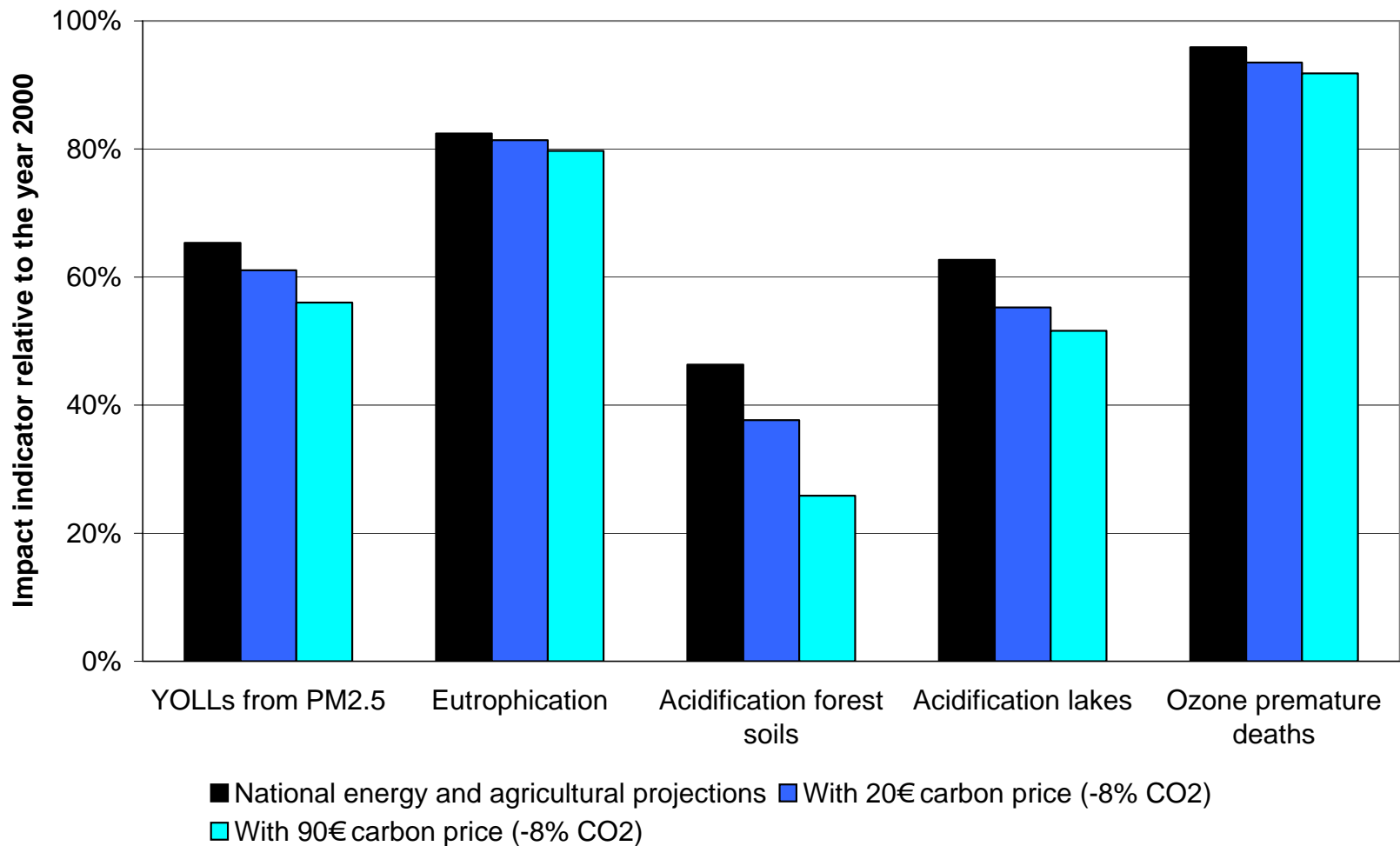


- Agricultural sources:
 - Low emission pig housing – NH_3 , CH_4 ↓ N_2O ↑
 - Covered storage of slurry – NH_3 ↓ CH_4 ↑
 - Injection of manure – NH_3 ↓ N_2O ↑
 - Anaerobic digestion (biogas) – CH_4 , N_2O ↓ CO_2 ↑ NH_3 ↓ ↑
- Other sources
 - Gas recovery and flaring: CH_4 ↓ CO_2 , PM, VOC, SO_2 , NO_x , CO ↑
 - Gas recovery and re-use: CH_4 ↓ CO_2 ↑
 - Improving flaring efficiency: PM, VOC, NO_x , SO_2 , CO ↓
 - Waste incineration: CH_4 ↓ CO_2 ↑
 - Gas recovery from wastewater treatment: CH_4 ↓ CO_2 ↑

In total approx 500 measures with multi-pollutant impacts considered in GAINS

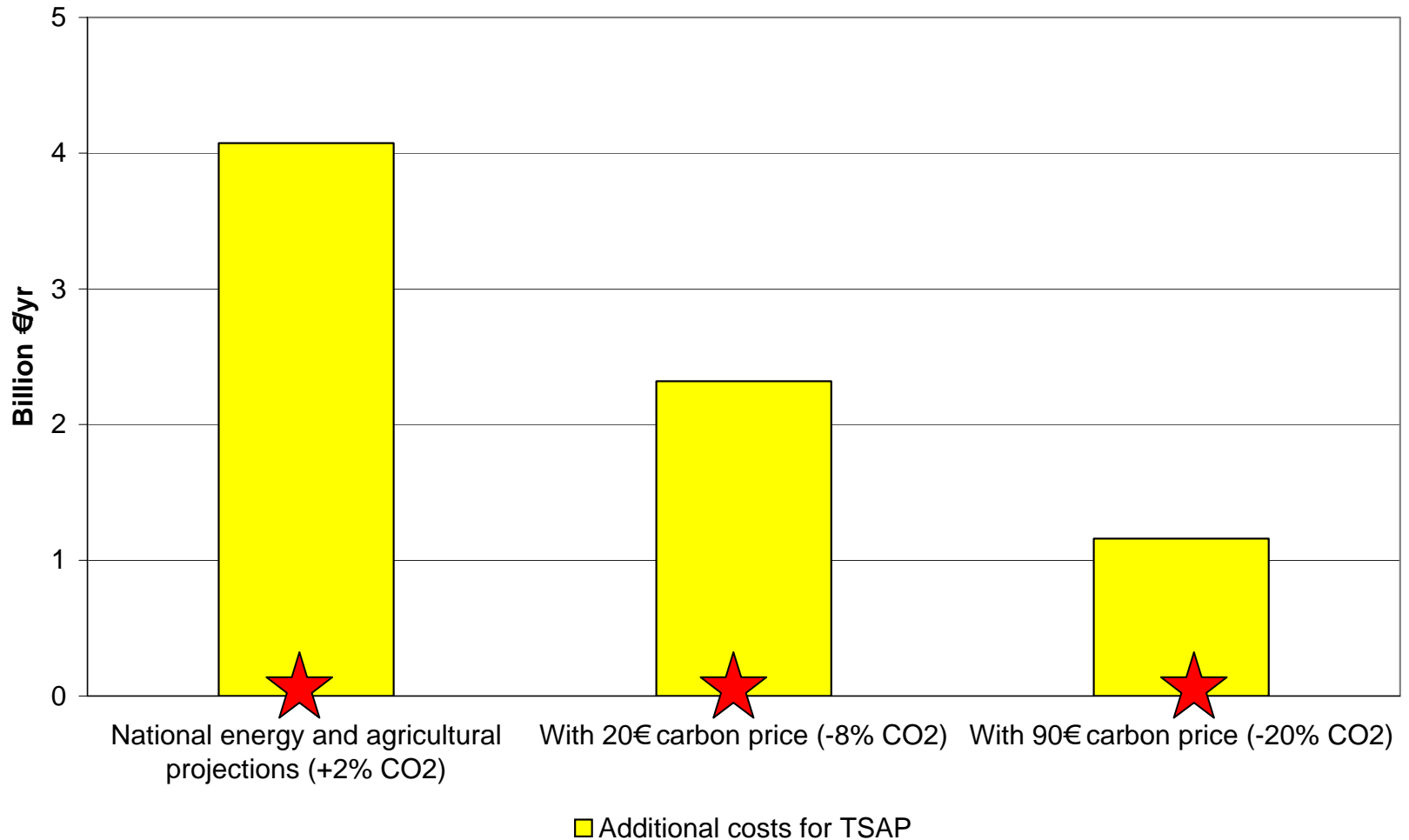
Impact indicators for different GHG projections

Relative to 2000, EU-25, current legislation baselines 2020

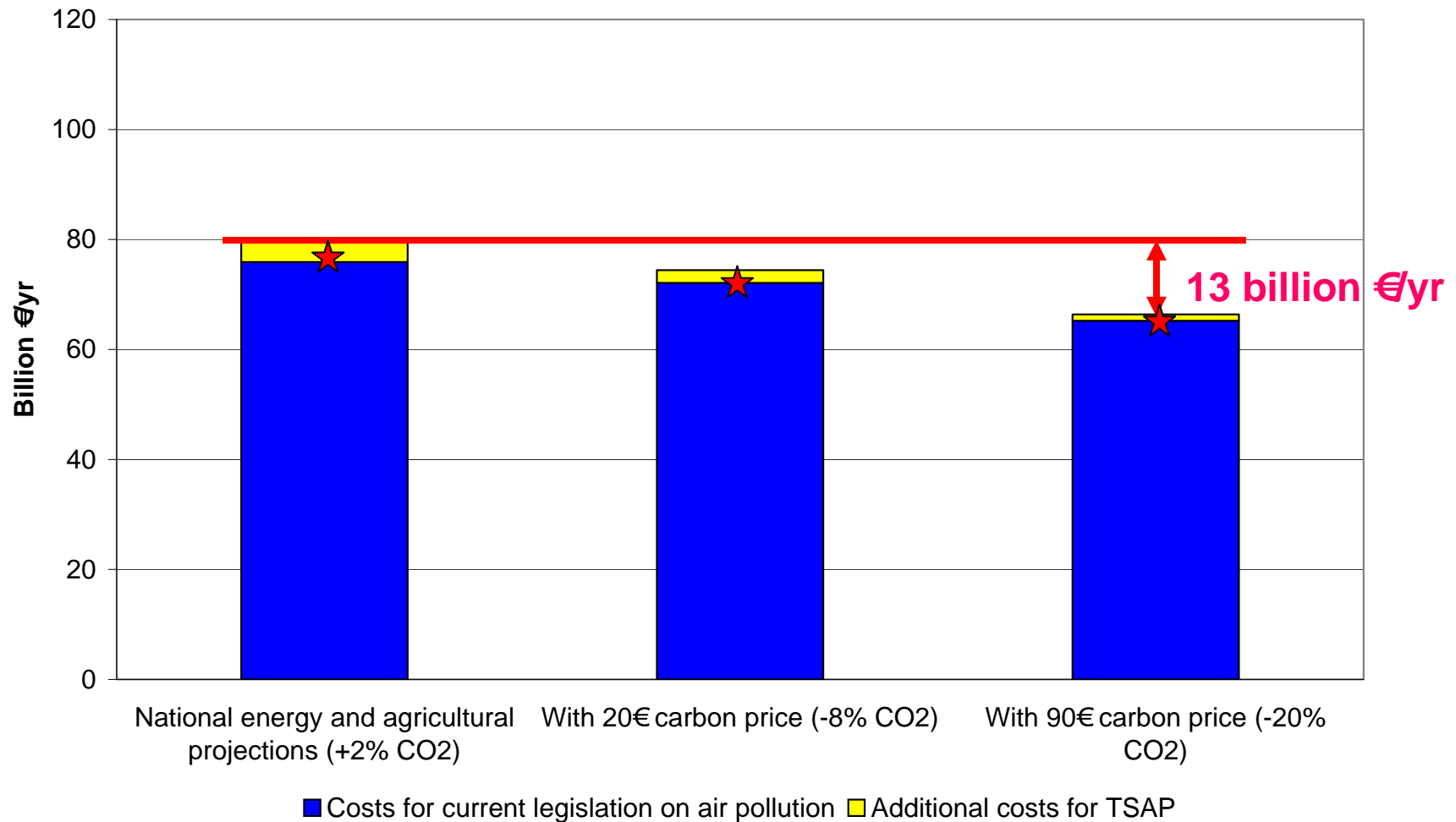


Costs of TSAP in 2020

in addition to the costs of the NEC baseline projections

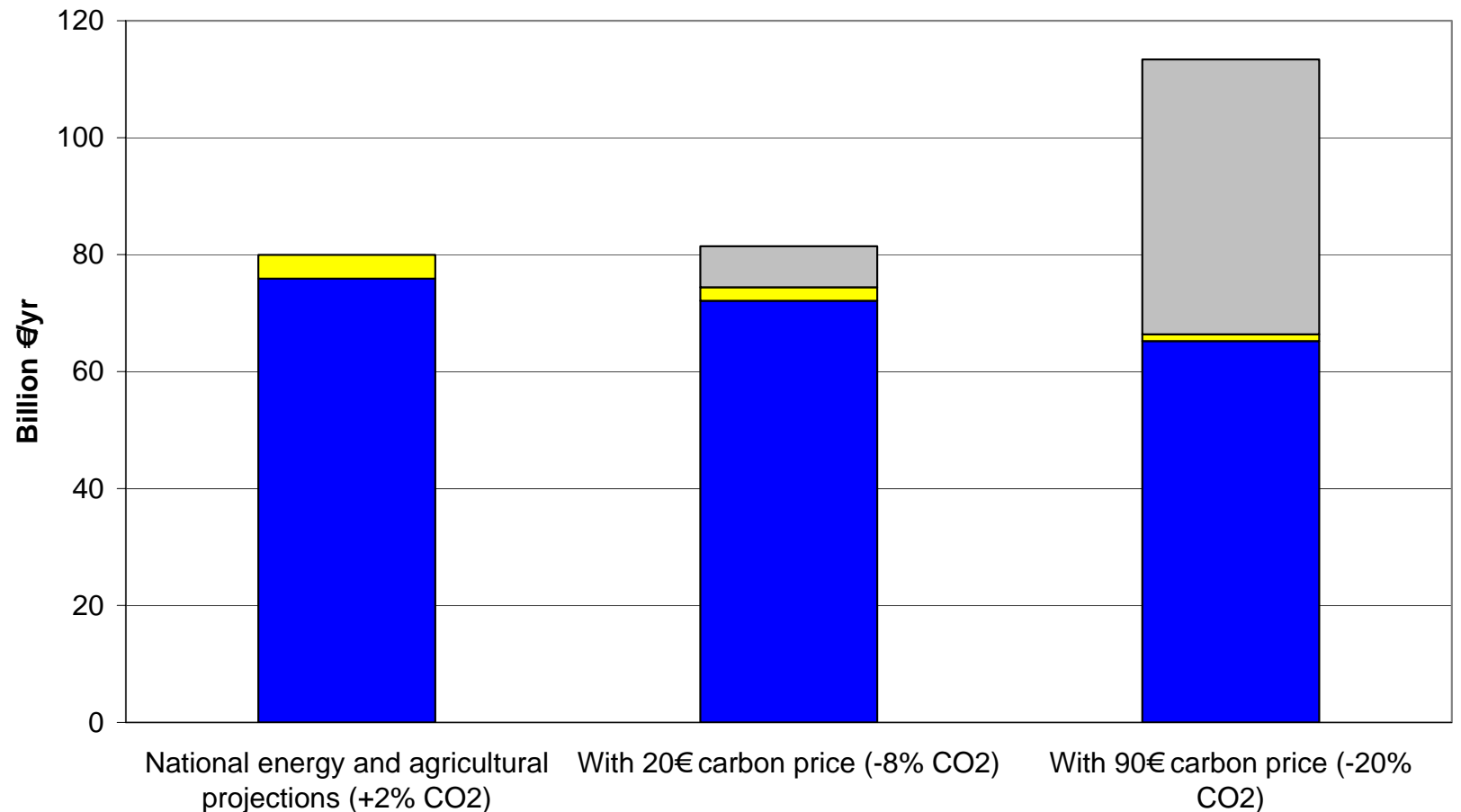


Total air pollution control costs in 2020 for reaching the TSAP environmental targets



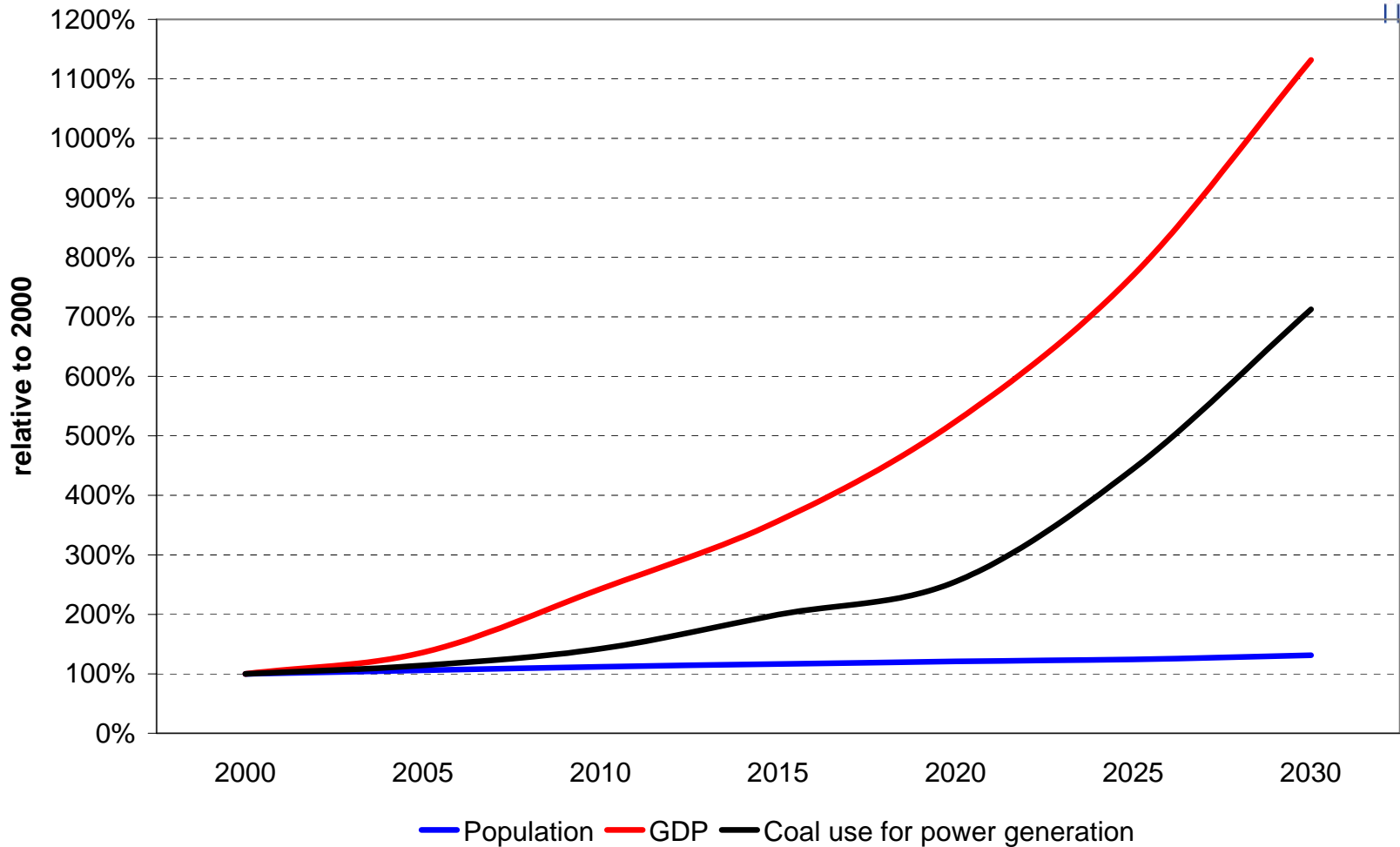
Costs for AP and GHG mitigation in 2020

Preliminary GAINS estimates

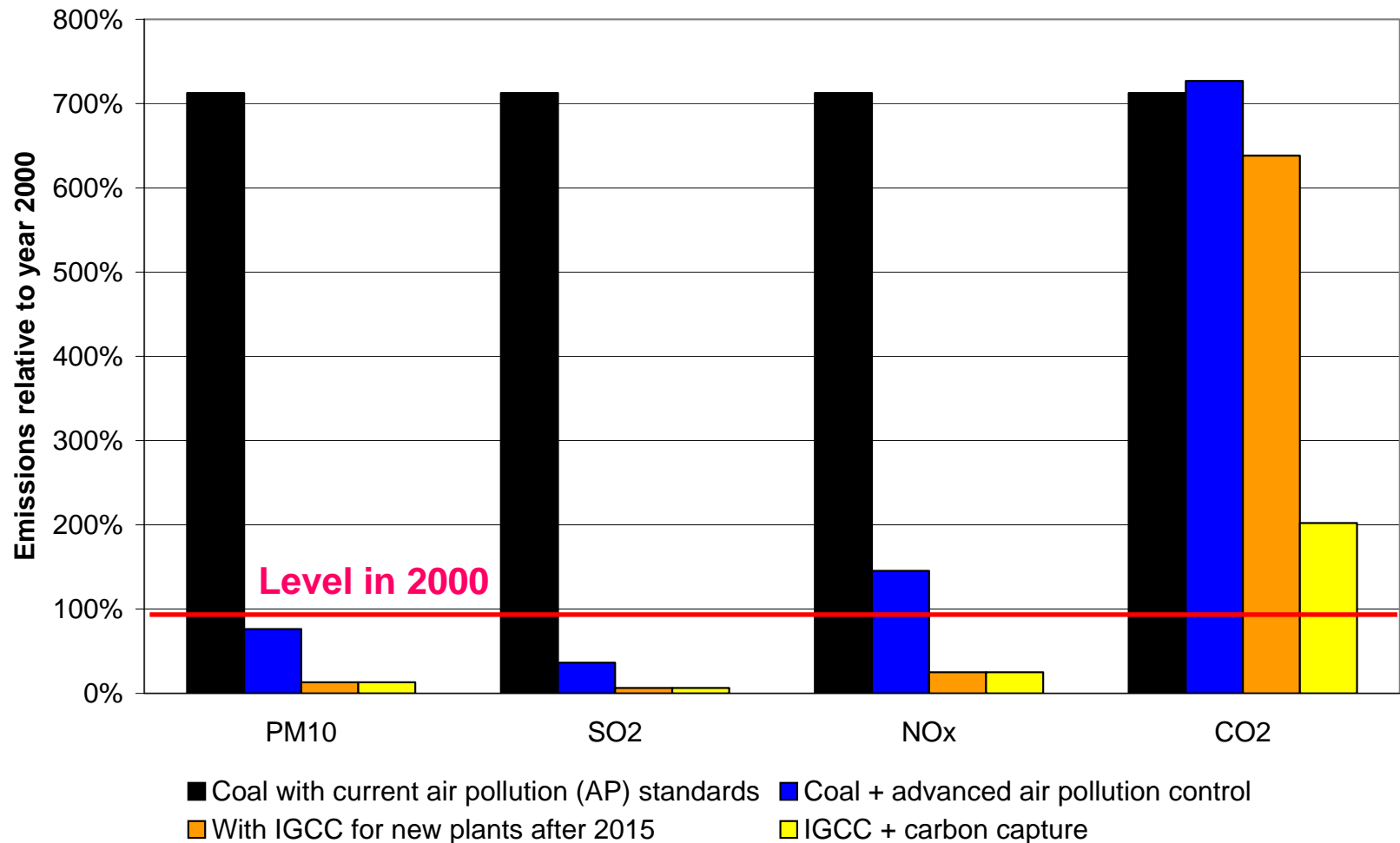


■ Costs for current legislation on air pollution ■ Additional costs for TSAP ■ Additional costs for the CO2 reduction

Population, GDP and coal use for power generation in Andhra Pradesh (projection provided by TERI)

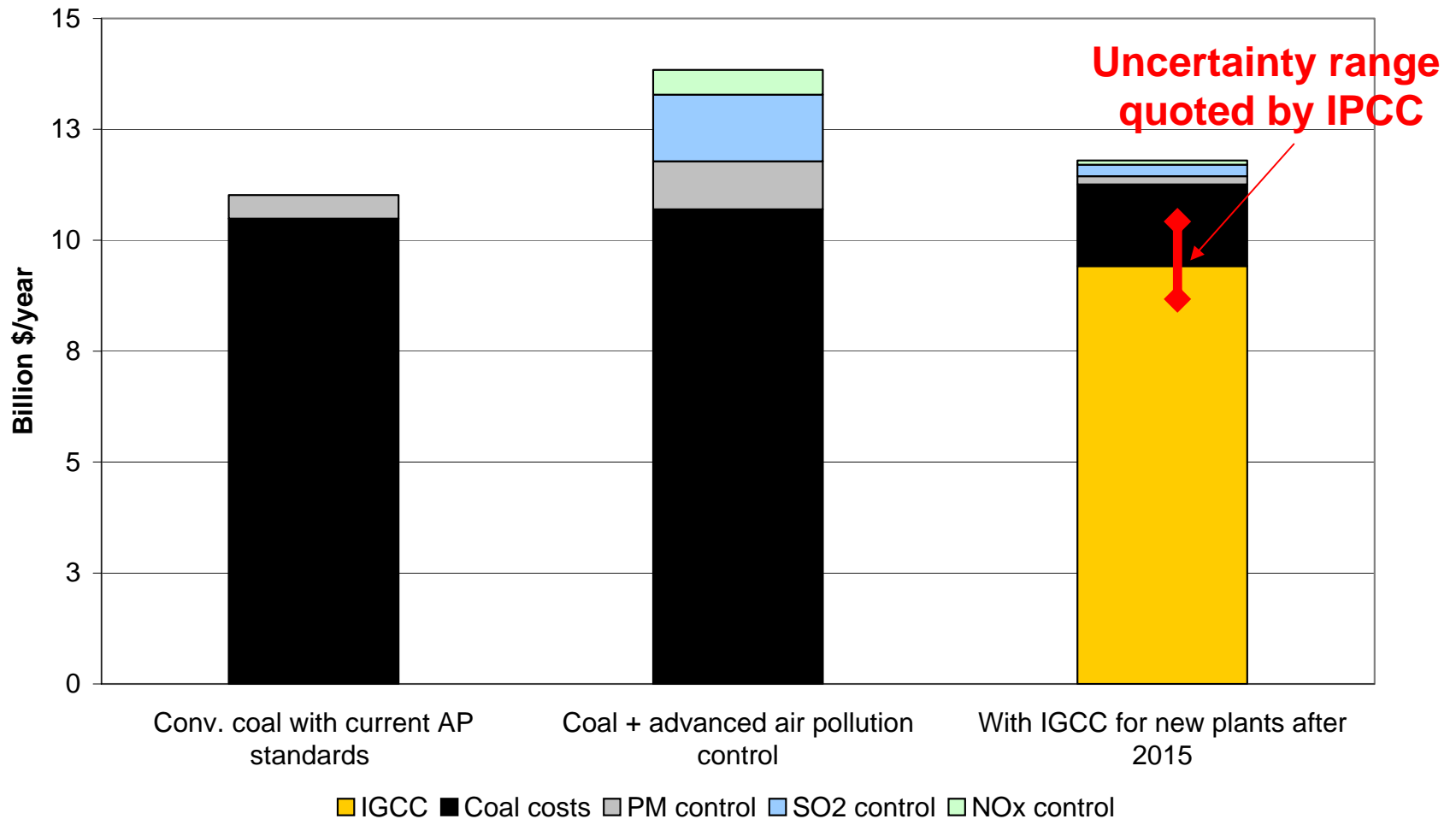


Emissions from power generation in Andhra Pradesh 2020 relative to 2000, provisional GAINS-Asia results,



Costs of electricity generation

Andhra Pradesh, 2020

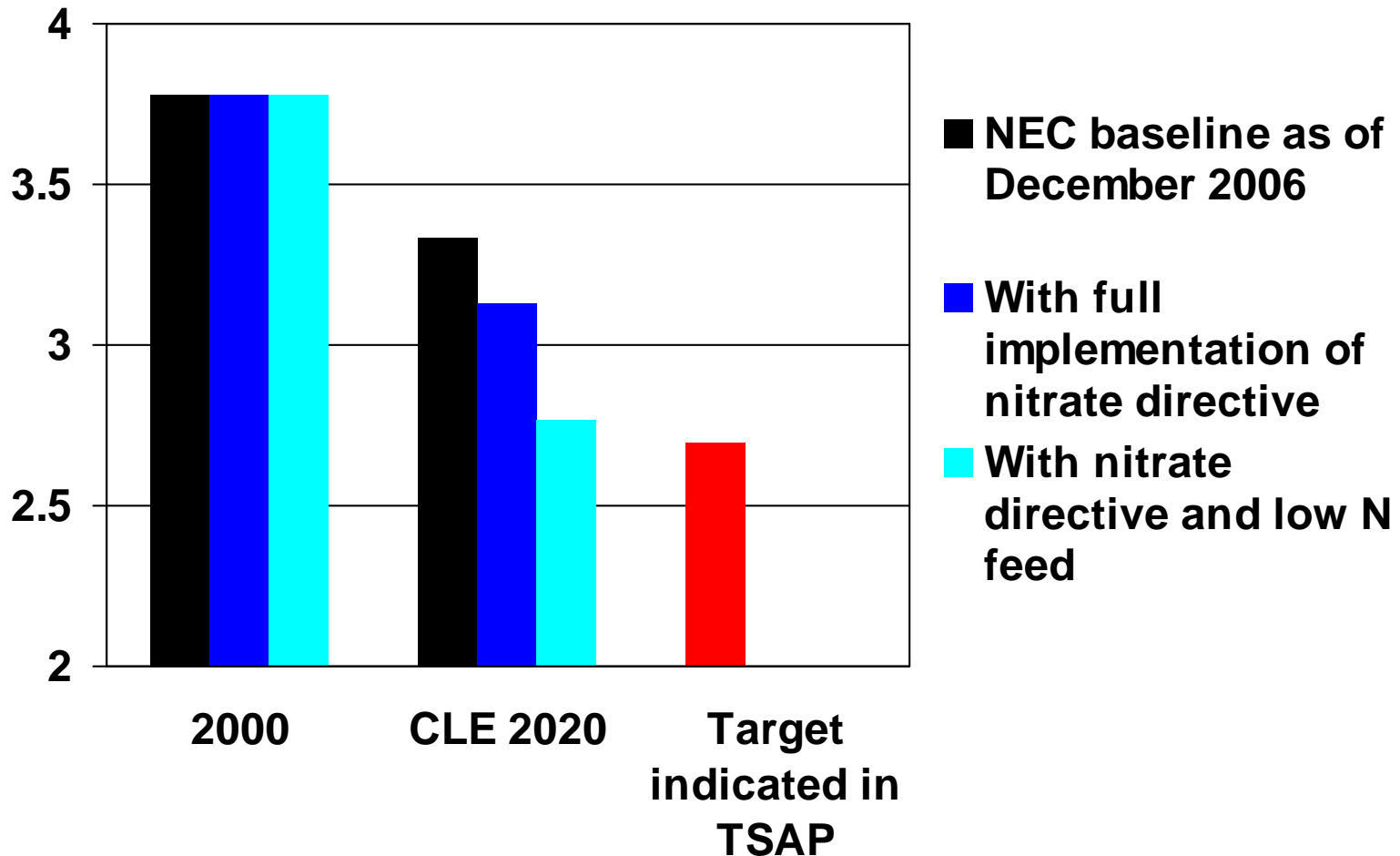


What's next for IAM? (2)



- Link to agricultural policies and nitrogen cycle

Expected impacts of the Nitrate Directive and optimized feed on EU-25 NH₃ emissions



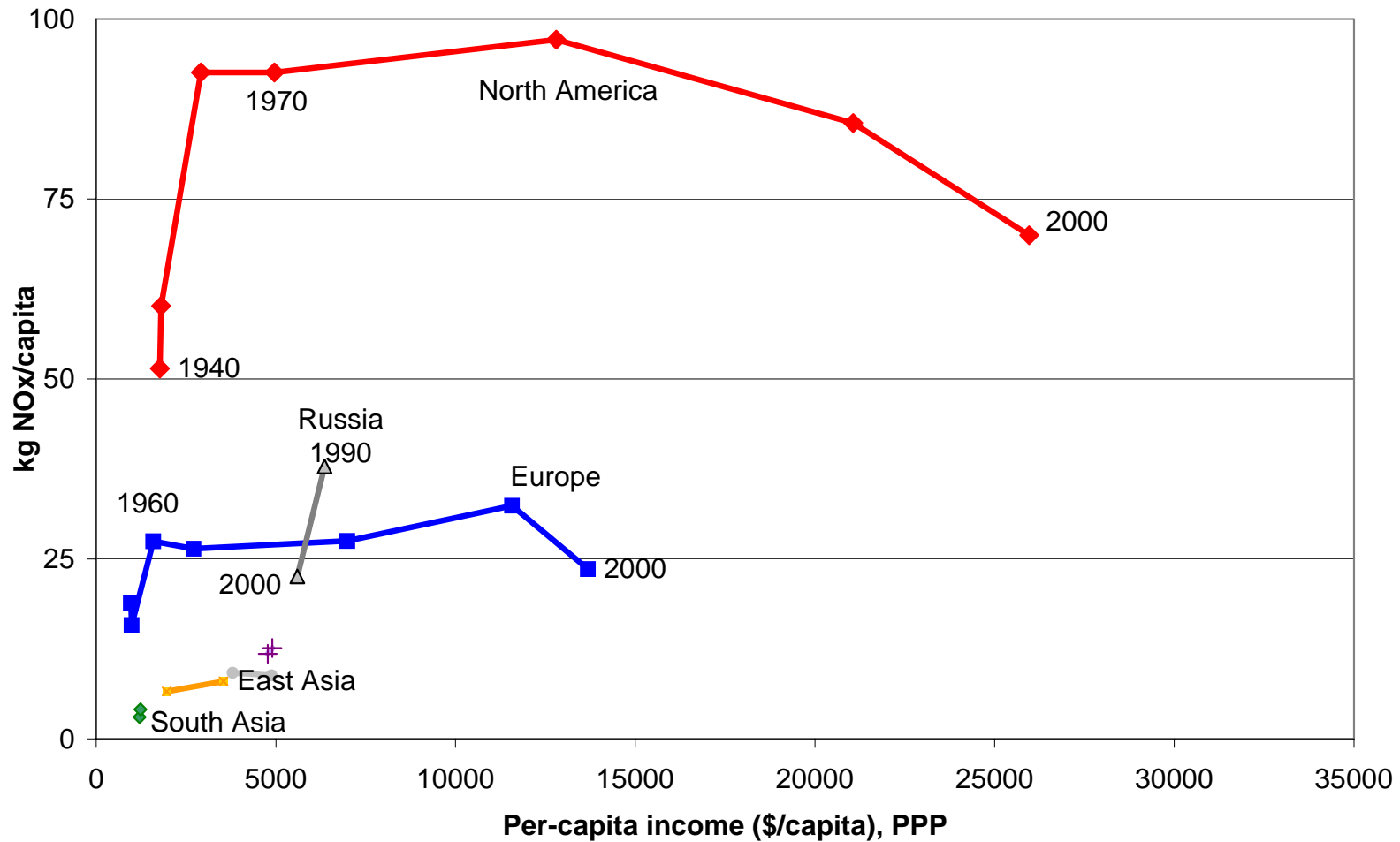
What's next for IAM? (3)



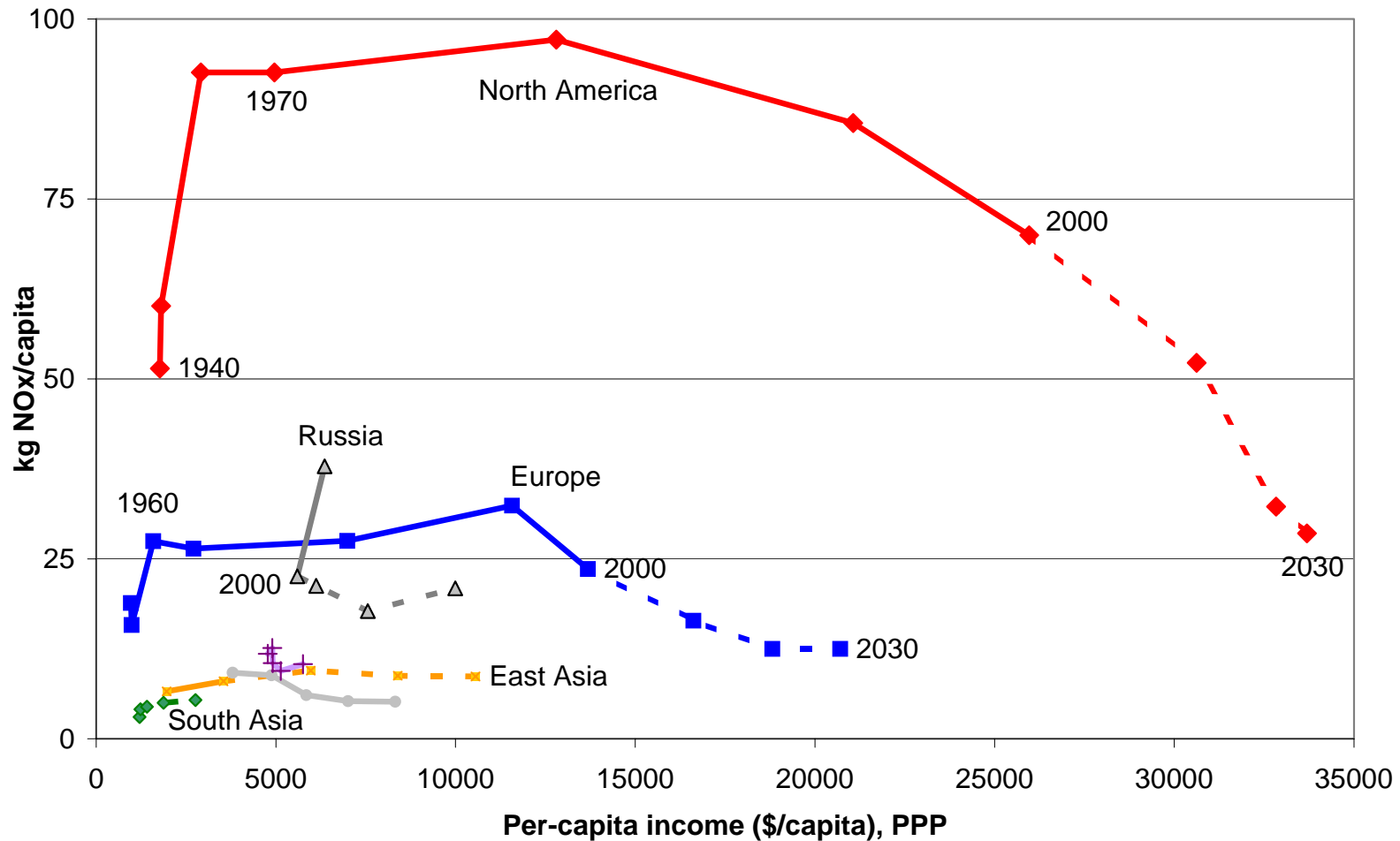
More comprehensive economic assessment

- Quantification of economic welfare impacts (employment, competitiveness, income levels, etc.)
- Quantification of non-monetary aspects of human welfare
- This could eventually allow a more comprehensive measure for welfare
 - and a re-evaluation of the value of environmental investments

Per-capita NO_x emissions 1940-2000



Per-capita NO_x emissions 1940-2030



Conclusions



- Integrated assessment modelling has achieved a lot, but there are still relevant issues with potentially even larger gains to be made
- Increasing complexity will pose challenges to model developers and model users
 - However, this concern is not new (was raised every time when a new aspect was added (full DPSIR chain, ozone, PM, etc.))
- The model must be kept manageable
 - Simplify treatment of issues that have been solved
 - Refrain from too many technical details
- Deeper commitment to and involvement in a systematic analysis from stakeholders indispensable
- The EU-LIFE project EC4MACS offers a financially more robust basis for further work