Global Commitments to Combat Global Warming

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Blocks of Presentation & Conclusions

- **Inaction (instead of actions to combat global warming) will be quite expensive**
- **Each global player acting as free-rider will warm the earth above 2°C at chances more than 50%**
- **Without binding commitments for DCs, the chance to warm the earth above 2°C are more that 50%, even when Annex B countries will eliminate their emissions**

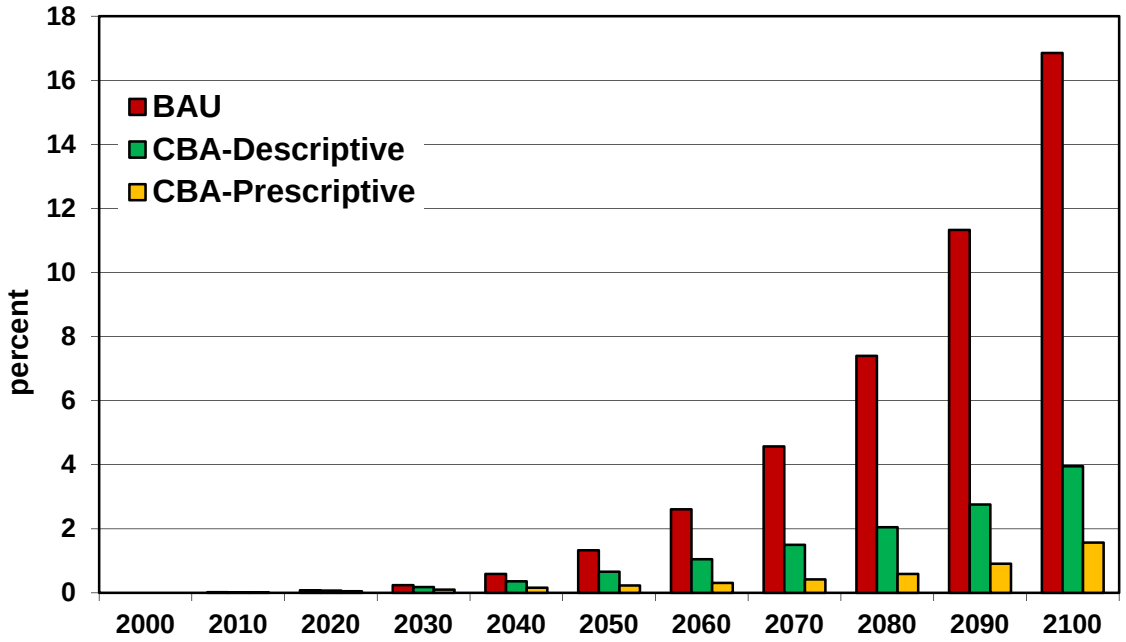
- **Technology Transfer Protocols (TTP) is a "Gedanken Experiment" made with the help of a computer model (modified MERGE)**

- **TTPs could control global warming at affordable cost and present an alternative against the deadlock of post-Kyoto negotiations**

The cost of Inaction and Cost/Benefit Analysis

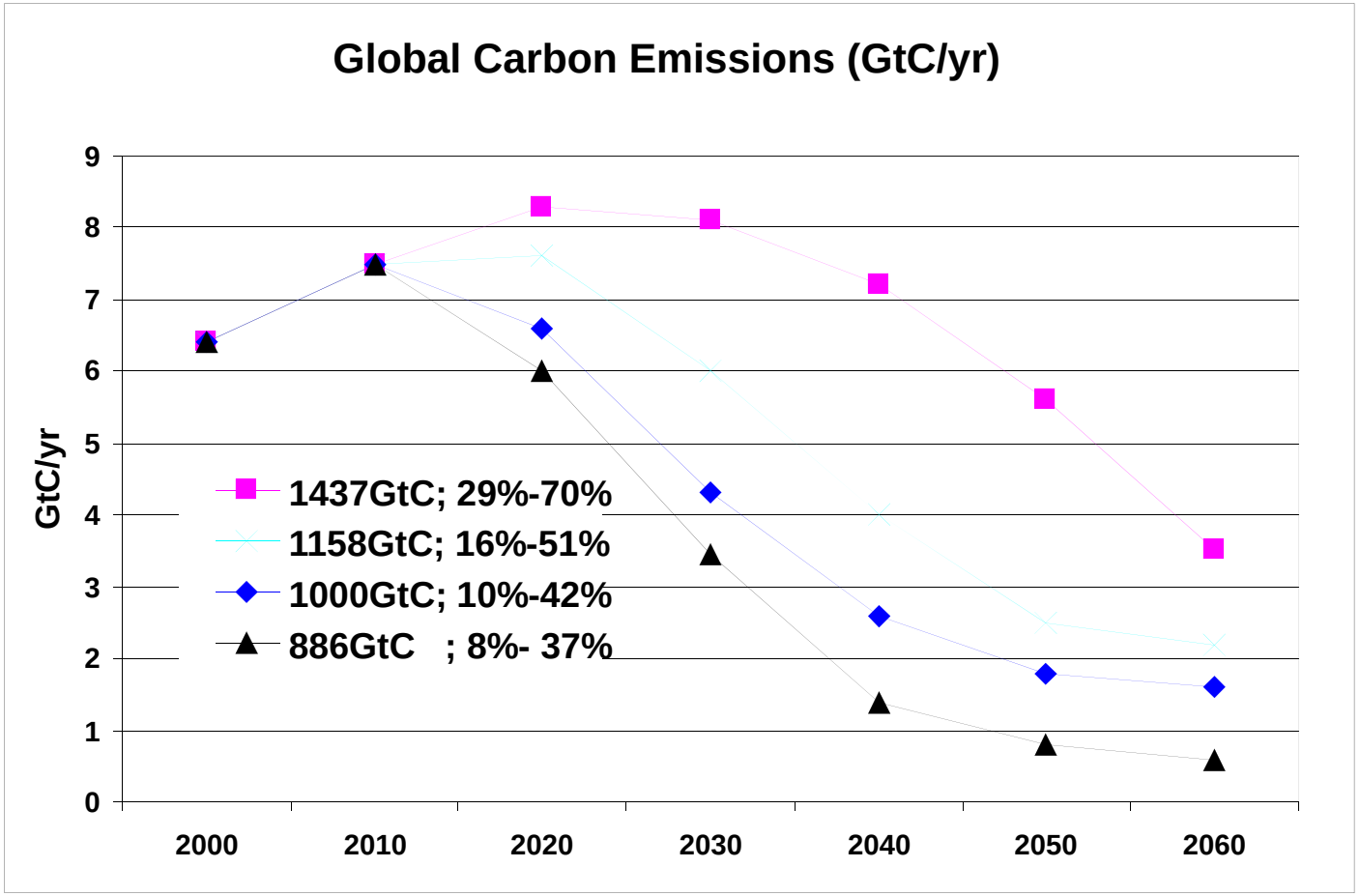
Scenarios analyzed:

1. The Baseline with present trends and regulations excluding damages
2. A CBA case with damages included and a 3% social discount rate (Nordhaus, descriptive)
3. A CBA case with damages included and a 1% social discount rate (Manne, prescriptive)



Market and Non-Market Damages as fraction of Consumption for the baseline and CBA cases.
Damages in the baseline (inaction) are by some factors higher than in the case of action.

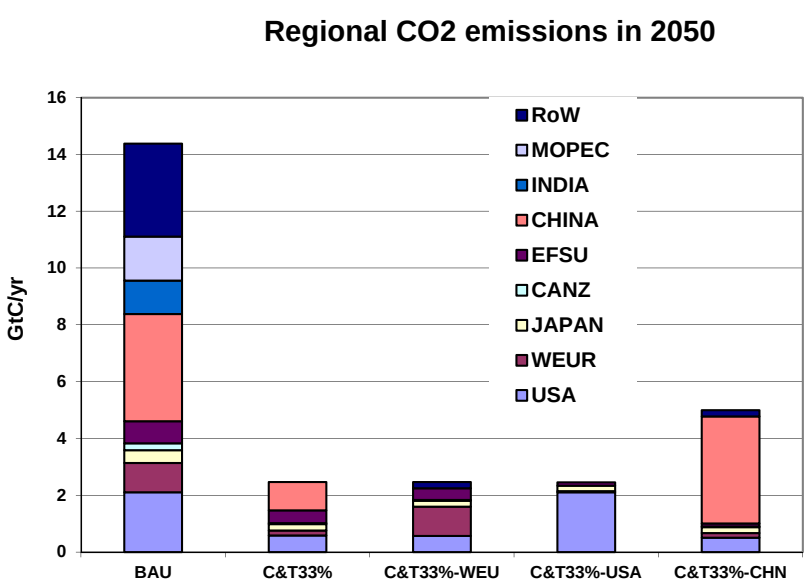
Importance of Free-Riders

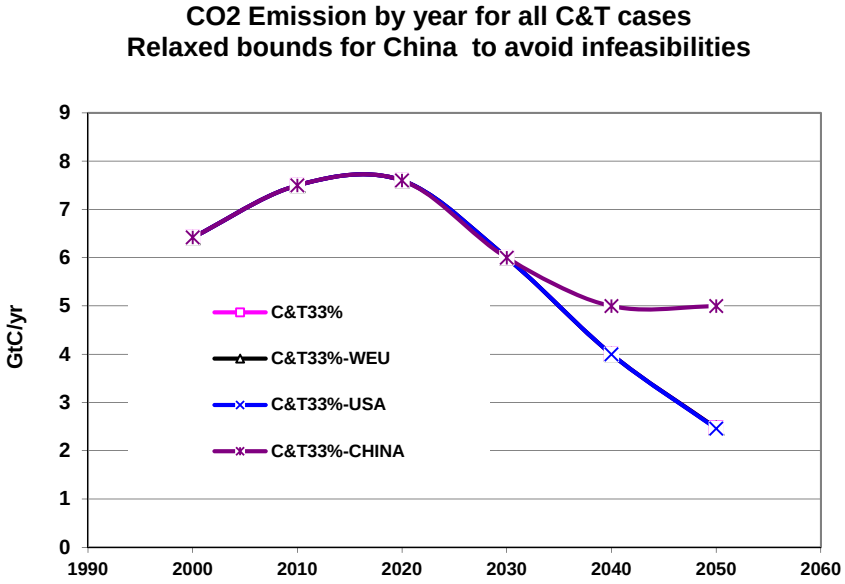


Annual carbon emissions bounds for MERGE consistent with 20%, 25%, 33% and 50 % probability of exceeding 2°C (i.e., from bottom to top) based on the maximum cumulative emissions defined by Meinshausen, M., et al. *Greenhouse-gas emission targets for limiting global warming to 2 °C*. Nature Vol. 458, 30 April 2009

Importance of Free-Riders

C&T subcases with one key-global player acting as free-rider





Carbon emissions in the baseline and the free-riding cases for the 33% probability variant.

In all cases one could rearrange emissions across regions to remain below 2 GtC/yr but in the case of China the solution is infeasible.

The situation is worse in the 25% and 20% probability variants or when the time horizon is extended. This should be obvious as global emissions in the 20% probability case approach levels below of 1 GtC/yr. In such case emissions of USA alone (followed by India and EU) are above the global target.

Technology Transfer Protocols (TTP)

SCOPE: Present a "Mind Experiment" with the help of a computer model (MERGE) where TTPs could balance commitments between North and South for a post-Kyoto Protocol with the following RULES OF THE GAME:

- **Industrialized countries finance the own R&D and the CA-fund with their tax-revenues**
- **The CA-fund supports low-carbon and carbon-free technology transfer to DCs**
- **DCs accept binding commitments for their emissions at high per capita incomes**
- **DCs use always their own tax-revenue (if taxes apply) to support their technology**
- **Donor regions transfer always their tax-revenue to CA-fund via their own export industry**

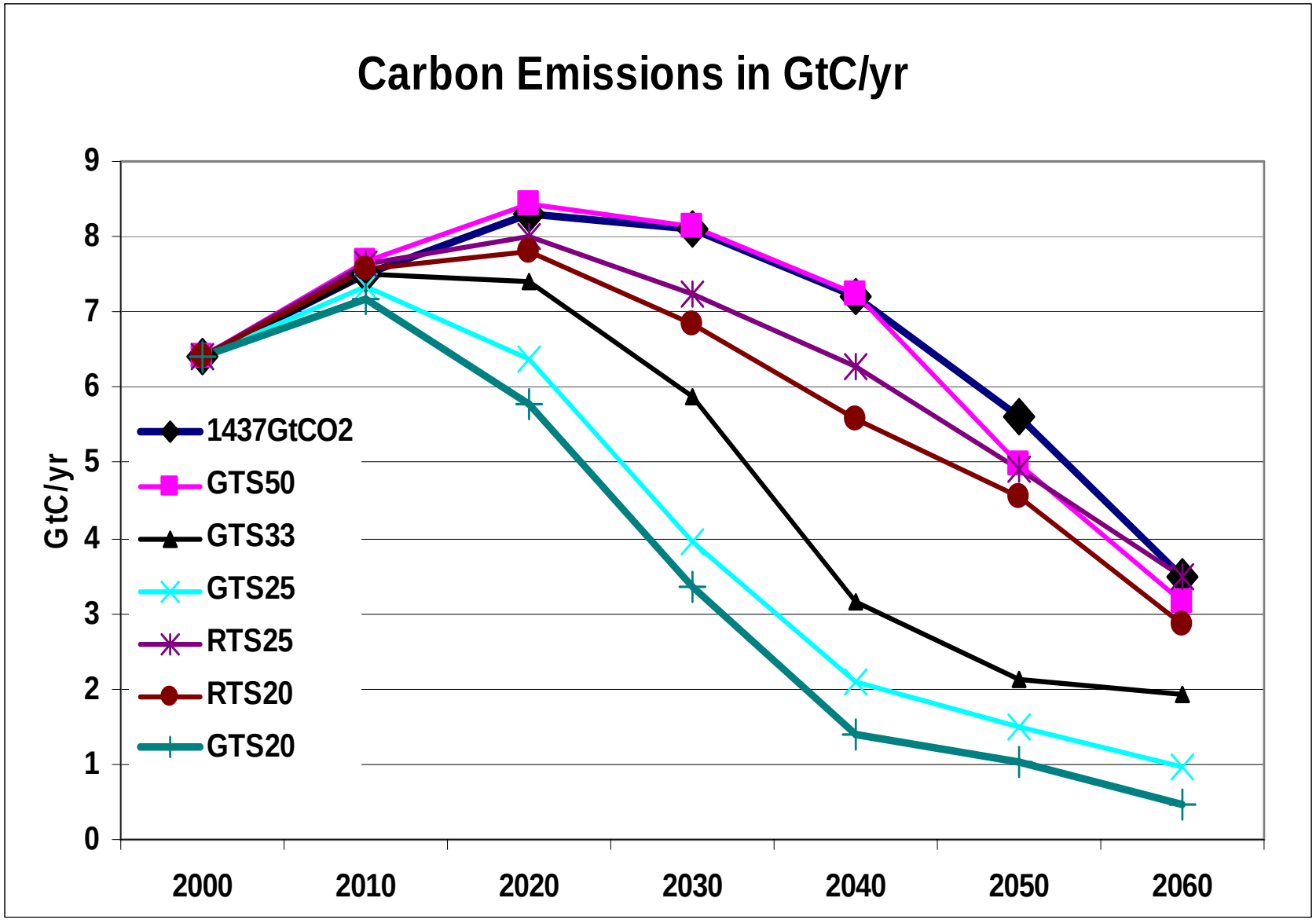
Three TTP case for each cumulative target and each probability range:

C&T preliminary scenarios estimate the global tax level, satisfying the 2°C case with different probabilities associated with cumulative CO2 emissions from 2000-2050 as below …..

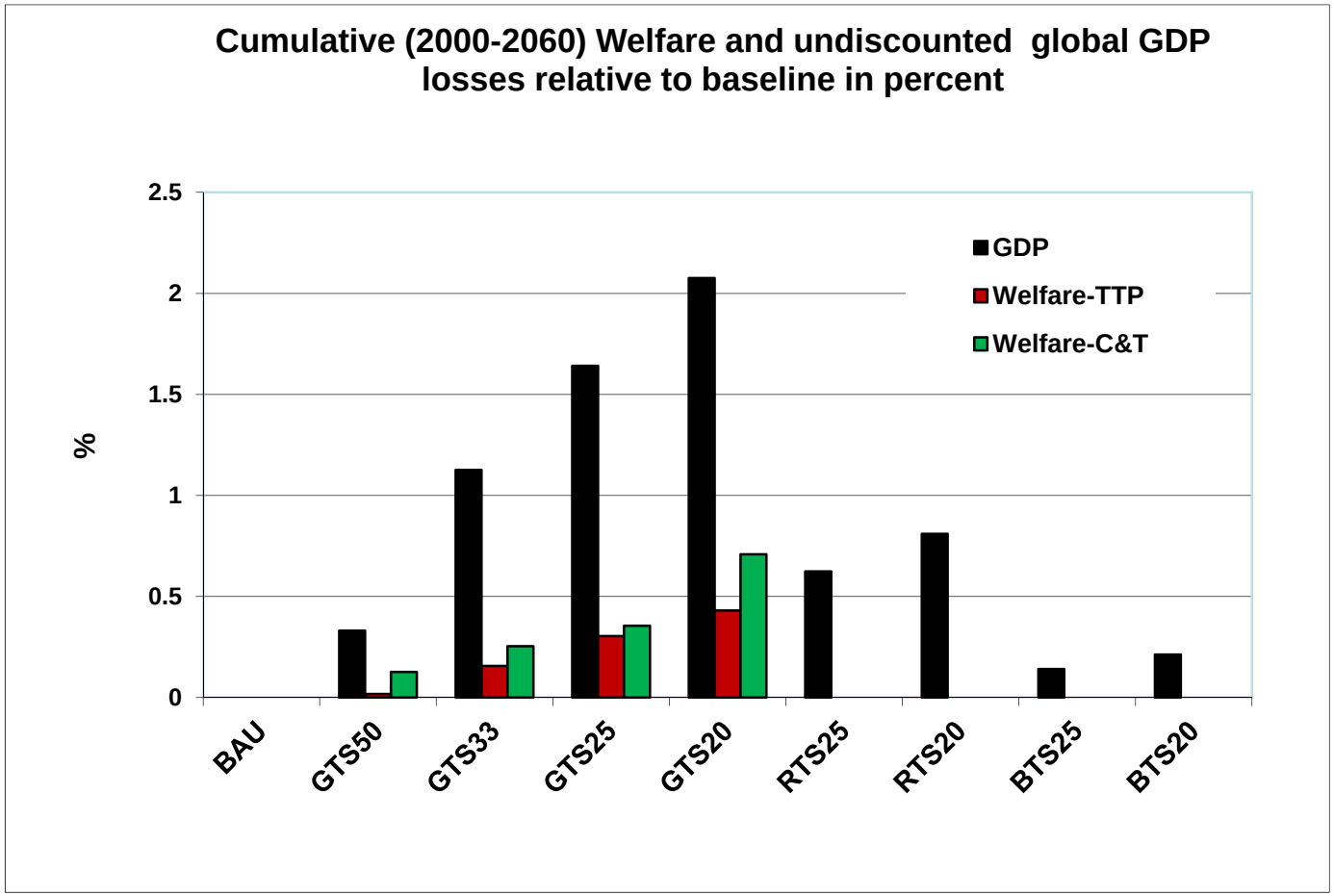
- 890 GtCO2 (20% chances to exceed the 2°C)
- 1000 GtCO2 (25% chances to exceed the 2°C)
- 1160 GtCO2 (33% chances to exceed the 2°C)
- 1440 GtCO2 (50% chances to exceed the 2°C)

- **GTS(XX): Global taxes as in XX cases and transfer of tax revenues to DCs**
- **BTS(XX): Taxes only in North for XX cases and transfer of revenues to DCs**
- **GRS(XX): Taxes for XX cases in North; DCs taxes with 20 years delay; transfer of tax revenues of Northern regions to DCs**

With XX defined as the (20%, 25%, 33%, and 50%) chances to exceed 2°C

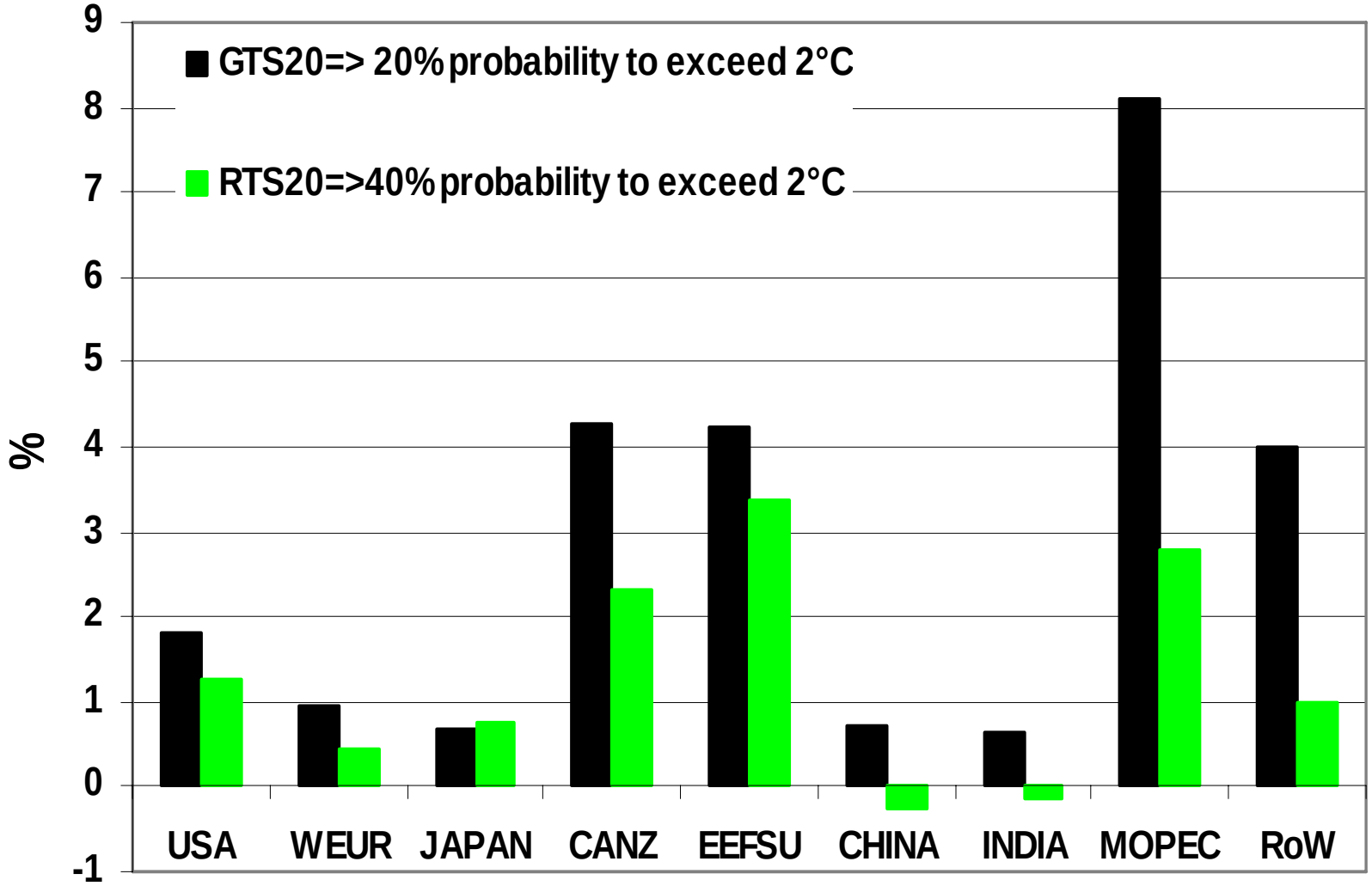


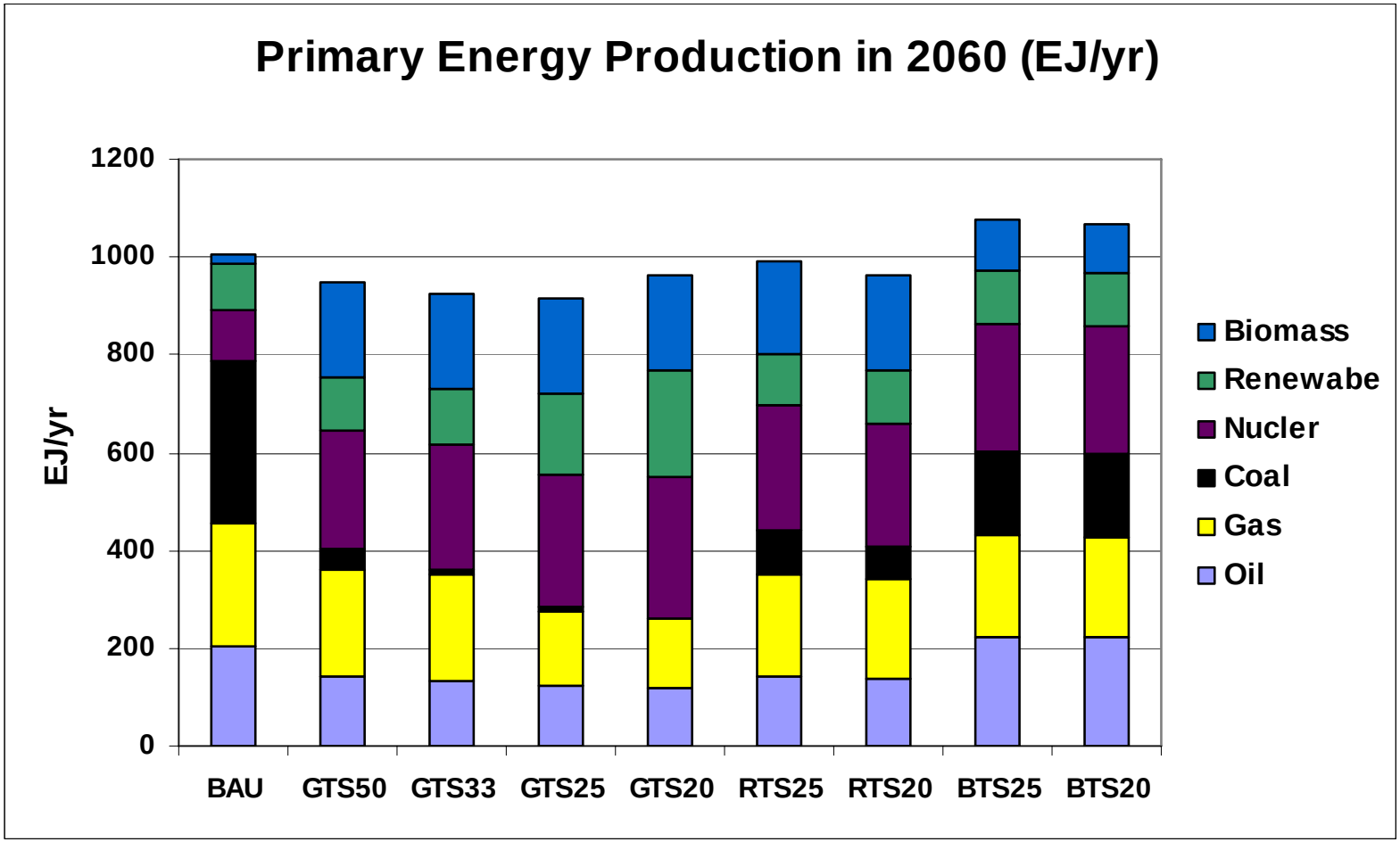
Only in 6 cases emissions remain below the 1440 GtCO2 envelope



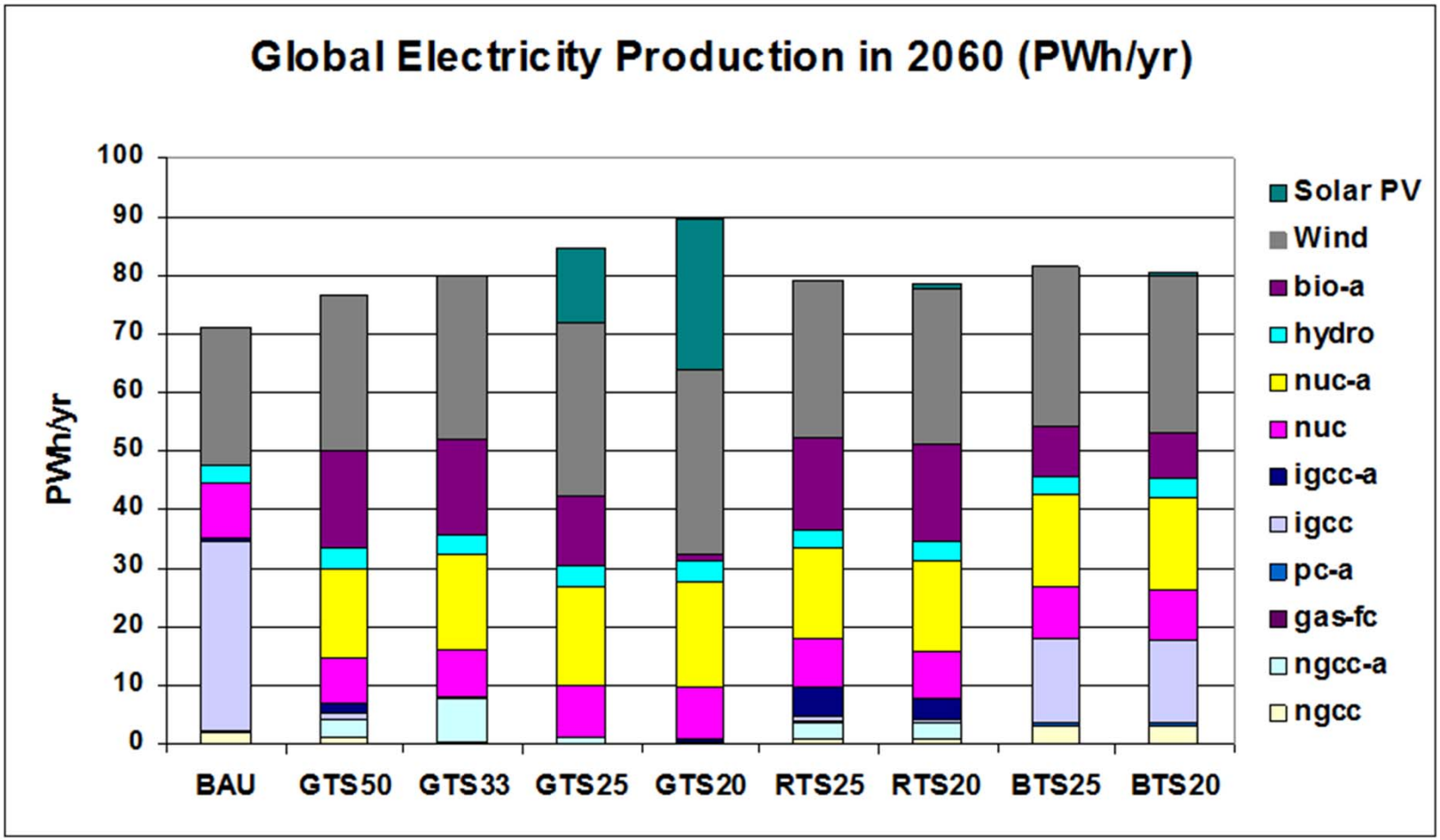
Global undiscounted GDP losses relative to baseline vary between 0.3 % to 2.1% percent depending on the probability to achieve the sustainability target of 2° C while welfare losses are lower than the corresponding losses under the preliminary C&T mitigation policies.

Cumulative undiscounted regional GDP losses for the GTS20 and the RTS20 case relative to BaU





Primary energy supply for all cases that remain below 2 °C warming for different probabilities, versus the baseline and the BTS20 and BTS25. The stringent the carbon control policy the higher the cost of energy and the lower the energy demands.



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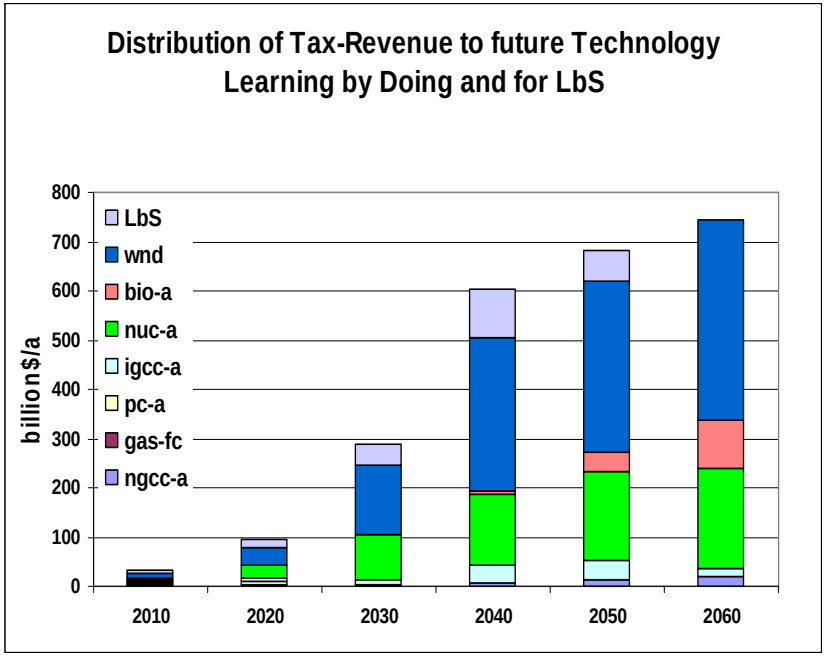
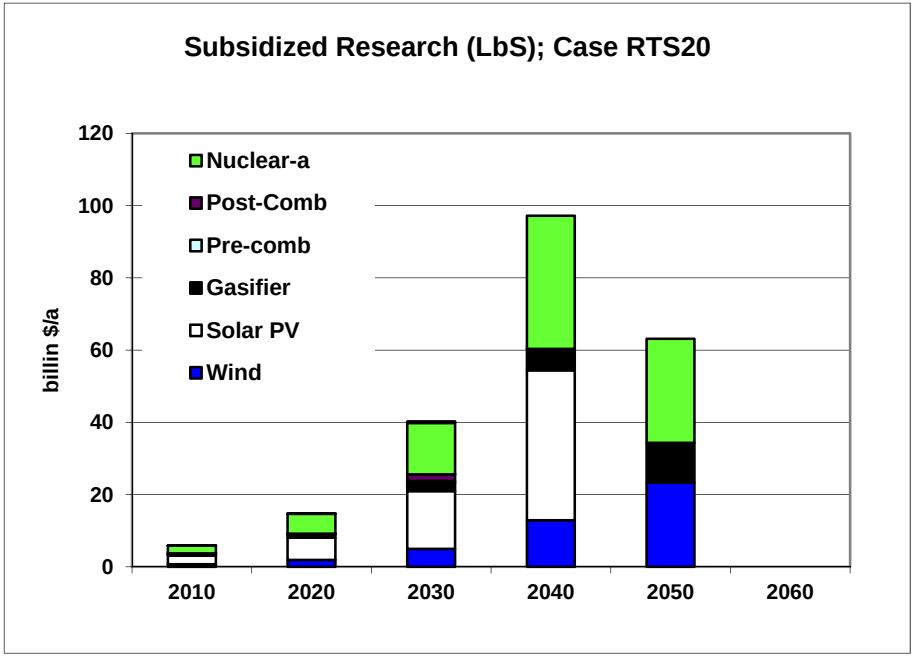
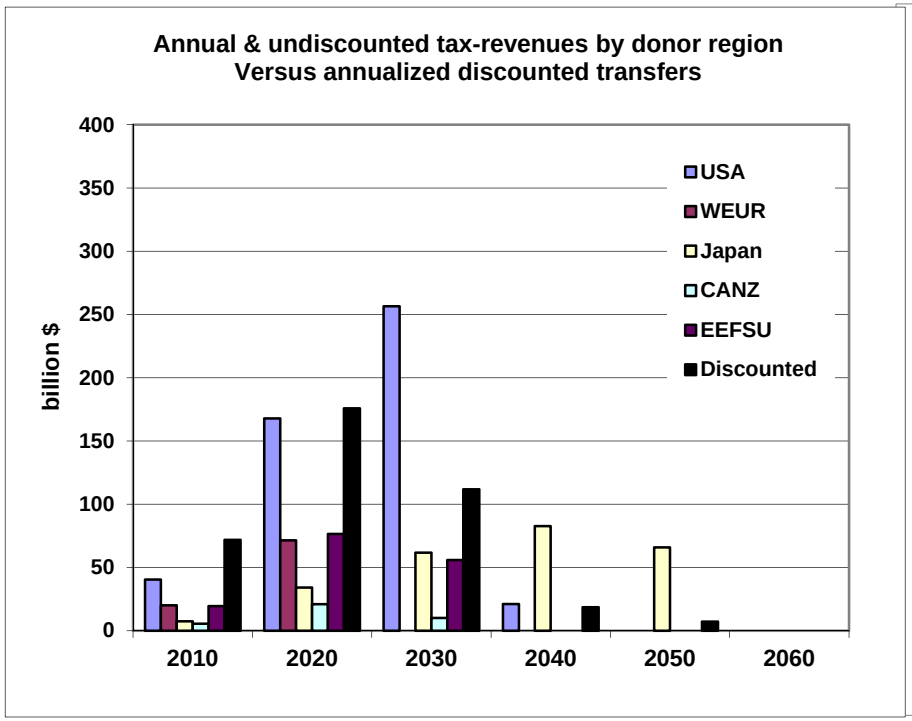
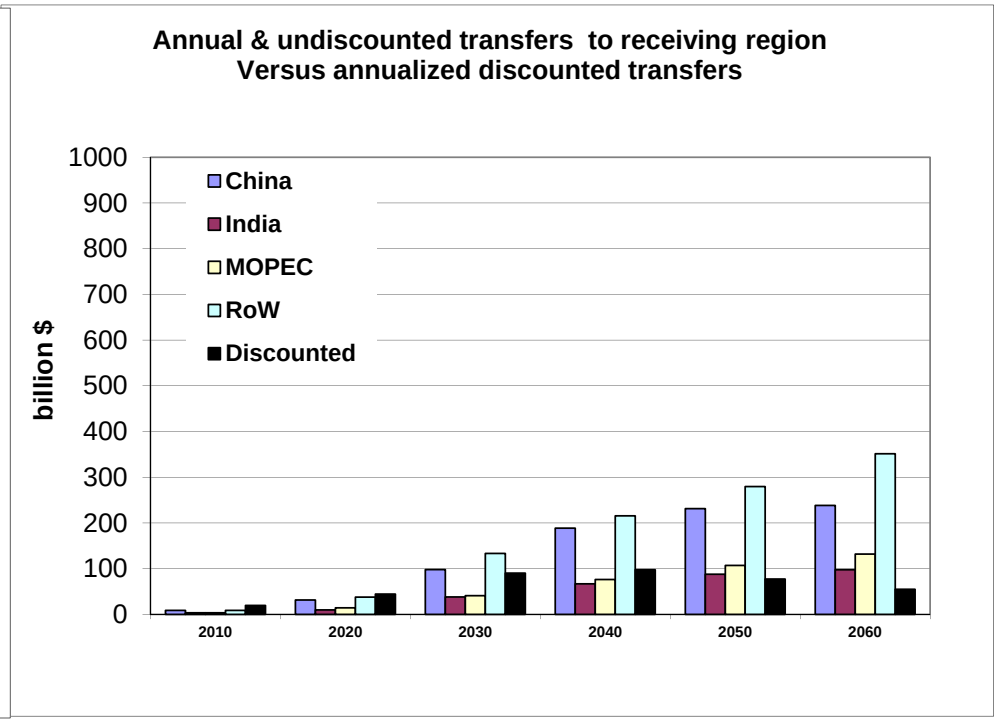
Electricity production for cases with and without subsidy in 2060. Wind and nuclear energy are the back-bones of electricity supply while coal IGCC is the key option in the baseline; wind, nuclear and solar PV becomes the primary technologies under stringent carbon control.





Some technologies like wind, Solar-PV and Gen-IV nuclear and Biomass-advanced profit the most





Annual LbD subsidies by region in DCs (right side) and the carbon tax-revenue of Annex B countries (left side) for the RTS20 case. The figure illustrates also the balance of discounted (5%/year) tax-revenue and LbD and LbS subsidies over time (given in black color).

Conclusions for TTPs

TTPs have positive outcomes in relation to C&T cases and could serve as guidence to reach a compromise in the post-Kyoto negociations

It is shown that without binding commitments for DCs, the warming temperature will be above 2°Celcius with a probability above 50%, even when Annex B countries will eliminate their emissions (i.e., all BTSXX cases are above the cumulative value of 1440 GtC).

In the RTS20 case where taxes are introduced everywhere but with a time shift of 20 years for DCs the probability to exceed the 2°C in less than 50%

Some technologies like wind, SPV and Gen-IV nuclear profit the most.

Inustrialized countries, if participating to TTPs, have good chances to booster exports of advanved low-carbon and carbon-free technology while some DCs have direct economic benefits relative to baseline or less economic losses relative to C&T for the RTS20 case.

Energy exporters (MOPEC, and EEFSU) have cumulative GDP losses relative to baseline of around 3% for the RTS20 case as prices and quantities of energy exports are low.

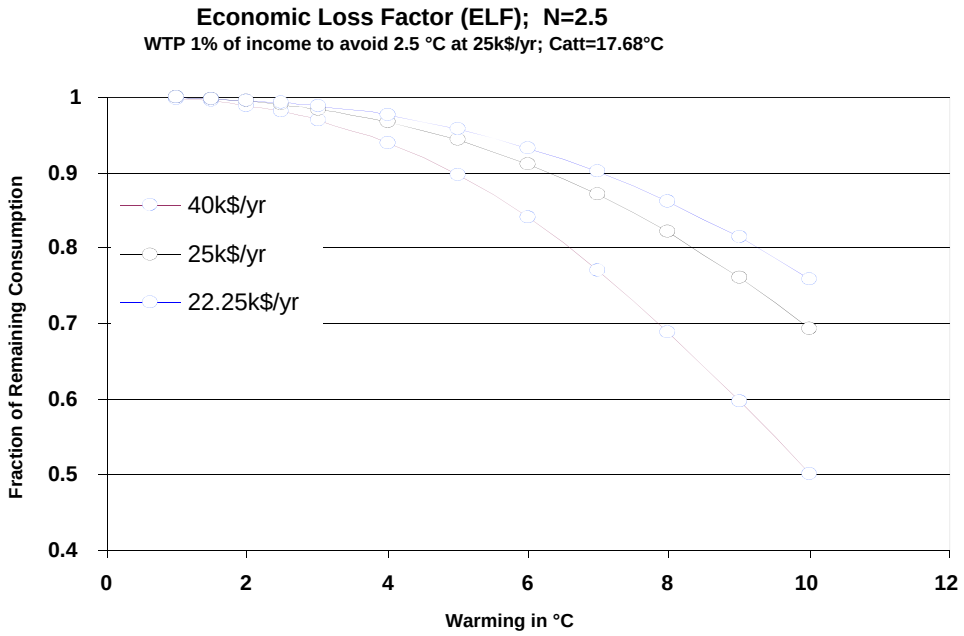
Thanks for your attention

The cost of Inaction and Cost/Benefit Analysis

MERGE maximizes the sum of Negishi-weighted regional welfares and is Pareto optimal

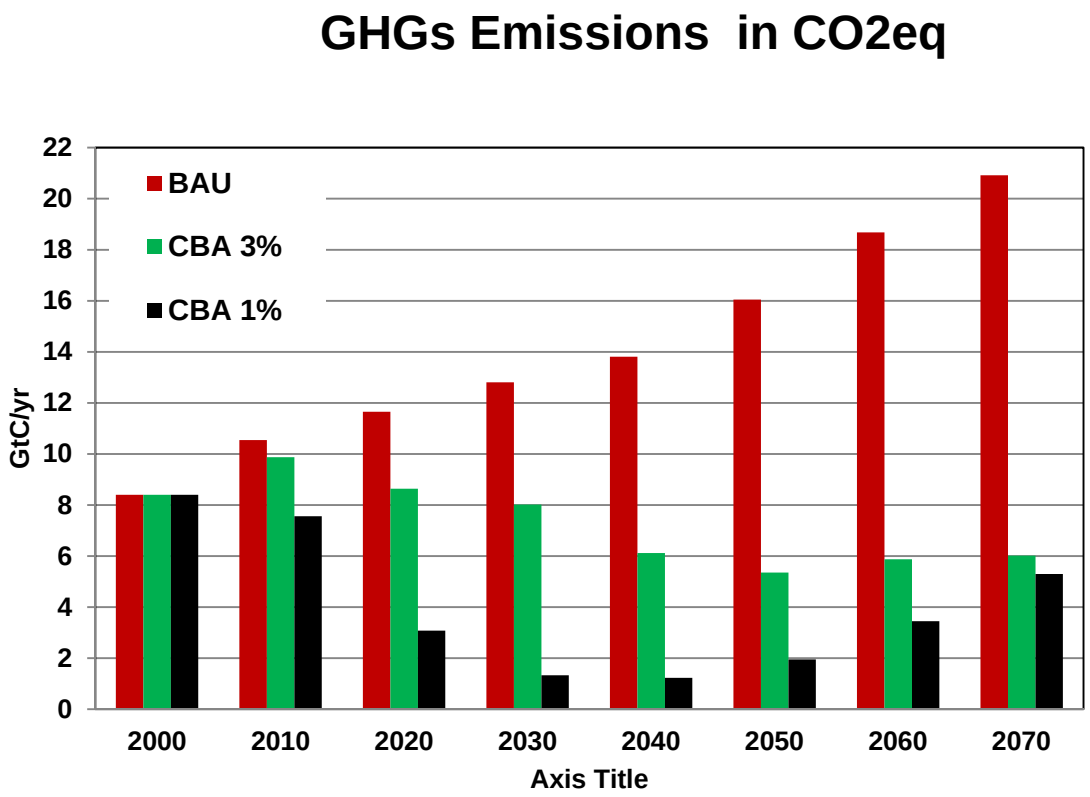
$$Maximize \quad GW = \sum_r nw_r \cdot \sum_t \log(C_{r,t} \cdot ELF_{r,t}) \cdot \exp^{-\delta t}$$

$$ELF(\Delta T) = \left[1 - \left(\Delta T / catt\right)^N\right]^{hsx}$$



The Economic Loss Factor as a function of warming and income calibrated as indicated. At high incomes and temperature change the factor becomes 50% and higher.

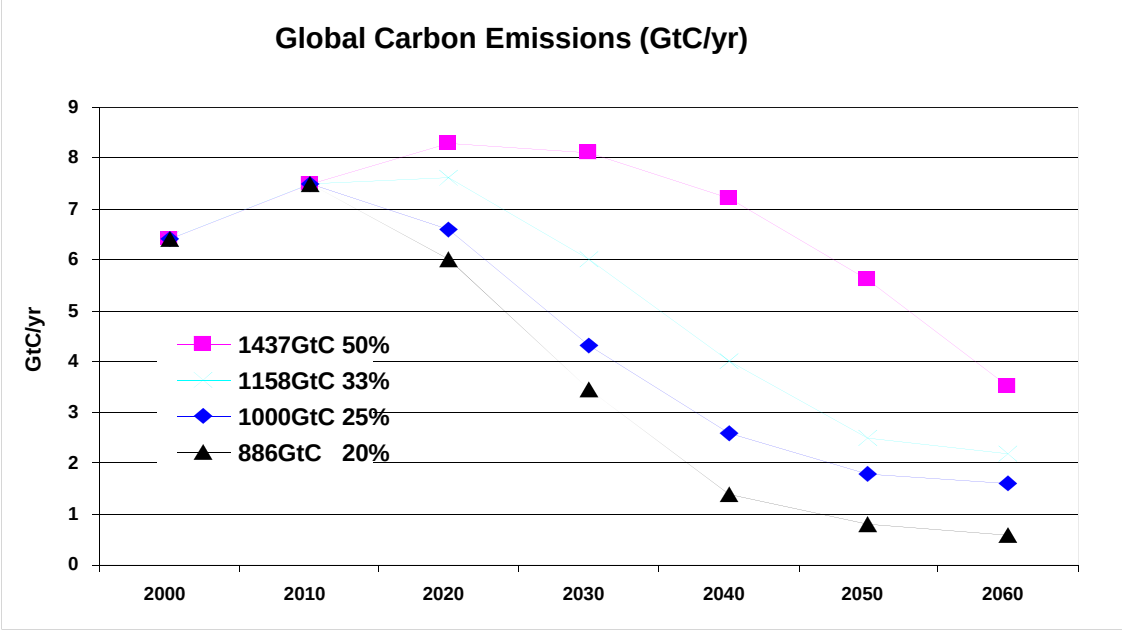
The cost of Inaction and Importance of Free-Riders



Emissions increase in the second half of the century even for the CBA cases

Taxes as applied in TTPs given in $/tCO2

Scenario	Prob. range	2010	2020	2030	2040	2050
50PC	29-70%	69.0	60.6	45.9	143.9	230.6
33PC	16-51%	58.2	60.4	137.7	372.1	539.8
25PC	10-42%	27.0	93.1	298.2	443.5	700.0
20PC	8-37%	32.1	129.7	316.2	646.6	1045.7



Taxes applied in TTPs are estimated first with preliminary C&T scenarios related to different probabilities ranges of exceeding 2°C (second column) post industrial and the global emissions bounds shown above.

MERGE Model changes for TTPs

The optimization software maximizes the global welfare and is Pareto optimal.

It defines the tax levels such that an exogenous cumulative global reduction of GHG emissions is obtained as well as the timing and distribution of tax revenues to receiving regions and to carbon-free technologies.

The world is divided to donors (R1, i.e., the Annex B regions of the KP) and receiving regions (R2, non-Annex B regions of KP) and two basic constraints apply:

1) Bounds on tax revenue for each donor R1 region and each time period:

The tax revenue of a region (R1) is equal to the technology-transfer CA-fund for receiving regions and the own R&D spending

2) Balance of cumulative subsidies for each receiving R2 region:

The discounted sum of capital transfers of all donor regions to a receiving R2 region, is equal to the discounted subsidies in favor of carbon-free and low-carbon technologies in R2.