Assessment of greenhouse gas emissions

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Sustainability Indicators for Policy Making

Green Growth and Green innovation

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Outline

1. Introduction
2. Indicators and their performance
   i. GHG emissions
   ii. Distance to target
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GHG emissions

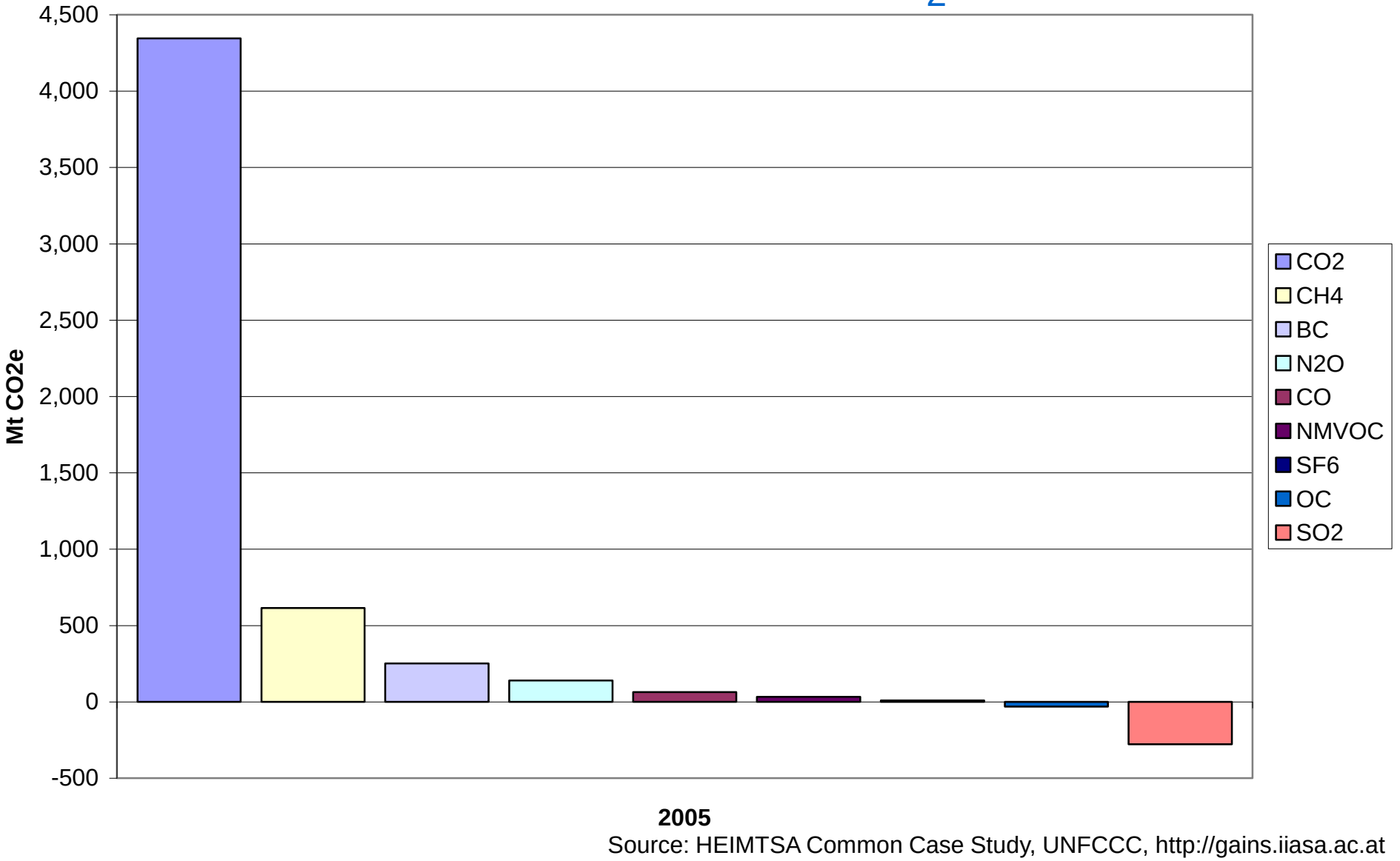
- In a first stage, all annual emissions of substances to the atmosphere leading to a change in radiative forcing are estimated, converted into a common unit (e.g. $CO_{2,equivalent}$) using the GWP and added.
- In a second stage, all processes leading to a change in radiative forcing (like changes in vegetation, carbon storage, albedo change) are added (not shown here, needs further research).

Global warming potentials (GWPs for non-GHG substances preliminary rough estimates!)

Gas	GWP 100 years (Range)
CO_2	1
CH_4	25 (16 – 34)
N_2O	298
SF_6	22800
SO_2	-40 (-24 – -56)
BC	680 (190 – 2240)
OC	-69 (-35 – -104)
VOC	3.4 (2 – 7)
CO	1.9 (1 – 3)
NO_x	~0

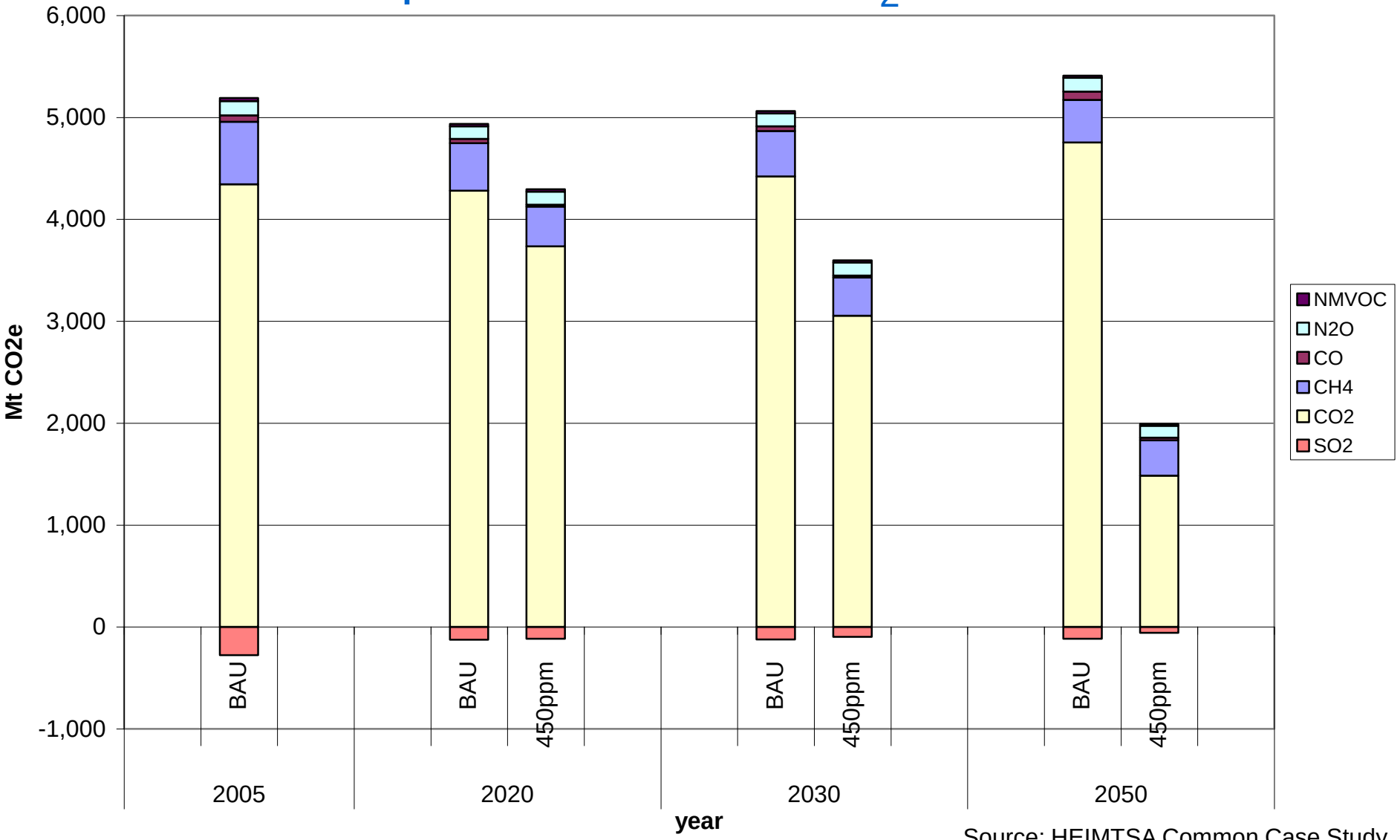
Sources: IPCC, 2007; http://cdiac.ornl.gov/pns/current_ghg.html; Amann et al., 2010, Amann, 2011; http://www.stanford.edu/group/efmh/jacobson/0710LetHouseBC%201.pdf

GHG emissions 2005 in EU29 in CO_2e



Source: HEIMTSA Common Case Study, UNFCCC, http://gains.iiasa.ac.at

GHG emission path in CO_2e

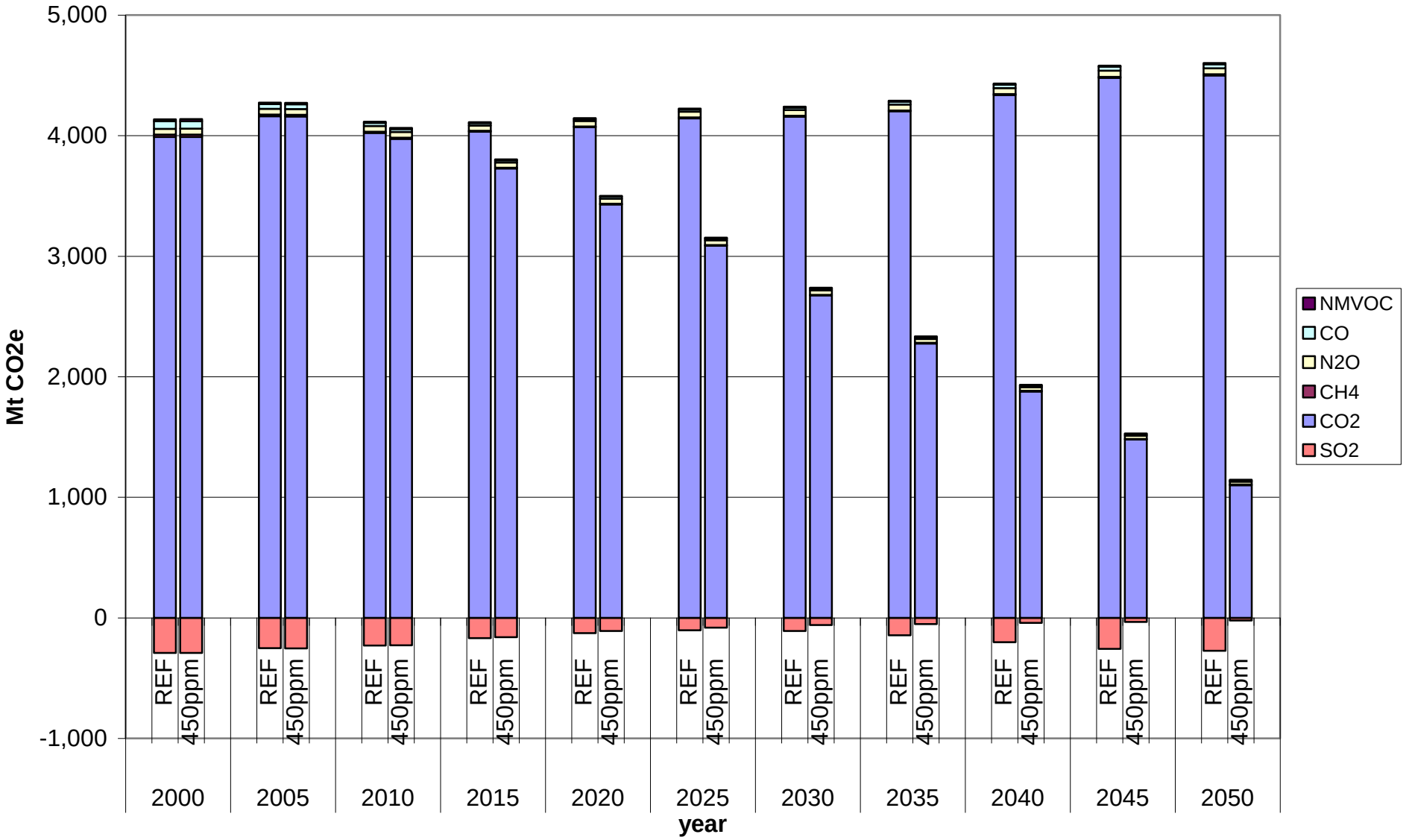


Source: HEIMTSA Common Case Study

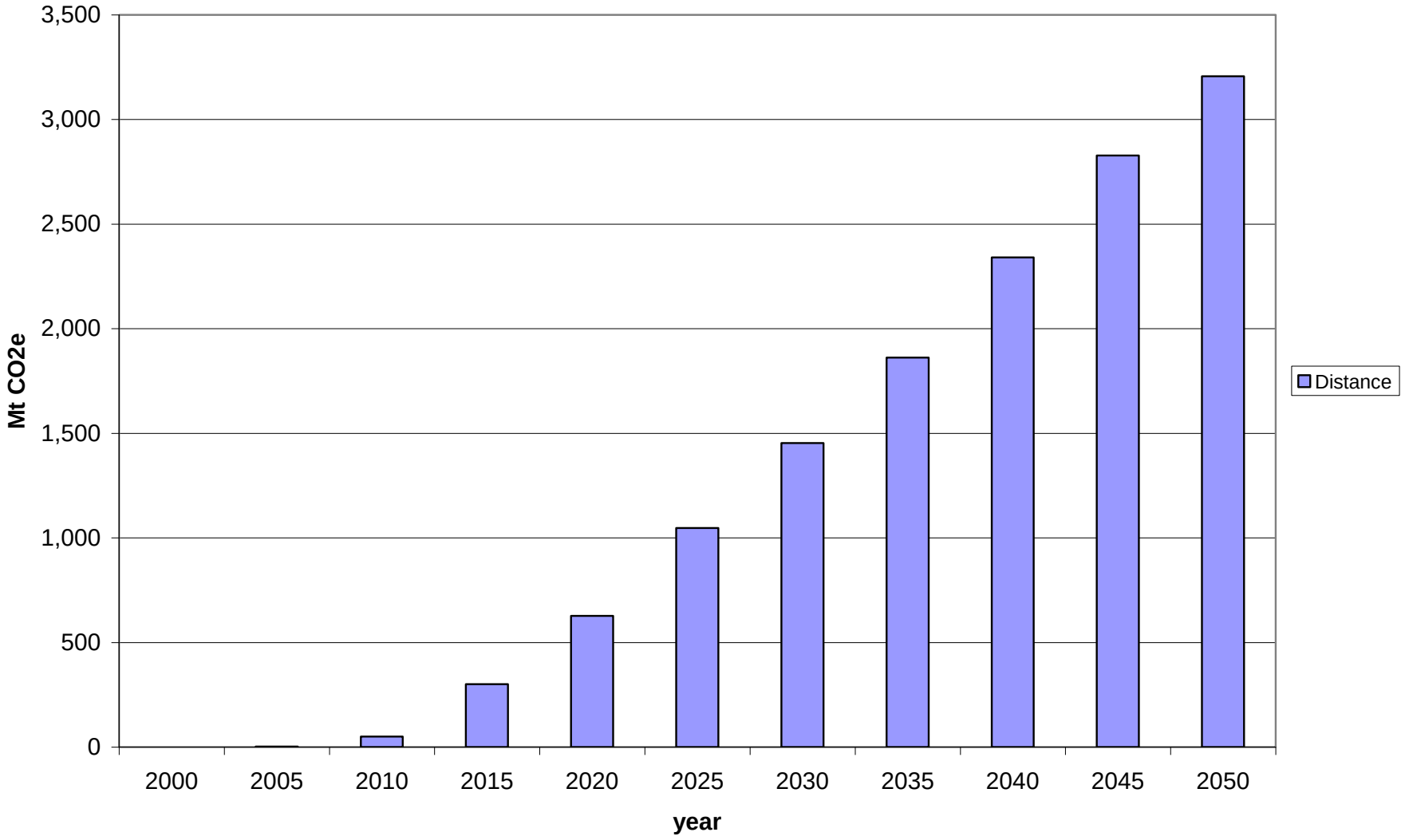
Distance to target

- The indicator distance to target compares actual emissions with a ‘sustainable emission pathway’, that is a path for European GHG emissions leading to a reduction of ca. 71% of EU GHG emissions 1990 – 2050. This might be part of a worldwide strategy leading to fulfilling the 2°C target.
- Cost-Optimal pathway calculated with models (here TIMES), starting e.g. 2010)
- Each year the sustainable emission path would have to be newly calculated in case of a deviance.
- Alternatively: calculate cumulative deviation for each year;
  Problem: negligence of time of emission (now or future)
- Procedure: Compare emission of sustainable emission path with actual emissions. Add differences to accumulated difference of past years.

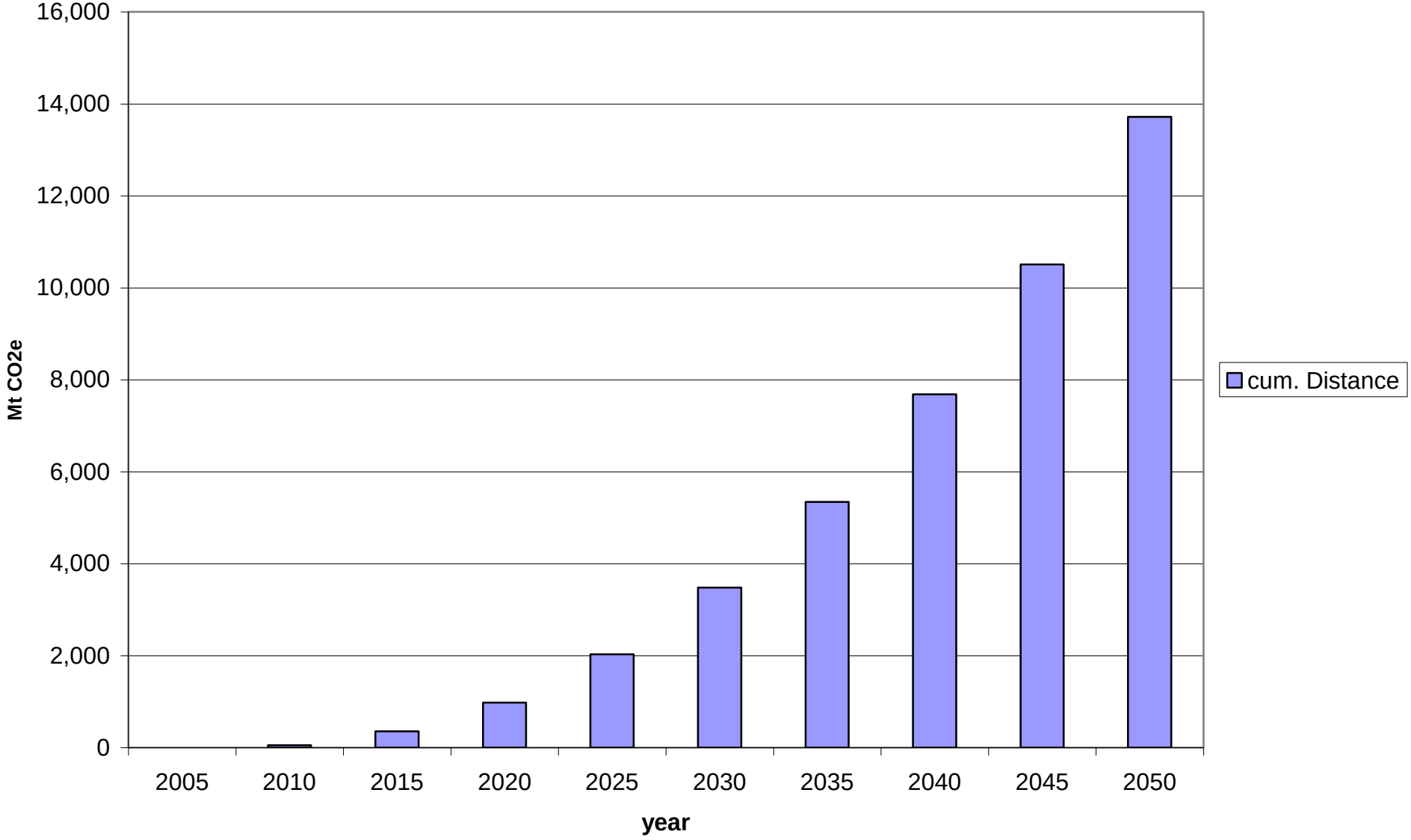
Emissions – TIMES model (only energy)



Distance to target emissions - TIMES



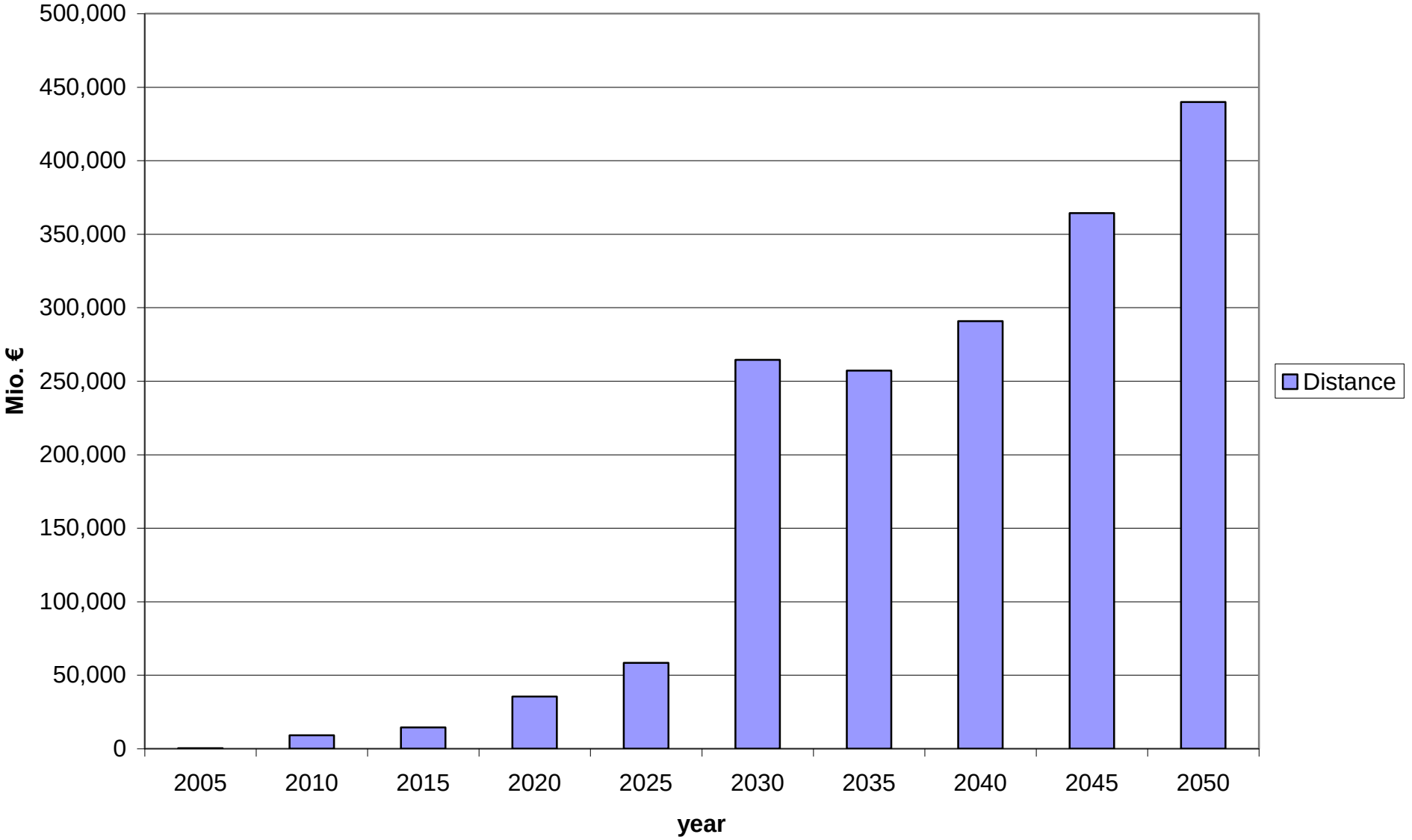
Cumulated distance to target emissions - TIMES



Costs distance to target

- The indicator ‘costs distance to target’ is based on the indicator distance (of emissions) to target. The annual costs for reducing the emissions values to the target value is estimated.
- This is done using partial equilibrium models (energy, agriculture).

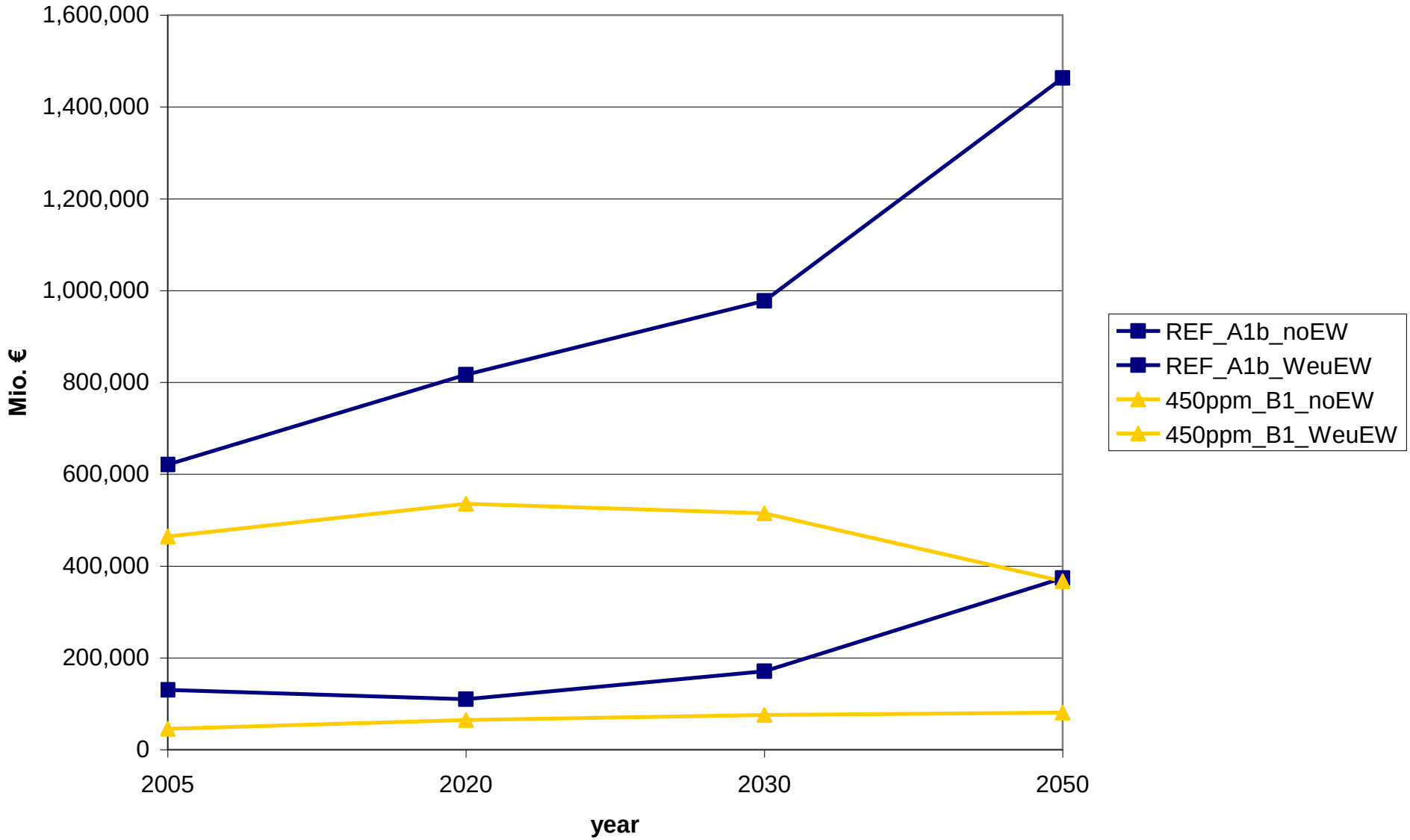
Costs distance to target – Annual System Costs (TIMES)



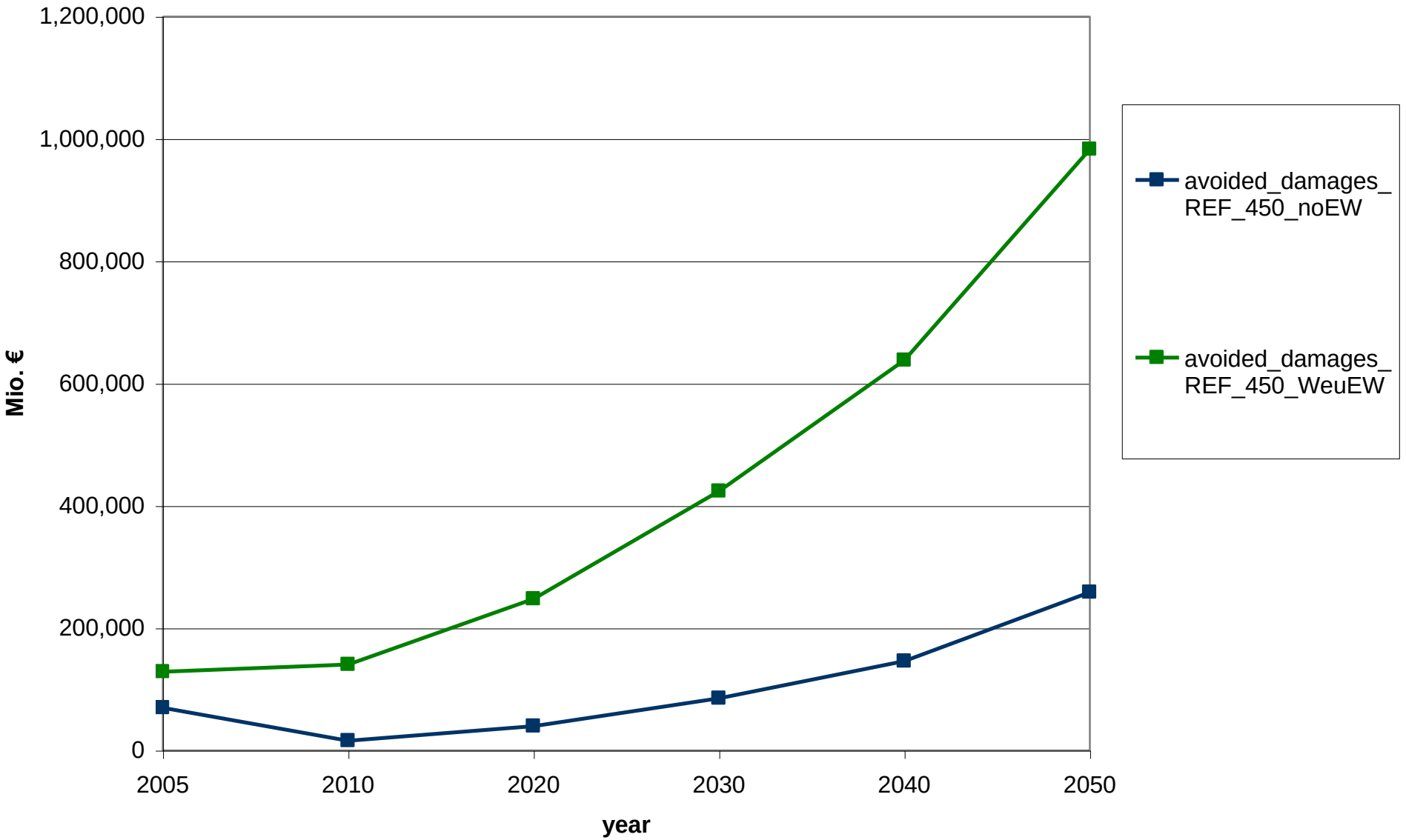
Total damage costs

- The indicator damage costs shows the monetized damage caused by the greenhouse gases emitted in a year (e.g. for EU29).
- Extra: Avoided damages can be compared with avoidance costs.
- Procedure: Calculate total damage costs of emissions by multiplying marginal damage costs with emissions (e.g. EU29) from all sectors in CO_2e.
- Marginal damage costs are calculated using integrated assessment models, here: FUND. Marginal damage costs here are estimated for two emission scenarios: SRES A1b (which leads to +3°C until 2100 and SRES B1 (leads to about +2°C).
- Open questions:
  usage of equity weighting or not;
  how to deal with uncertainty whether important damages are missing.

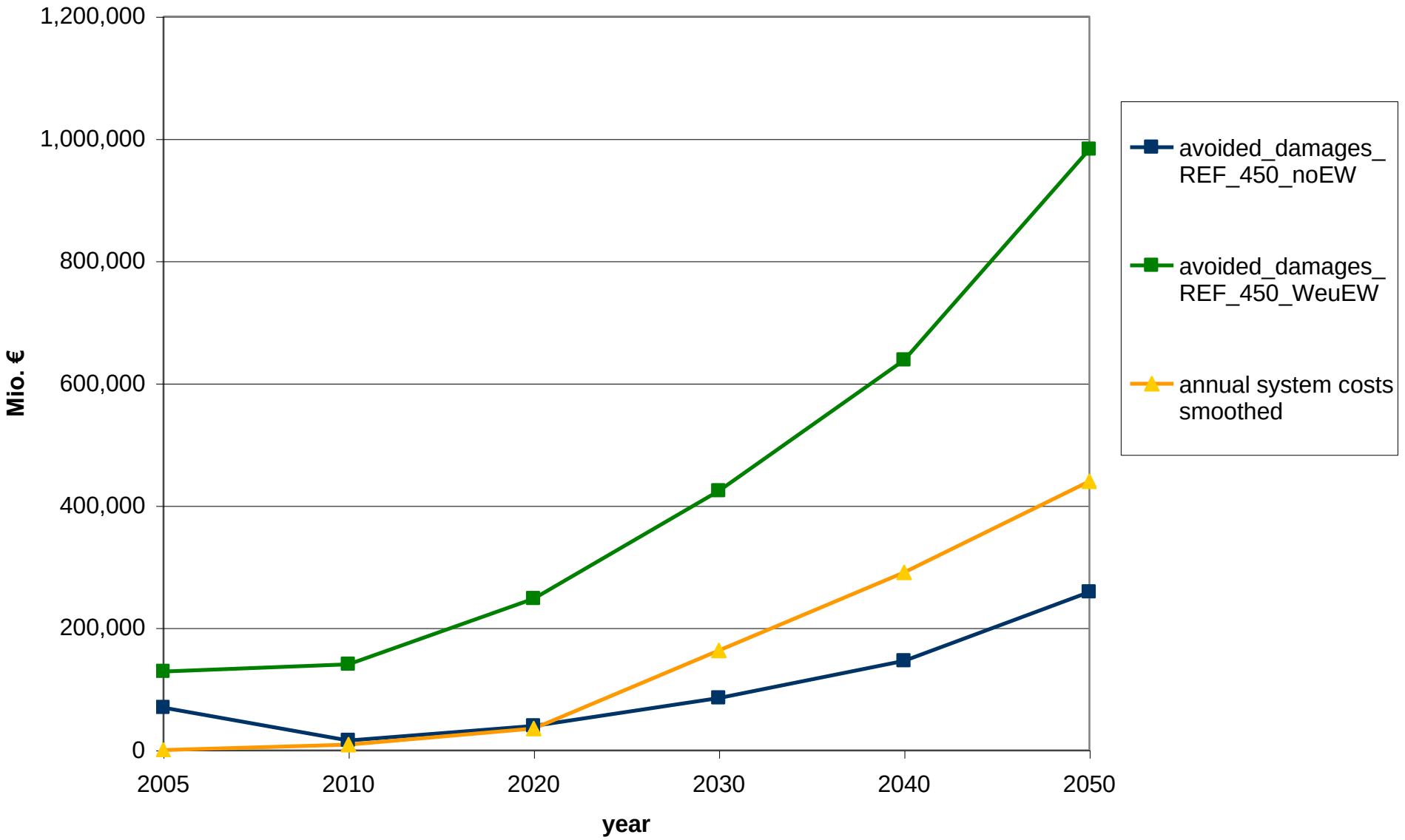
Damage costs due to emissions of a year– EU29



Avoided annual damage costs – EU29



Avoided damage costs and avoidance costs– EU29 (TIMES)



Conclusion

- **GHG emissions:**
  + easy to calculate; minor errors; new: also non-GHGs included
  - only relative comparison to previous year or per capita; no certainty if sustainable path.

- **Distance to target:**
  + distance to sustainable path visible
  - path calculated by model; comparison with other indicators and aggregation not possible

Conclusion

- **Costs distance to target:**
  + comparability to other indicators; aggregation possible
  - costs depend on assumptions (e.g. innovation potential difficult to determine)

- **Damage costs:**
  + similar to indicator above; aggregated measure for damages; worldwide emission path
  - possibly not all damages included (precautionary principle); to be decided, if EW or no EW.

- All indicators could/ should be further developed!

References:

GWPs

IPCC: http://www.ipcc.ch

Amann, M., I. Bertok, C. Heyes, Z. Klimont, K. Kupiainen, W. Schöpp (2010): Identifying promising measures that could help reducing near-term forcing, State of play of the UNEP BC assessment, 38thSession of the Task Force on Integrated Assessment Modelling, Dublin, May 17-19, 2010

Amann, M. (2011): The UNEP/WMO Integrated Assessment of Black Carbon and Tropospheric Ozone, 39th Meeting of the Task Force for Integrated Assessment Modelling, Stockholm, February 23-25, 2011.

HEIMTSA – Common Case Study: http://www.heimtsa.eu

TIMES model

Blesl, M., D. Bruchof, T. Kober, R. Kuder (2011): Energy model runs with TIMES PanEU for the Common Case Study – Scenario analysis of the 2 °C target with and without external costs. Deliverable within the HEIMTSA project, Stuttgart.

FUND model: http://www.fund-model.org