



On the Economics of Renewables: Costs, Infrastructure Challenges and Policies

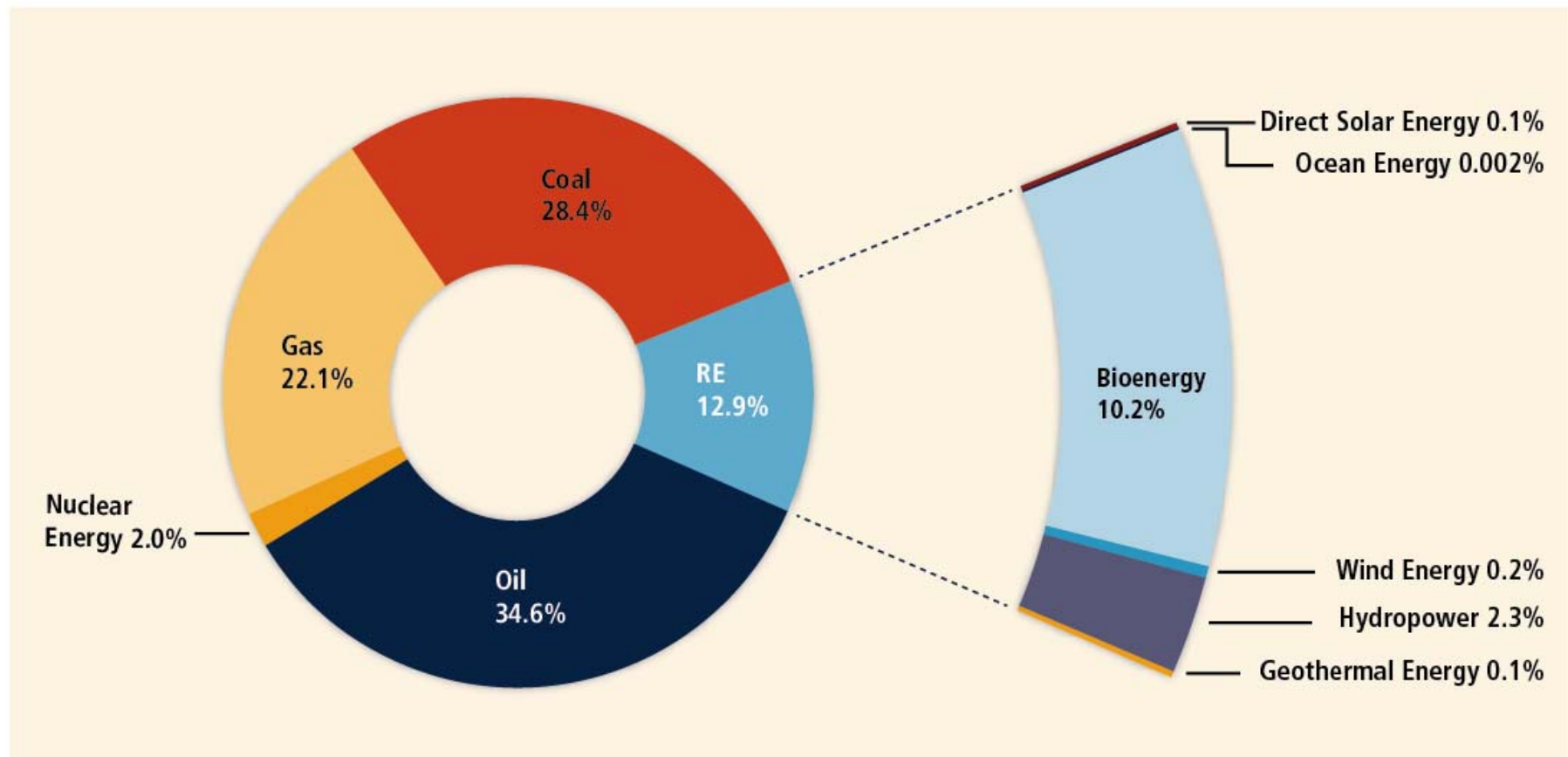
10th Conference on Applied Infrastructure Research – INFRADAY

TU Berlin, 8th October 2011

Prof. Dr. Ottmar Edenhofer

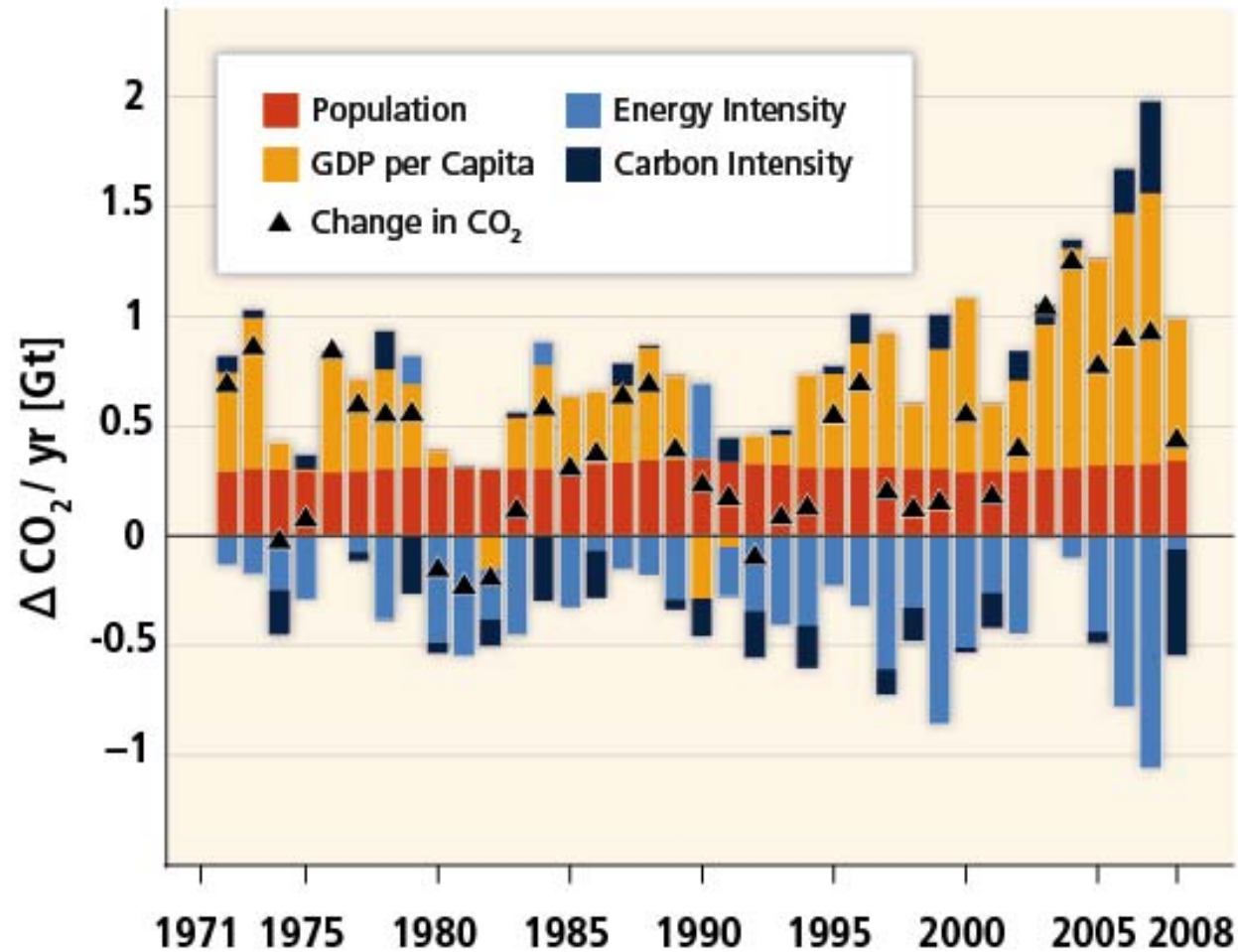


The current global energy system is dominated by fossil fuels.

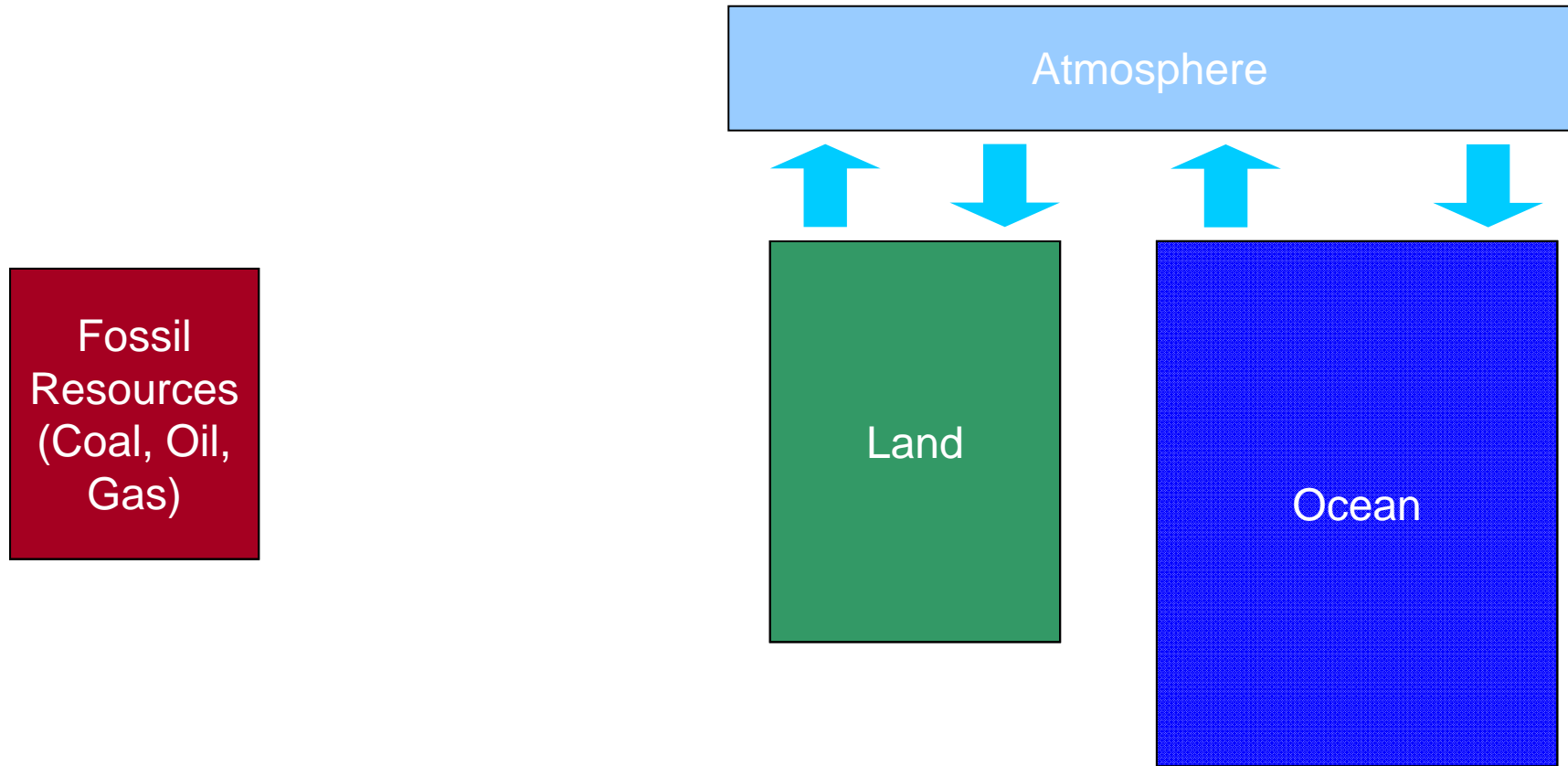


Shares of energy sources in total global primary energy supply in 2008

We are not on track – Renaissance of Coal!



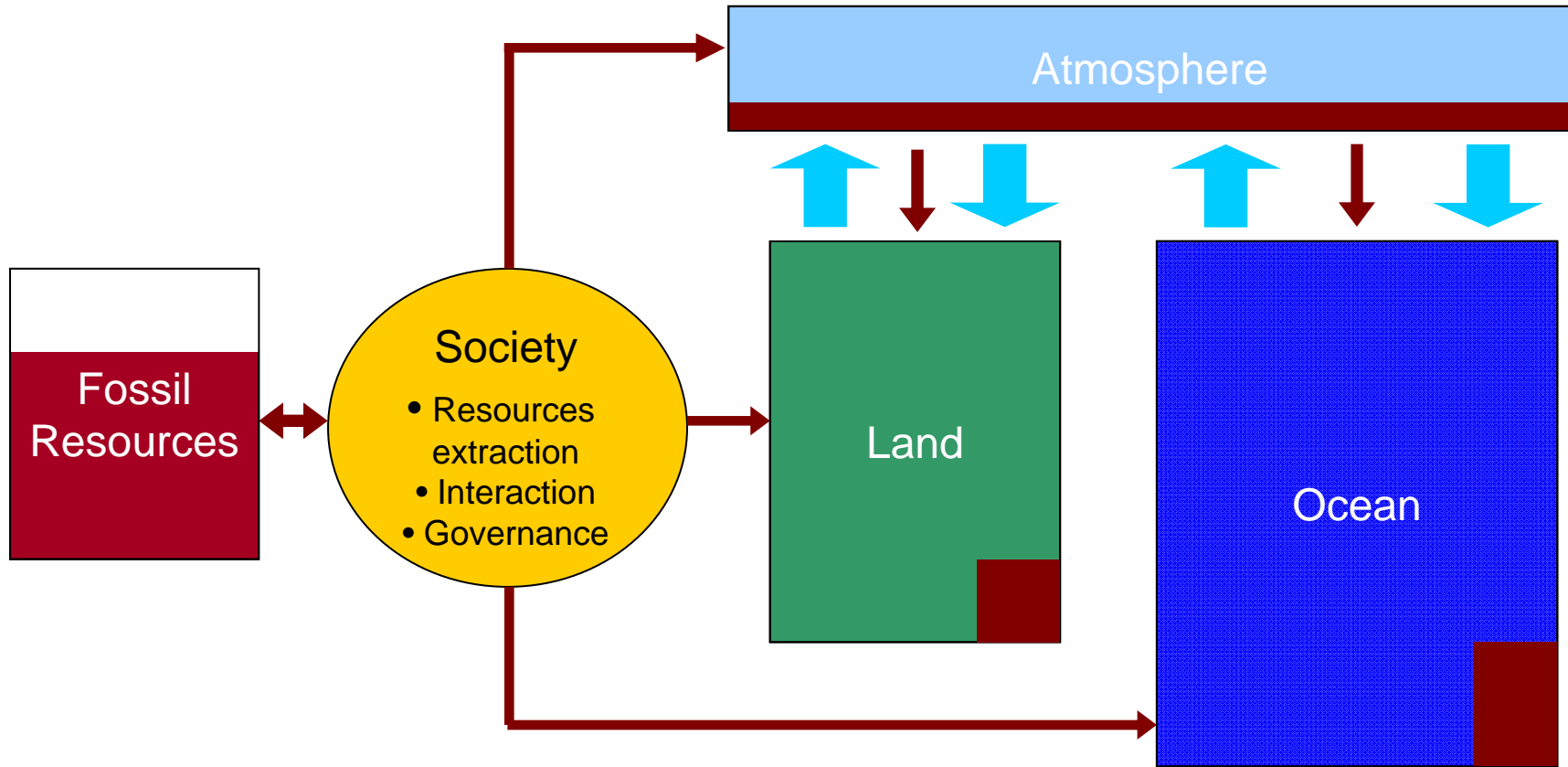
The Preindustrial Earth System – A Sketch



According to Lenton (2011)

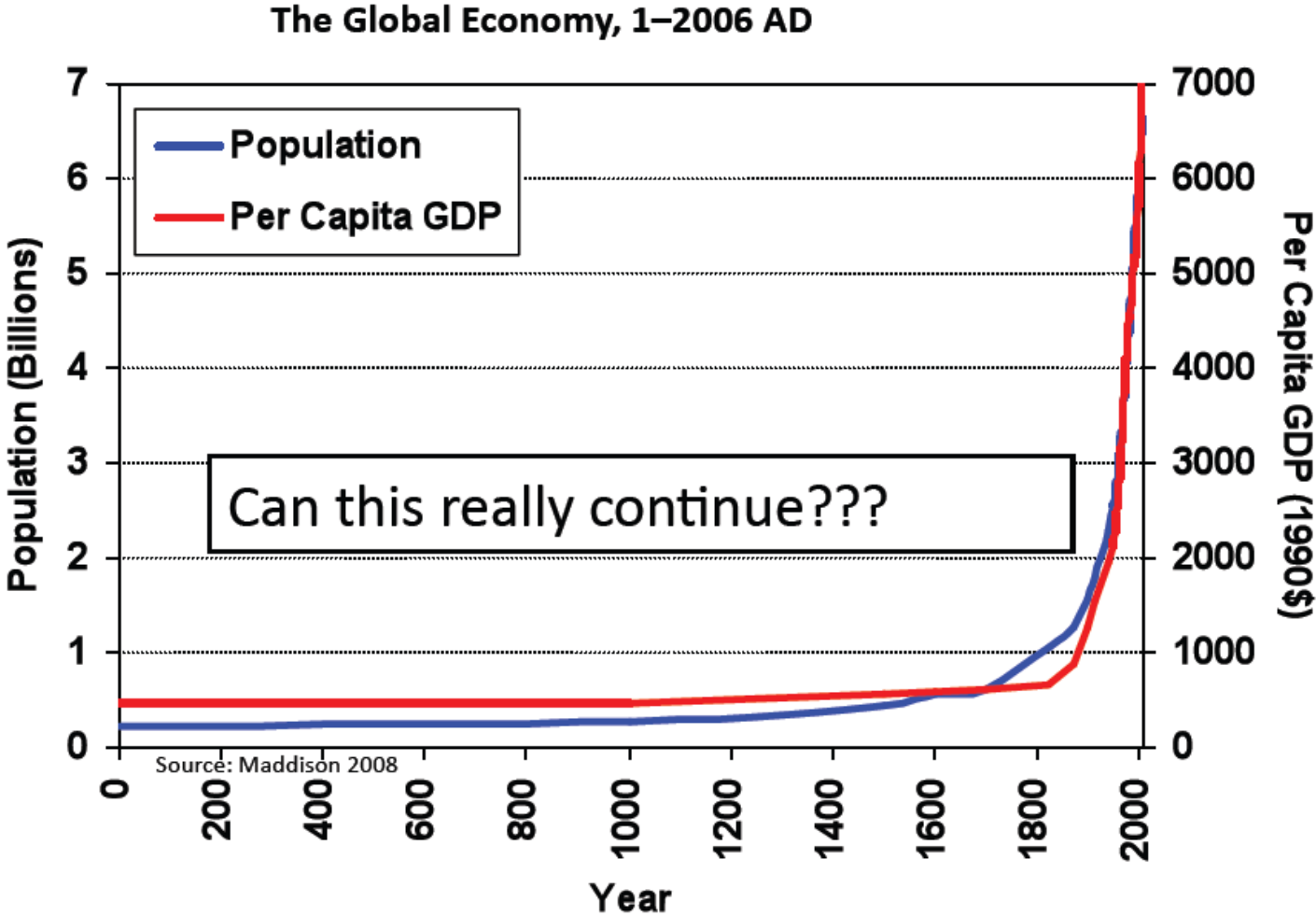
From a Solar to a Fossil Stock Economy

The Earth System of the Anthropocene

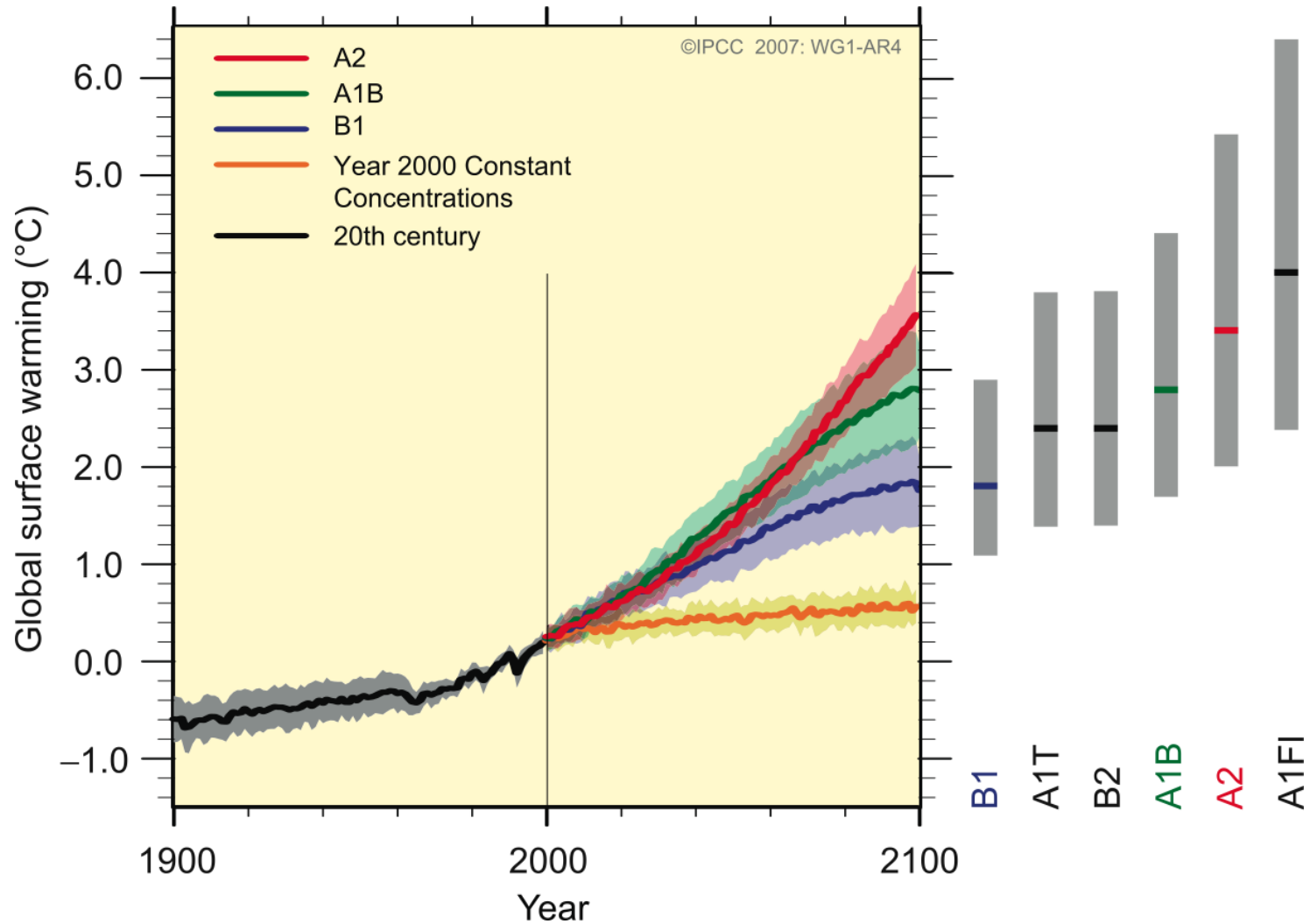


According to Lenton (2011) and Ostrom (2011)

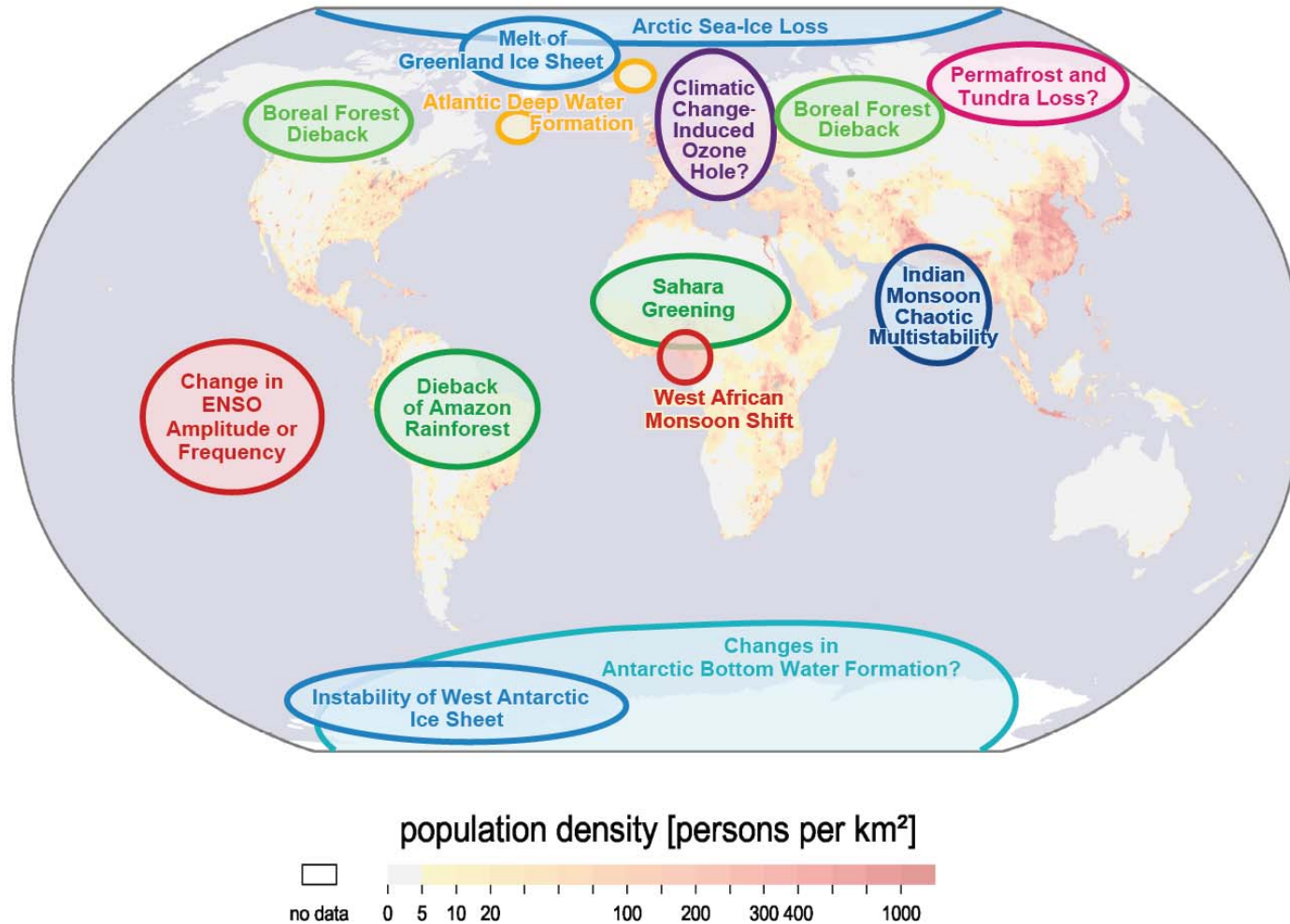
Fossil Resources Stock – A Lottery Prize!



What are the Impacts on Climate?

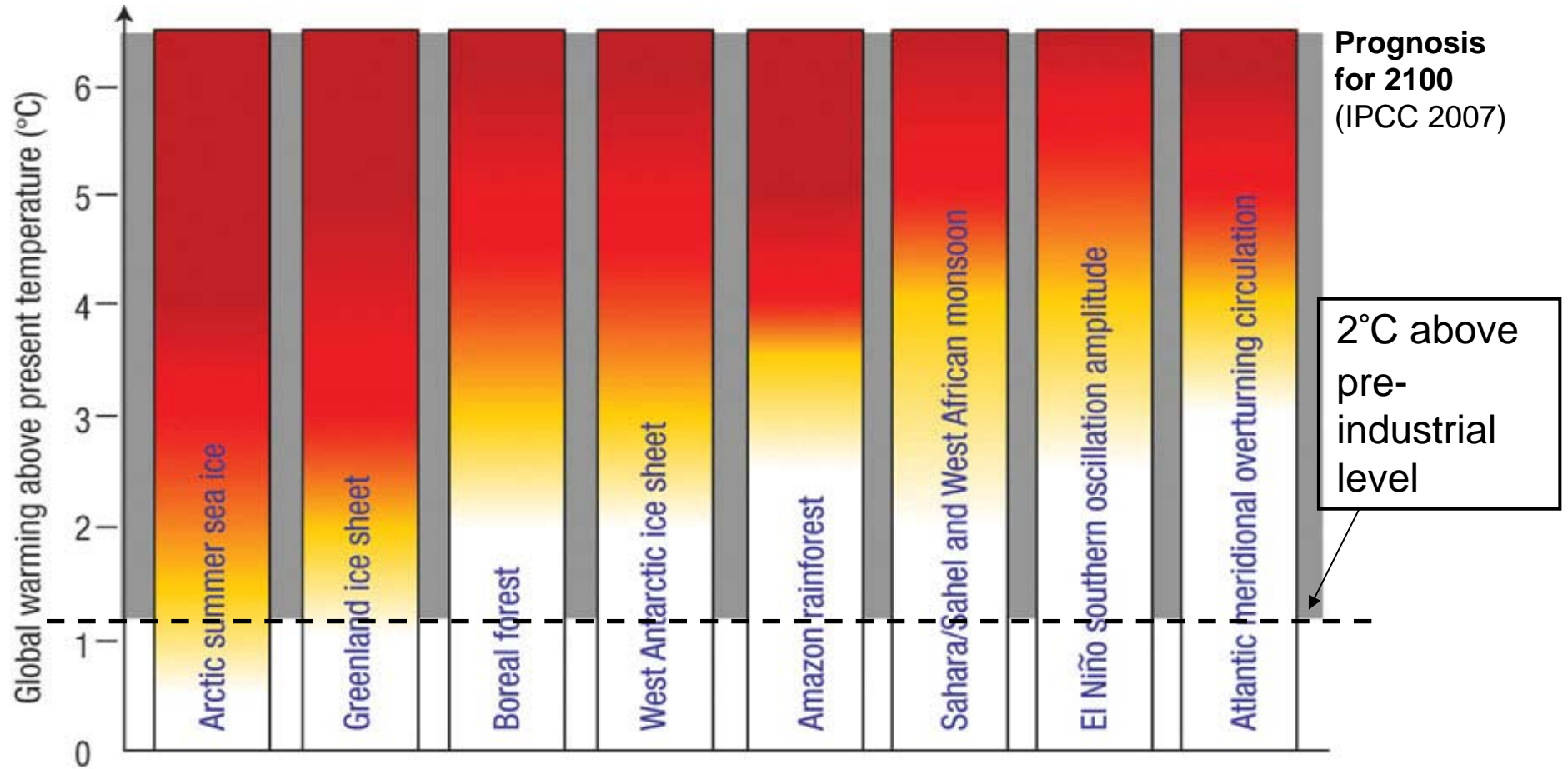


Tipping Points in the Earth System

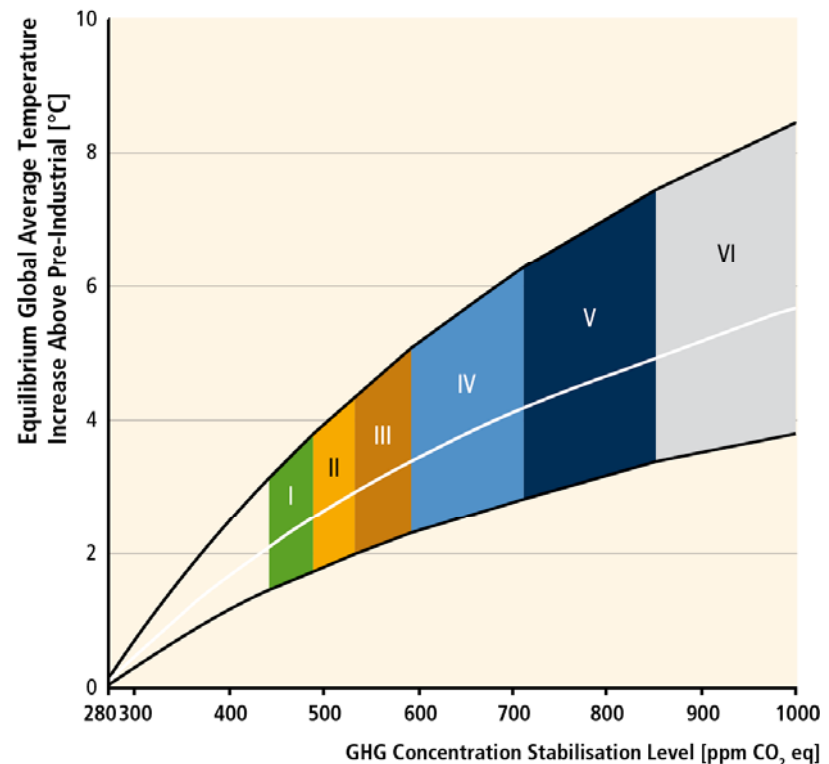
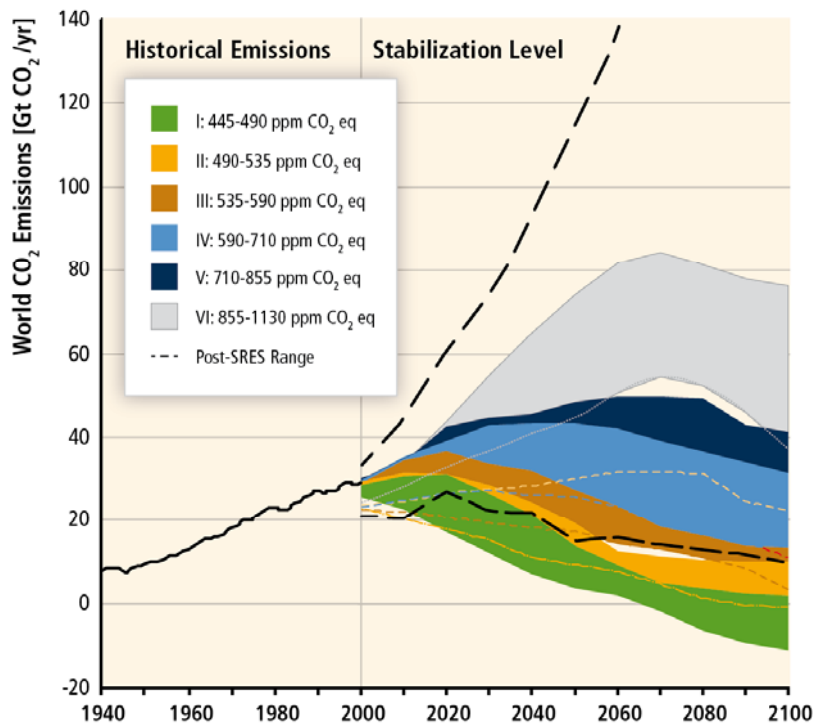


“Tipping processes of the climate system” show a strong reaction already to small climate changes

Burning Embers Diagram

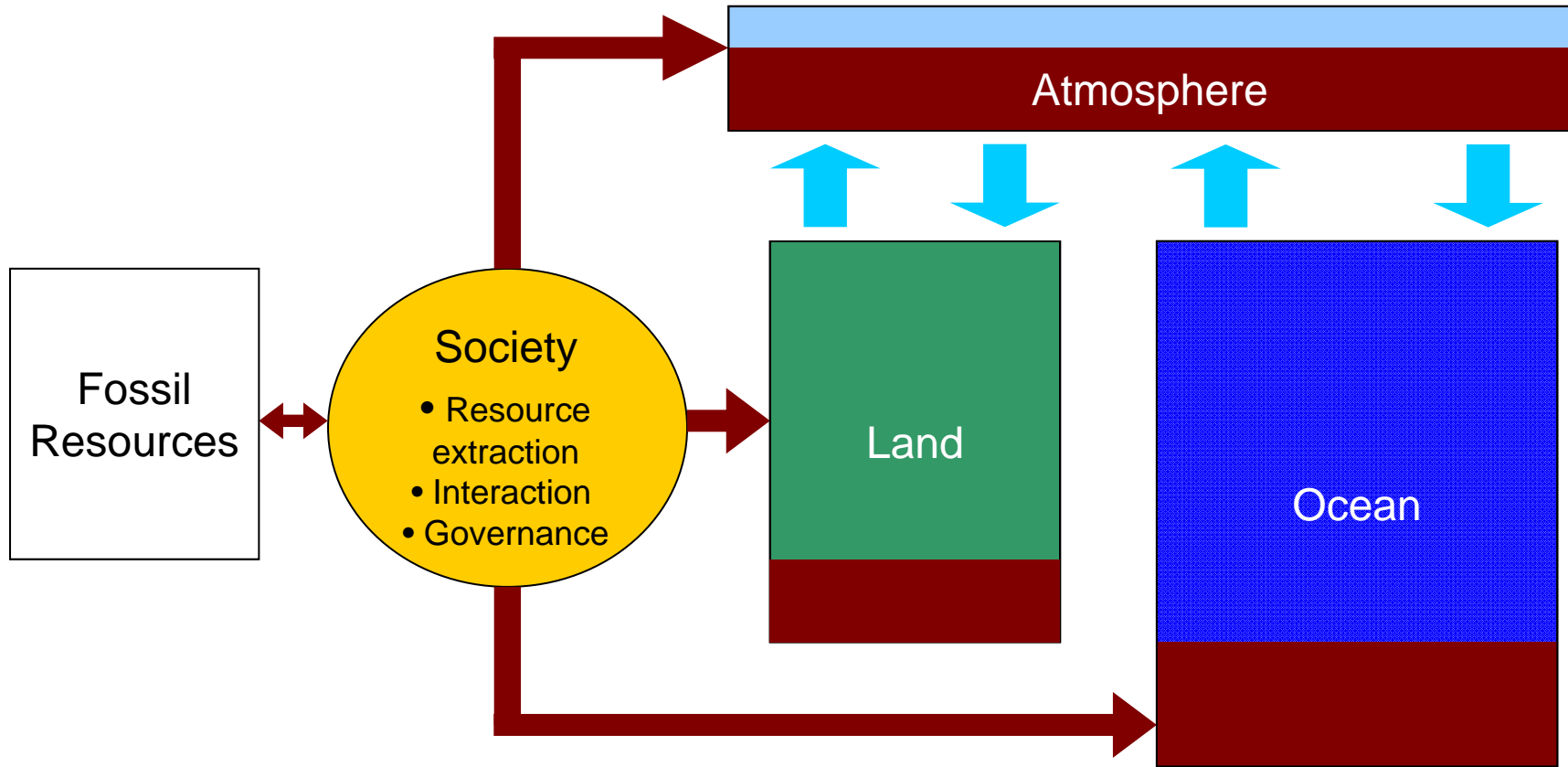


Climate Policy as an Insurance



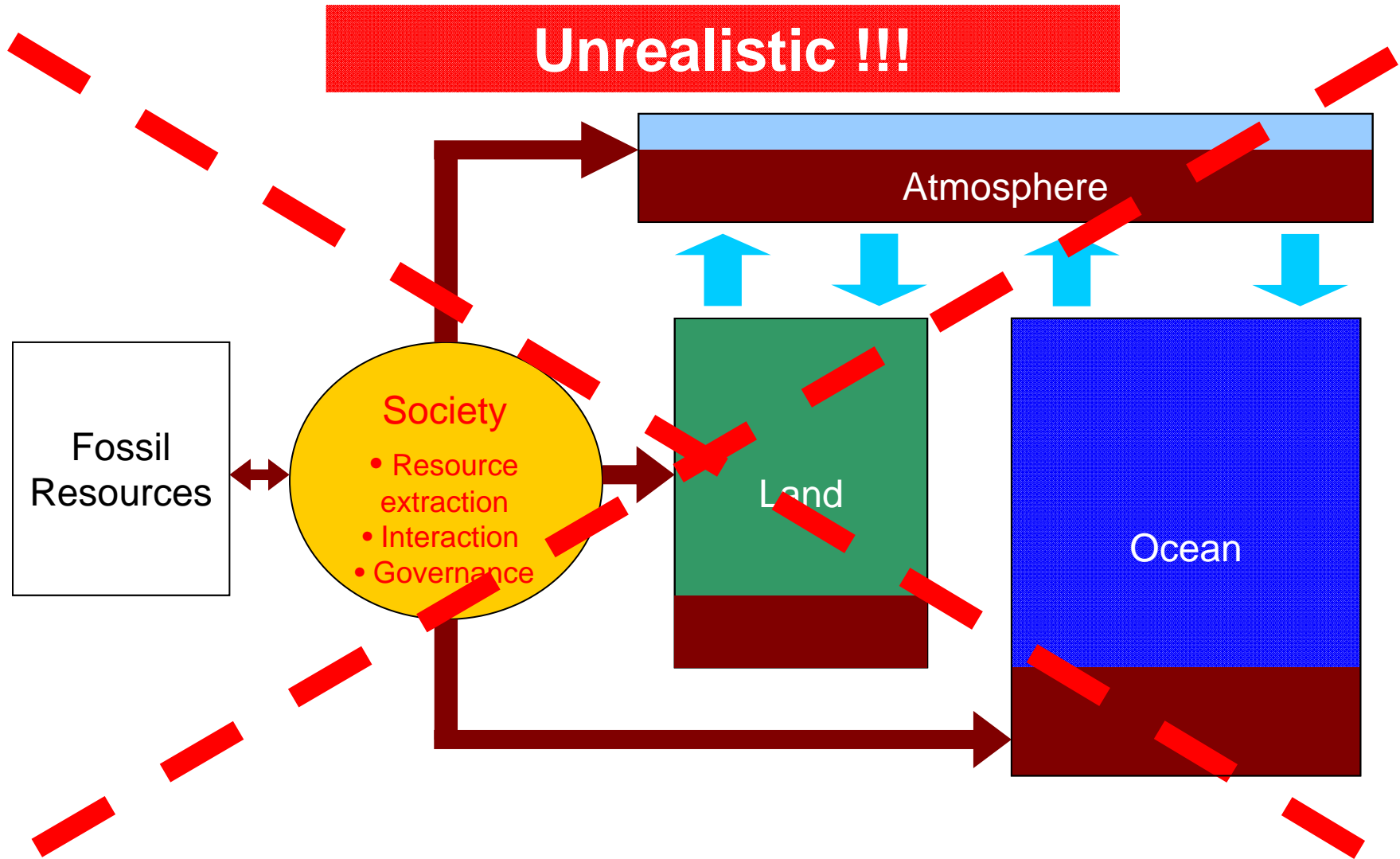
GHG emissions resulting from the provision of energy services contribute significantly to the increase in atmospheric GHG concentrations.

Facing which Future?



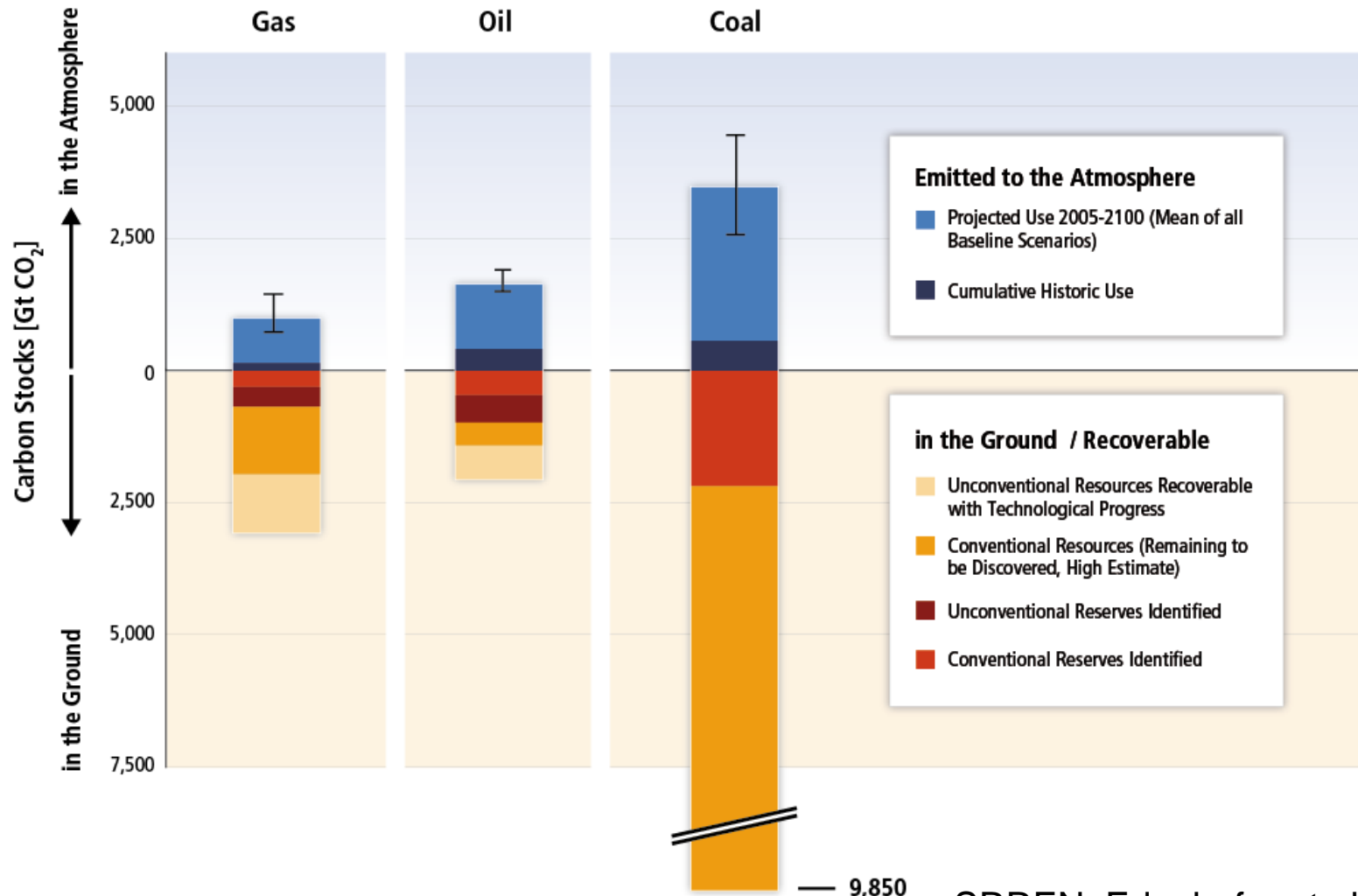
According to Lenton (2011) and Ostrom (2011)

Facing Which future?



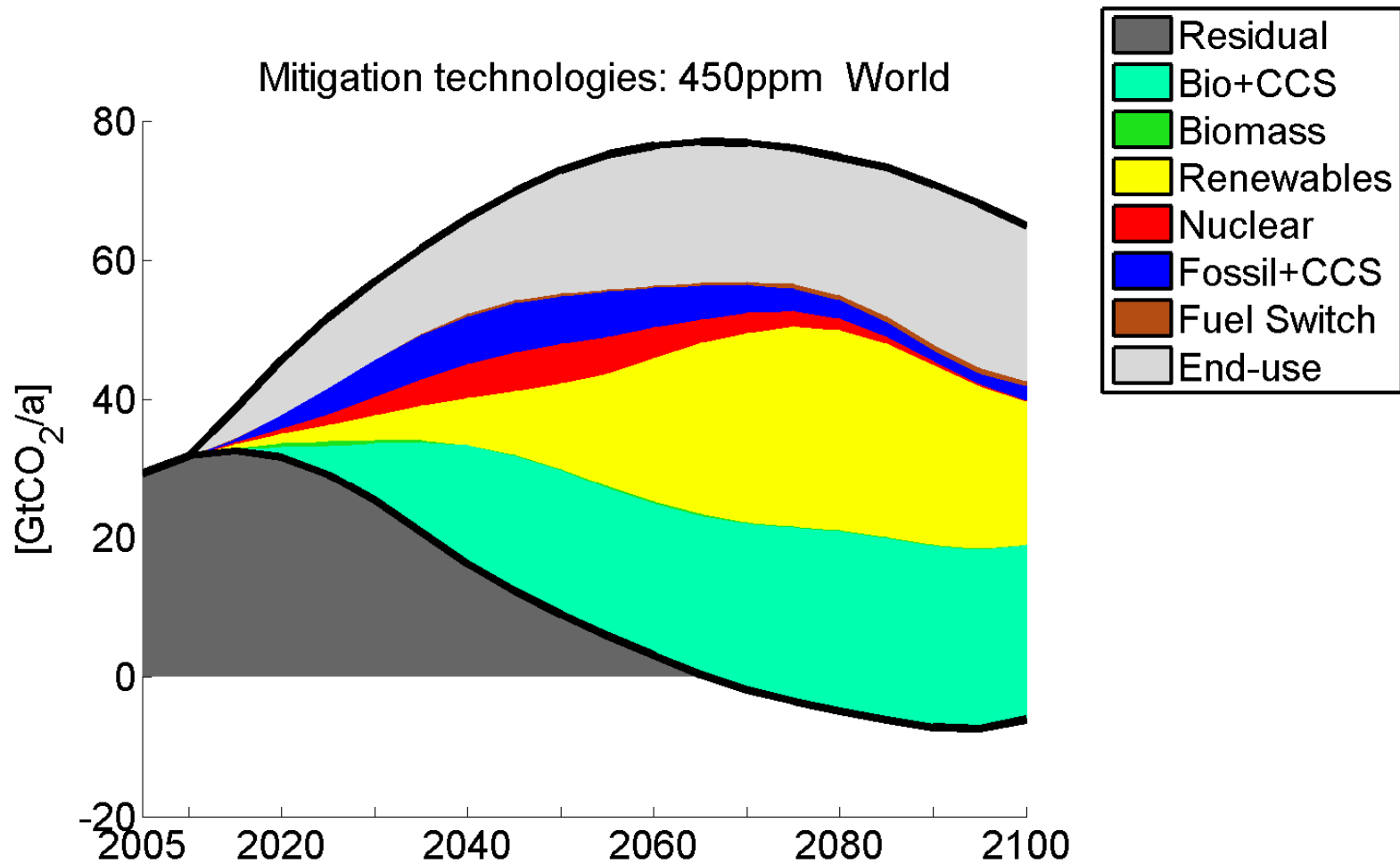
According to Lenton (2011) and Ostrom (2011)

The BAU Scenarios Could Exceed the Level of Greenhouse Gas Concentration of 600ppm (~4°C Temperature Increase)



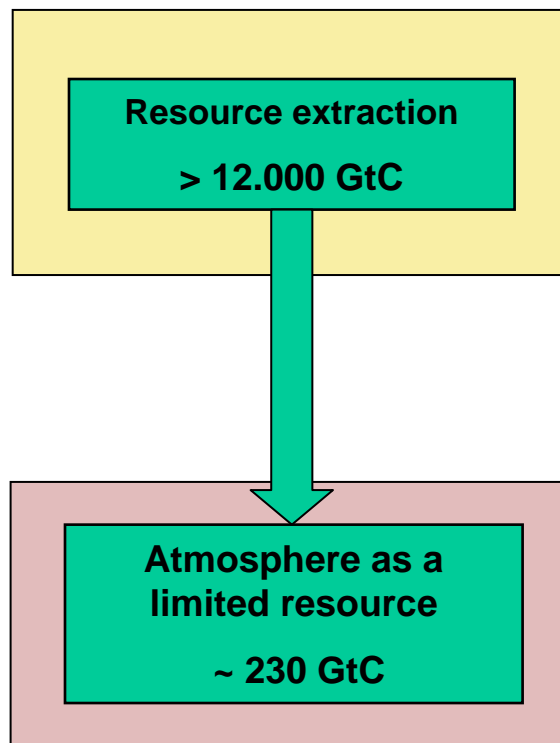
SRREN, Edenhofer et al. (2011)

The Great Transformation

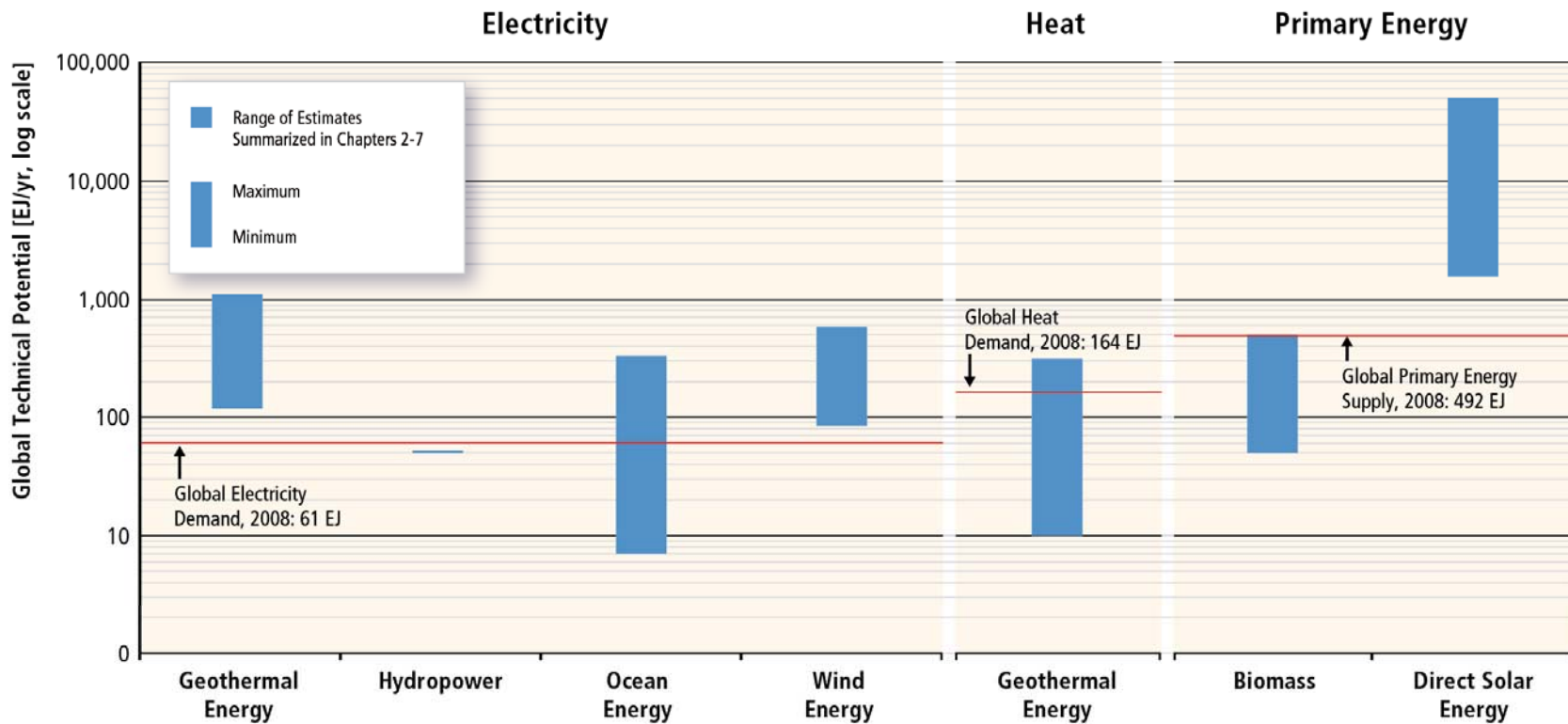


(Luderer et al., 2011)

The Atmosphere as a Global Common



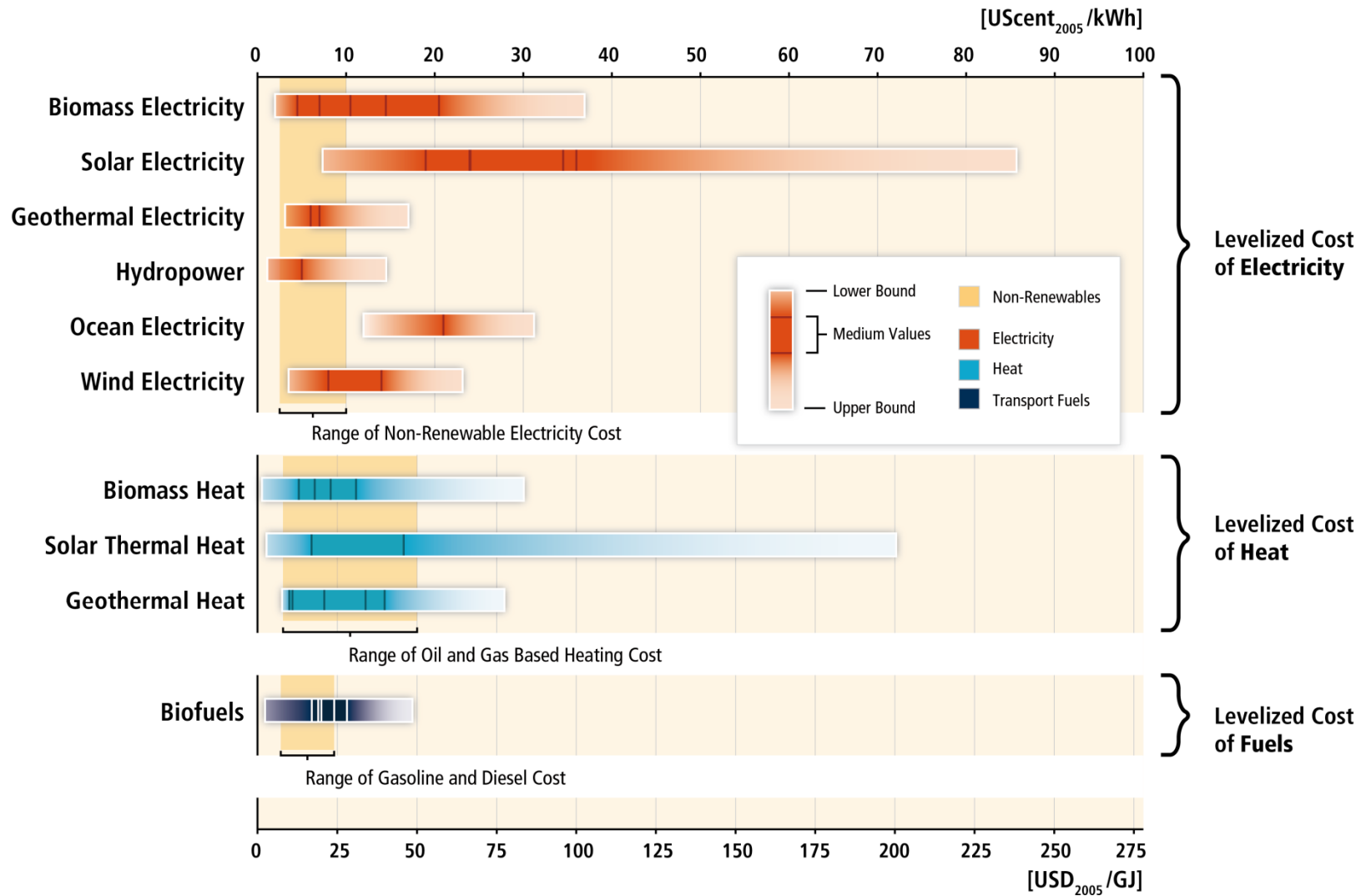
The Technical Potential of Renewable Energies



Range of Estimates of Global Technical Potentials

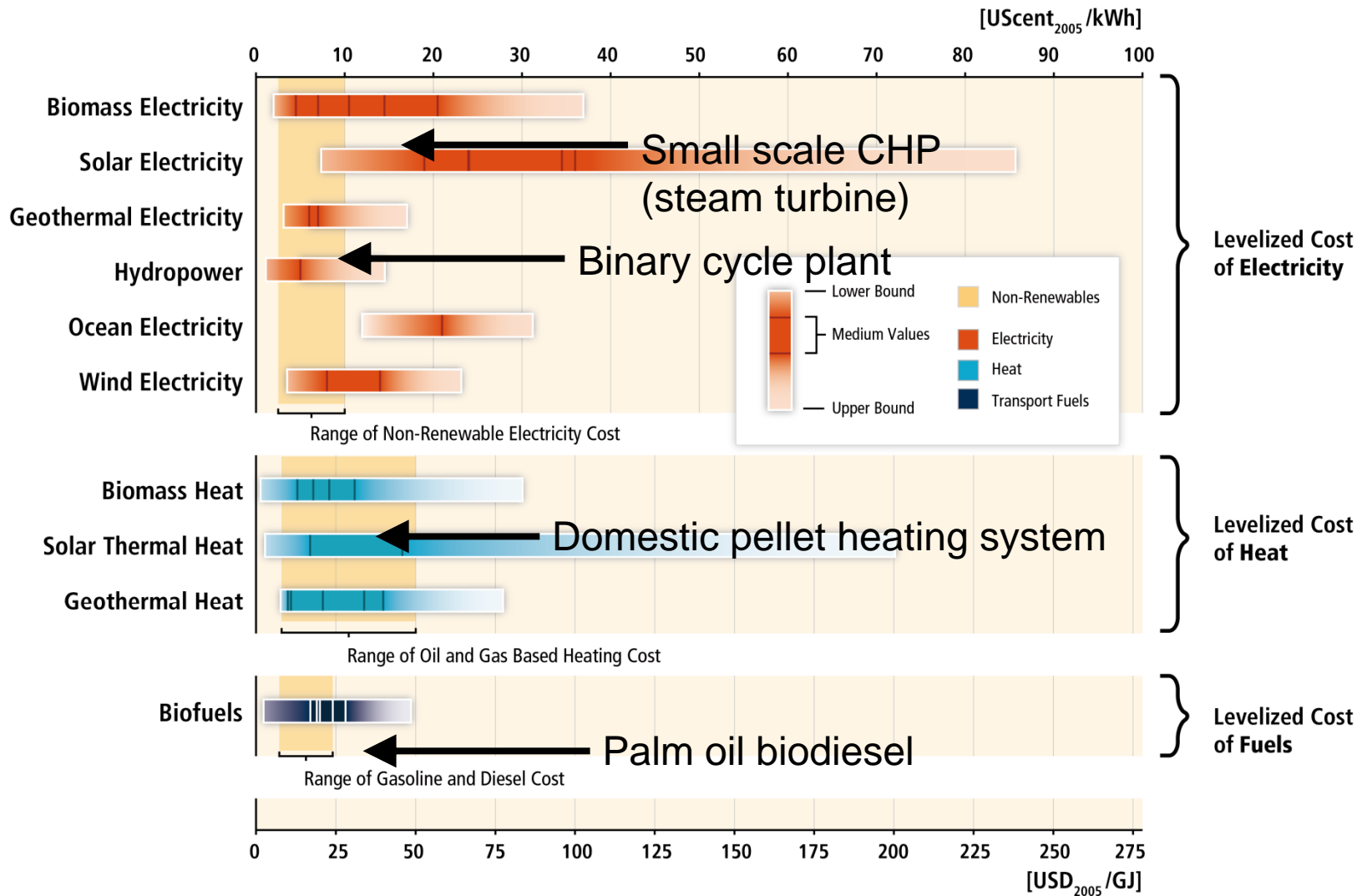
Energy Source	Minimum (EJ/yr)	Maximum (EJ/yr)
Geothermal Energy	118	1109
Hydropower	50	52
Ocean Energy	7	331
Wind Energy	85	580
Geothermal Energy	10	312
Biomass	50	500
Direct Solar Energy	1575	49837

The Costs of Renewables Are Often Still Higher Than Those of Non-Renewables But...

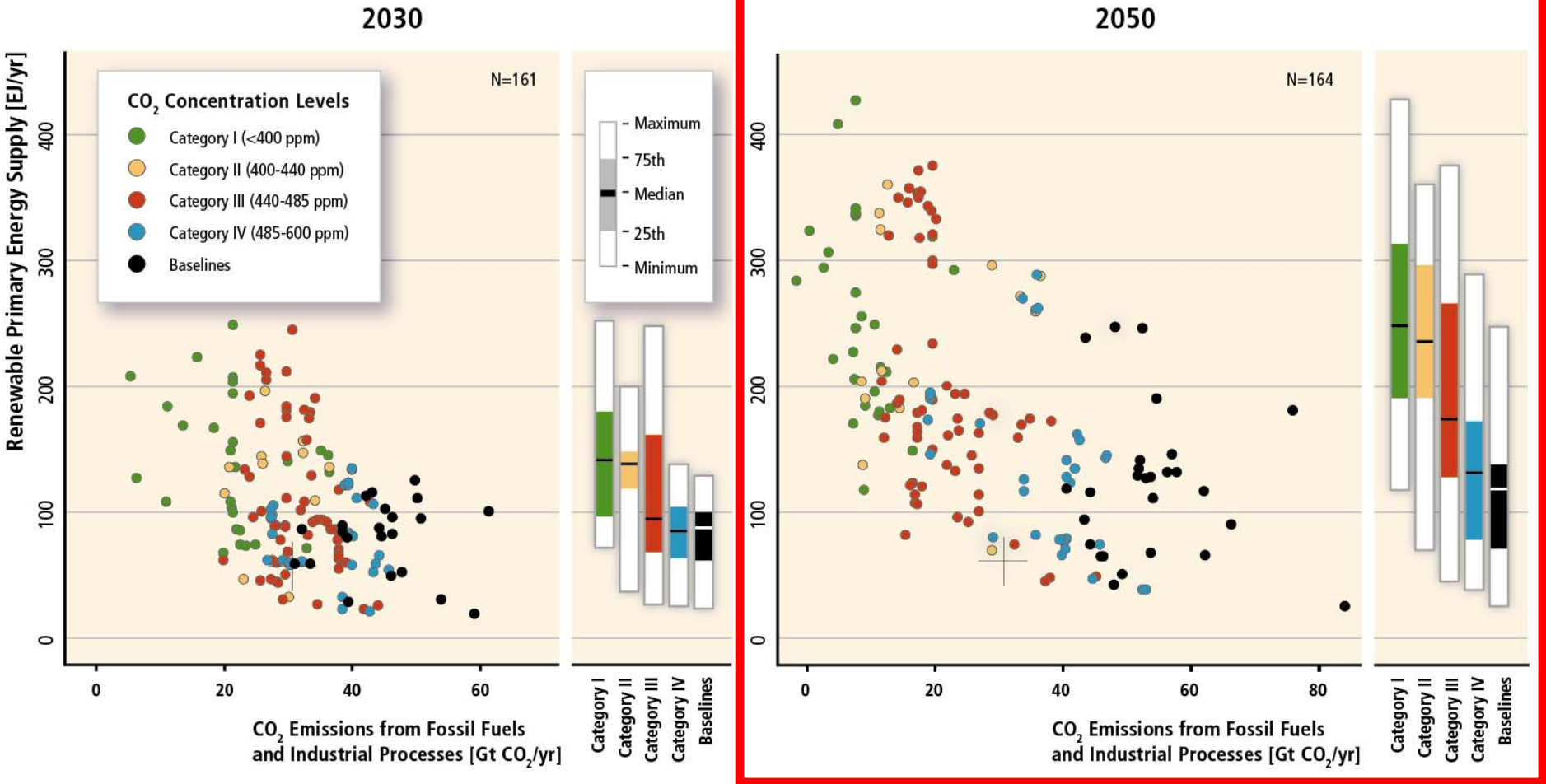


SRREN, Edenhofer et al. (2011)

...Some RE Technologies Are Already Competitive



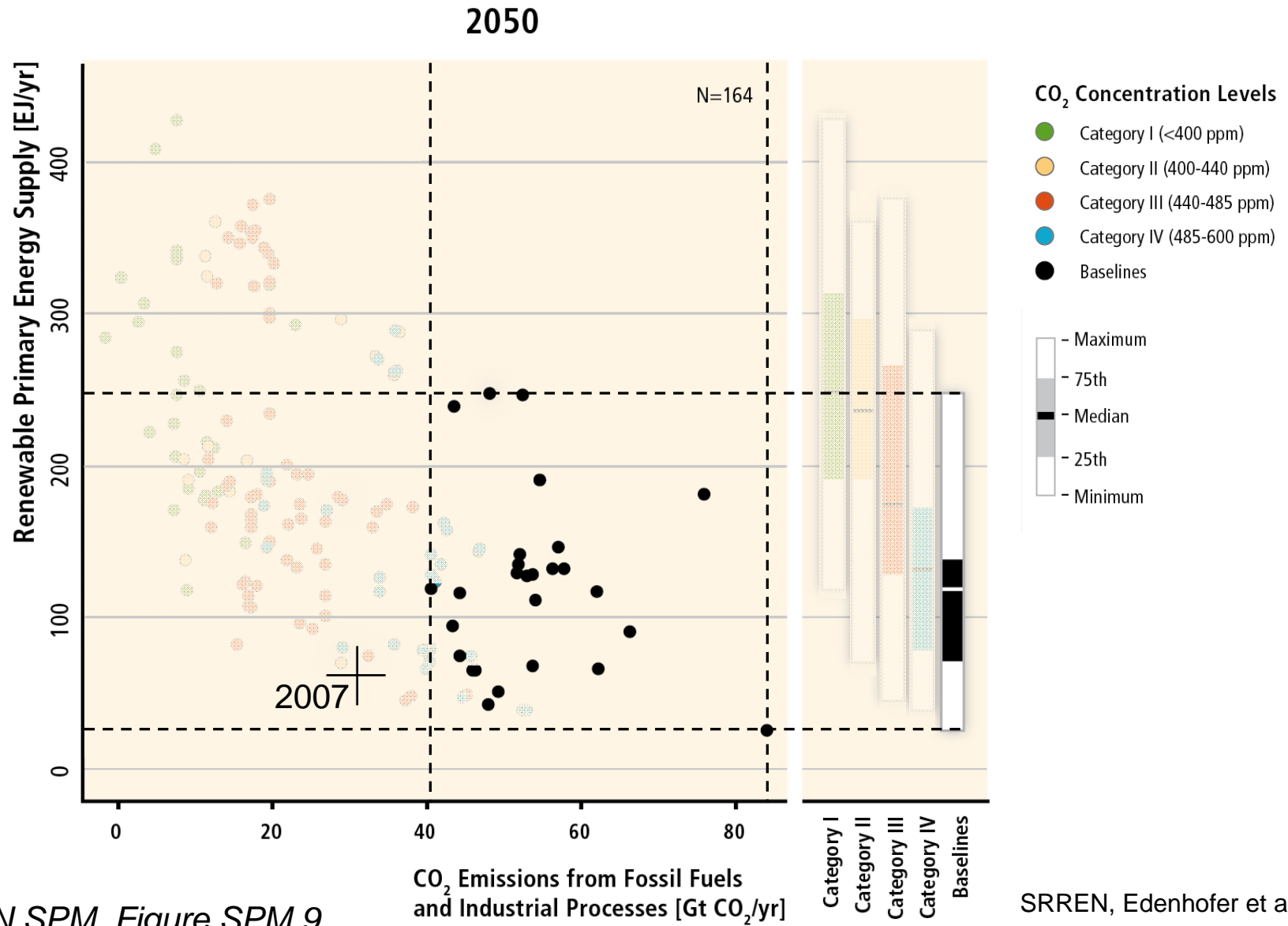
Global RE Primary Energy Supply from 164 Long-Term Scenarios versus Fossil and Industrial CO₂ Emissions



SRREN SPM, Figure SPM.9

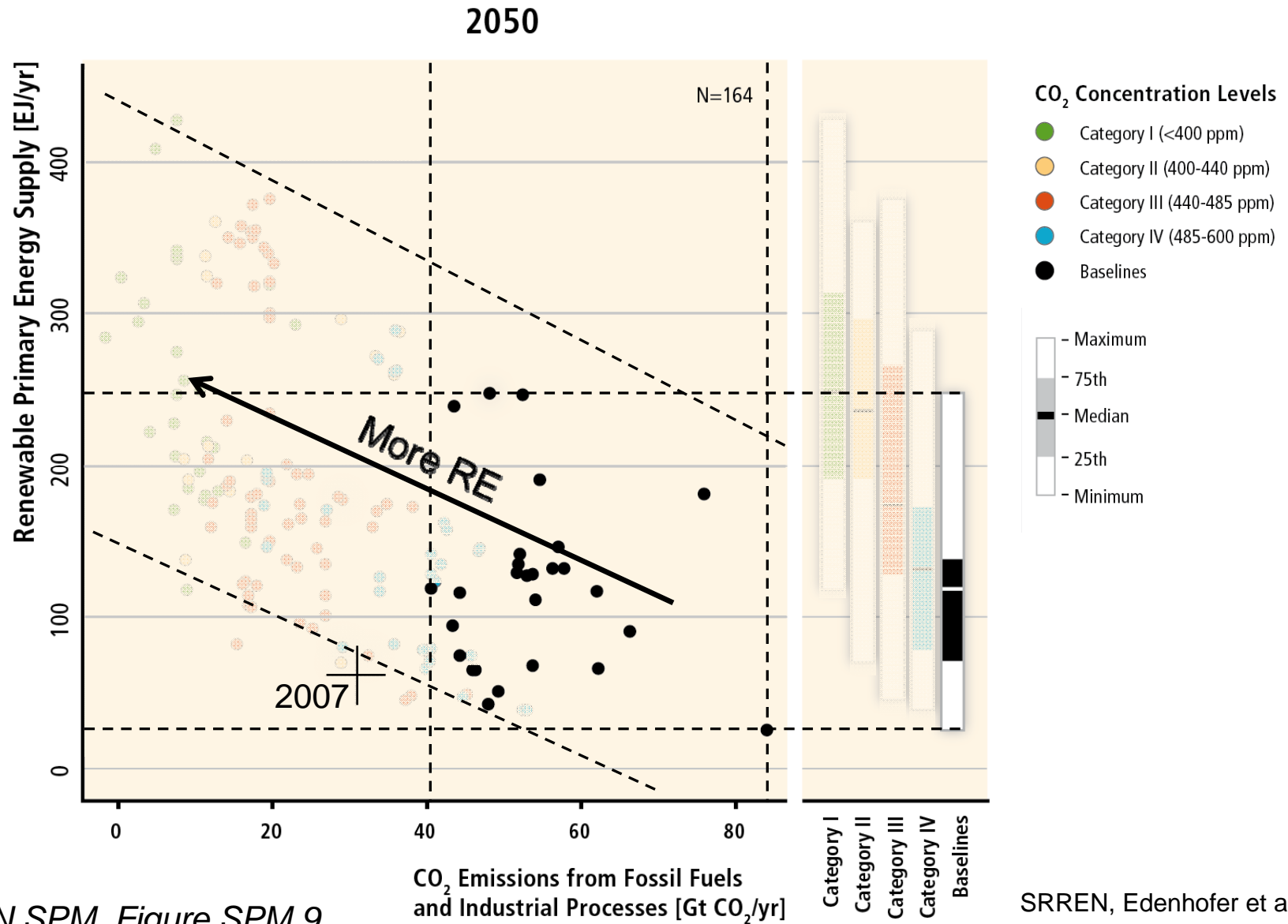
SRREN, Edenhofer et al. (2011)

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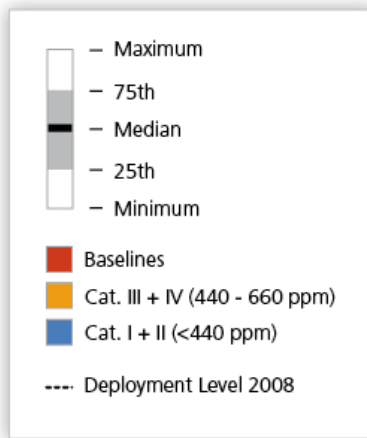
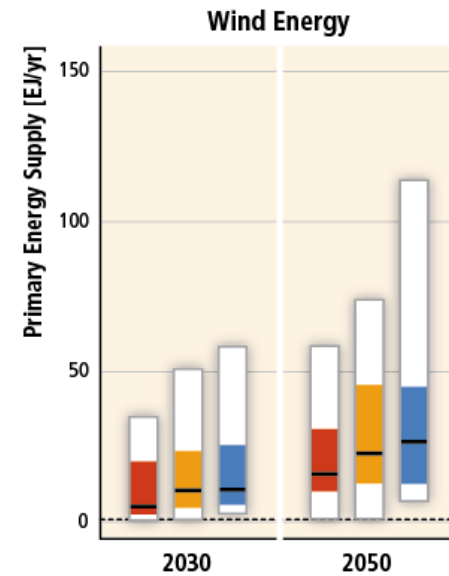
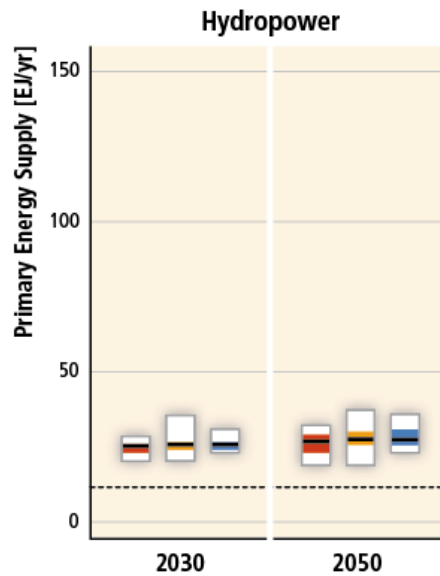
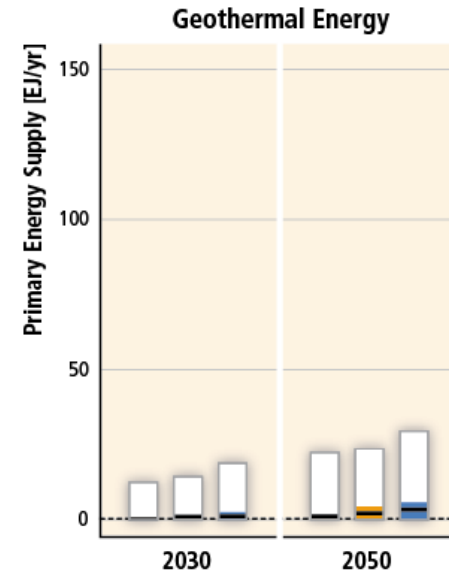
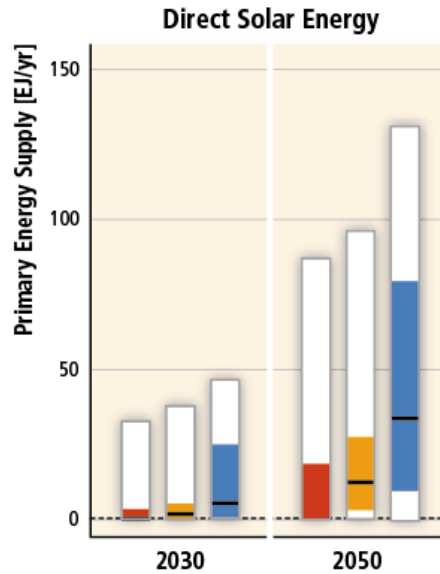
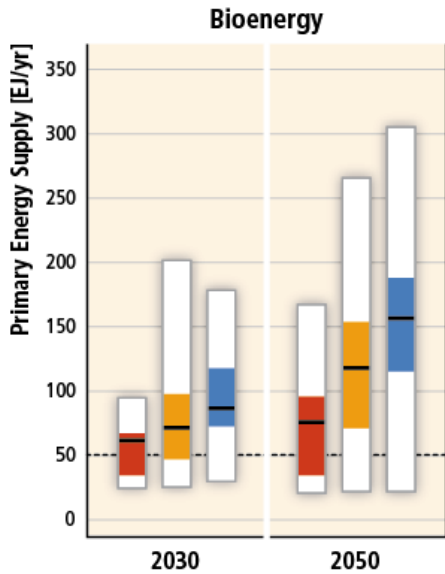
SRREN SPM, Figure SPM.9

Global RE Primary Energy Supply from 164 Long-Term Scenarios versus Fossil and Industrial CO₂ Emissions



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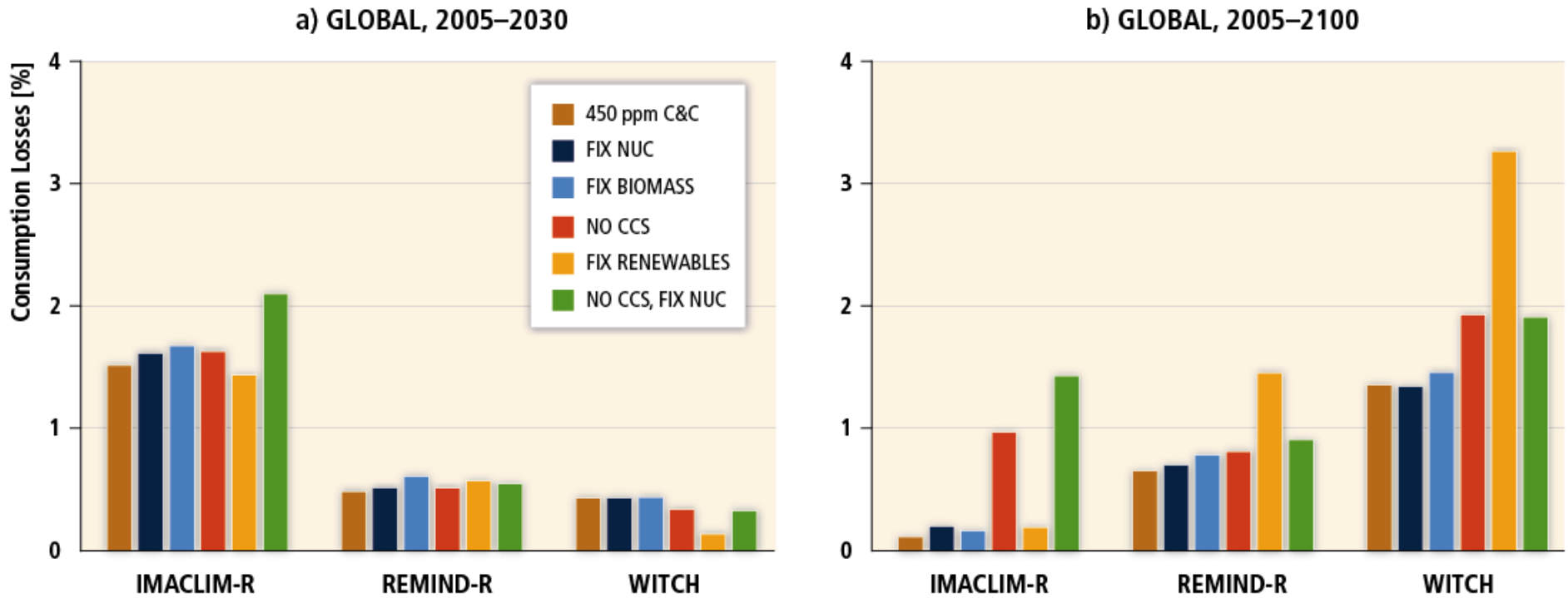
Potential Role of Renewables



Bioenergy Supply is Accounted for Prior to Conversion

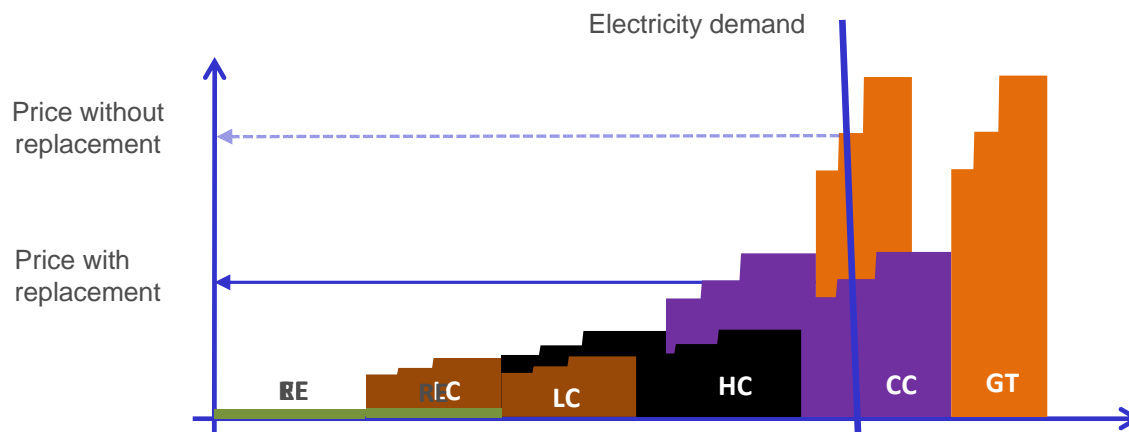
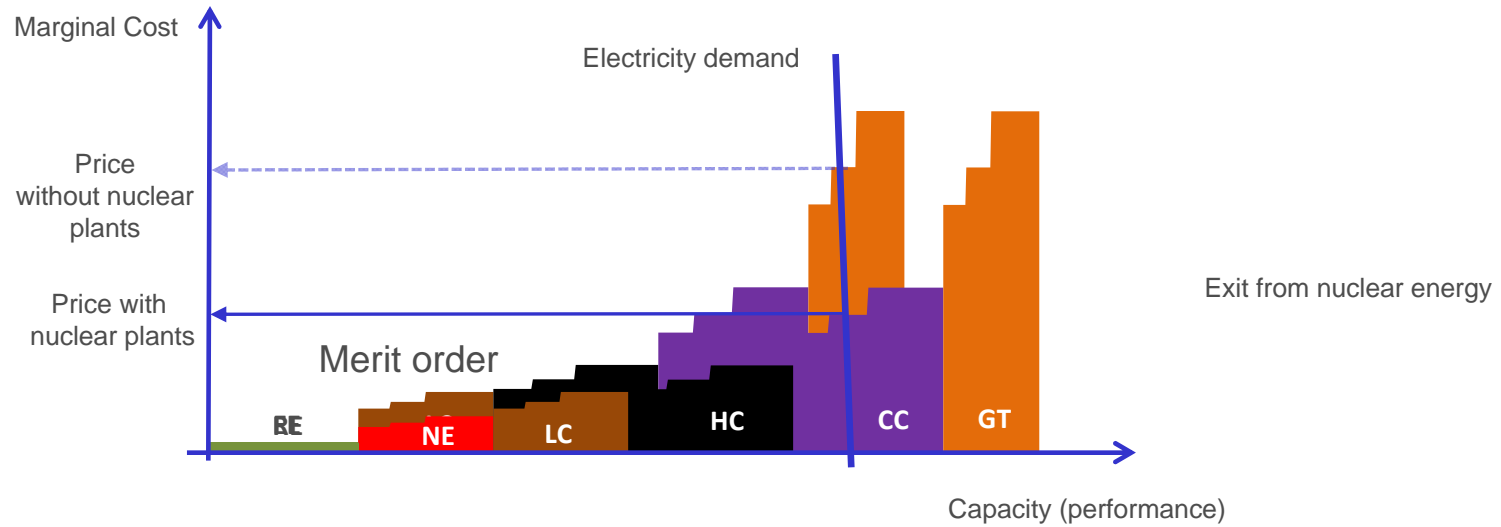
Primary Energy Supply is Accounted for Based on Secondary Energy Produced SRREN, Edenhofer et al. (2011)

Macroeconomic Costs

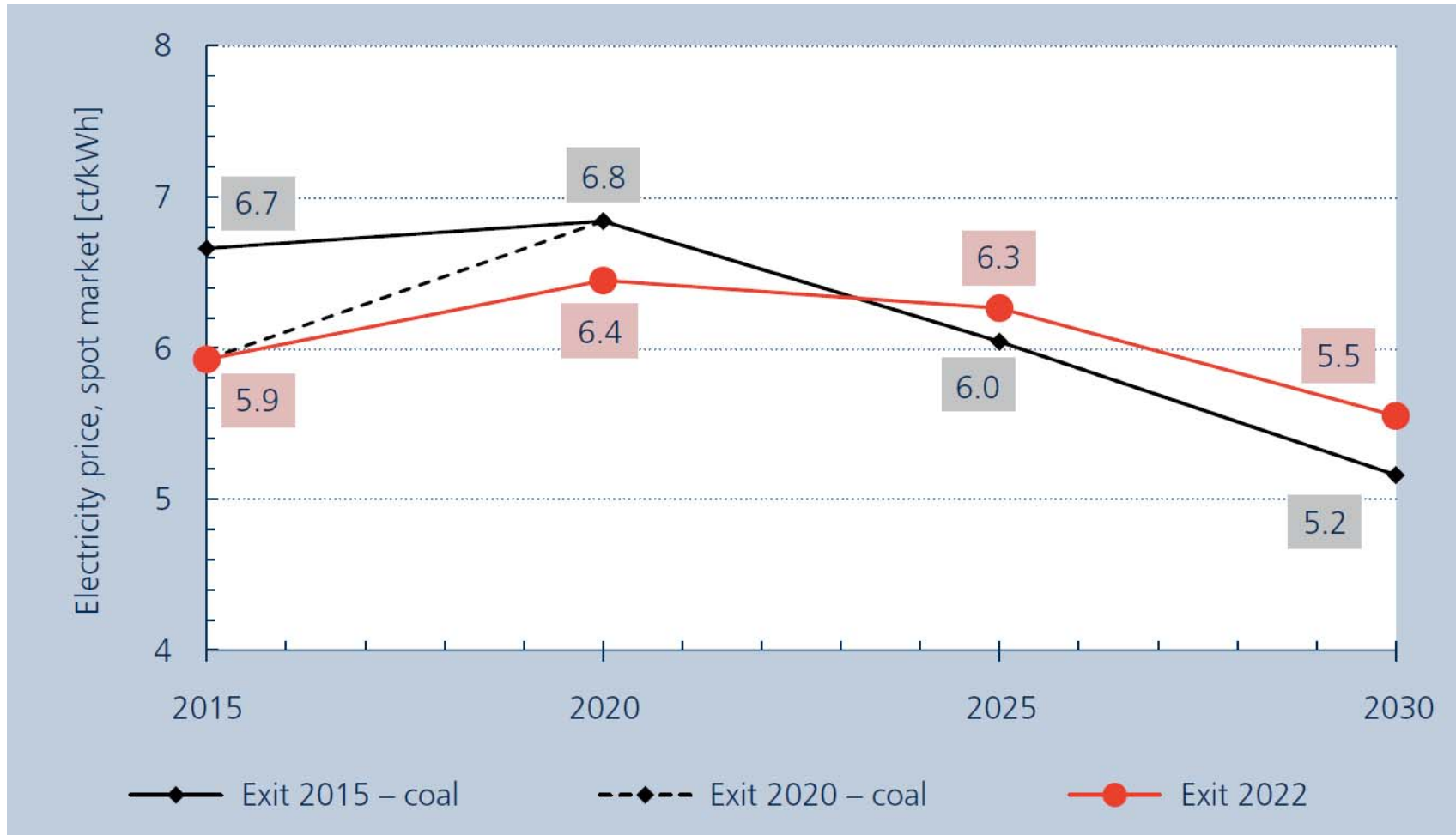


Limited availability of technologies

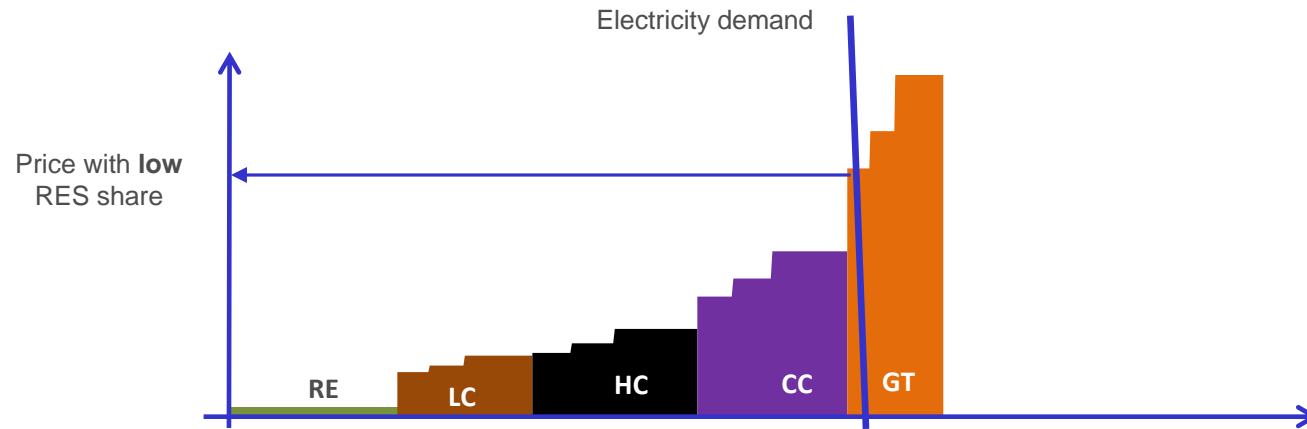
The German Case: Pricing in a Liberalised Electricity Market



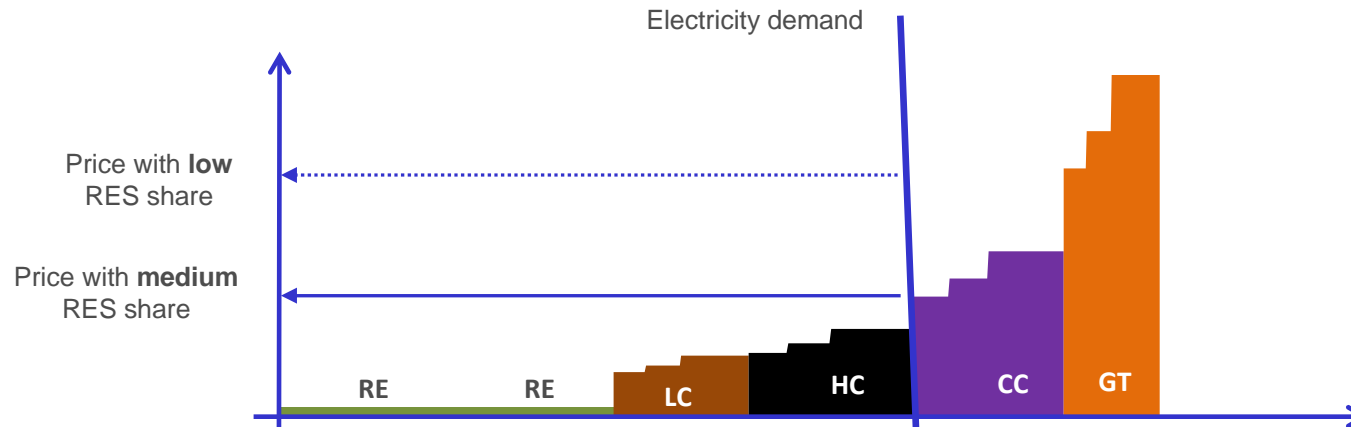
Wholesale Market Prices



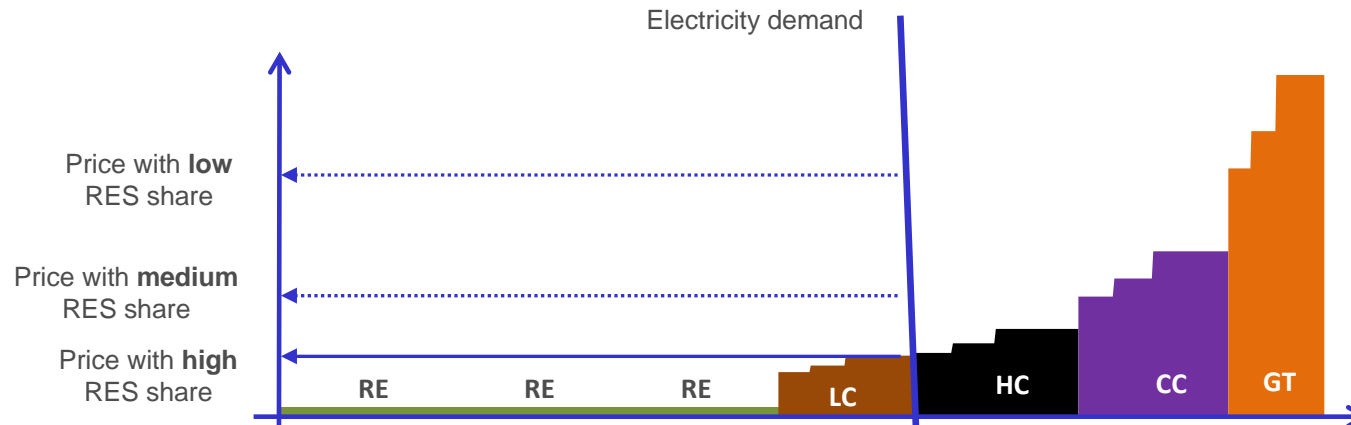
Impact of High Shares of REs on Price Formation



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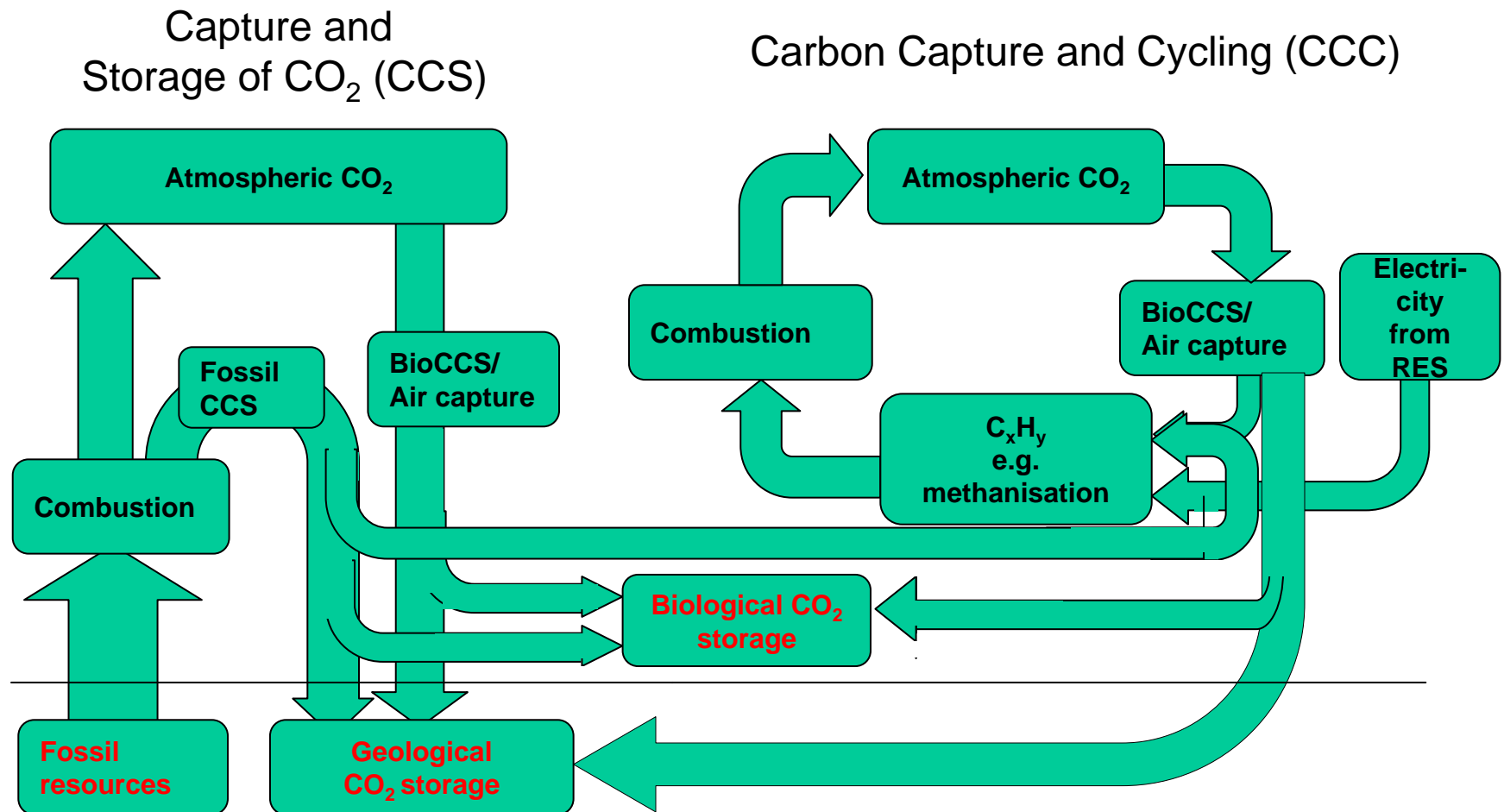
- Merit-Order effect of RES: Decreasing power prices
- Negative long-term impact:
 - Reduction of profitability of conventional technologies, less investments
 - Risk of capacity shortage in times of low RES generation (intermittency)
 - What kind of capacity instruments are needed?

Options of Integration

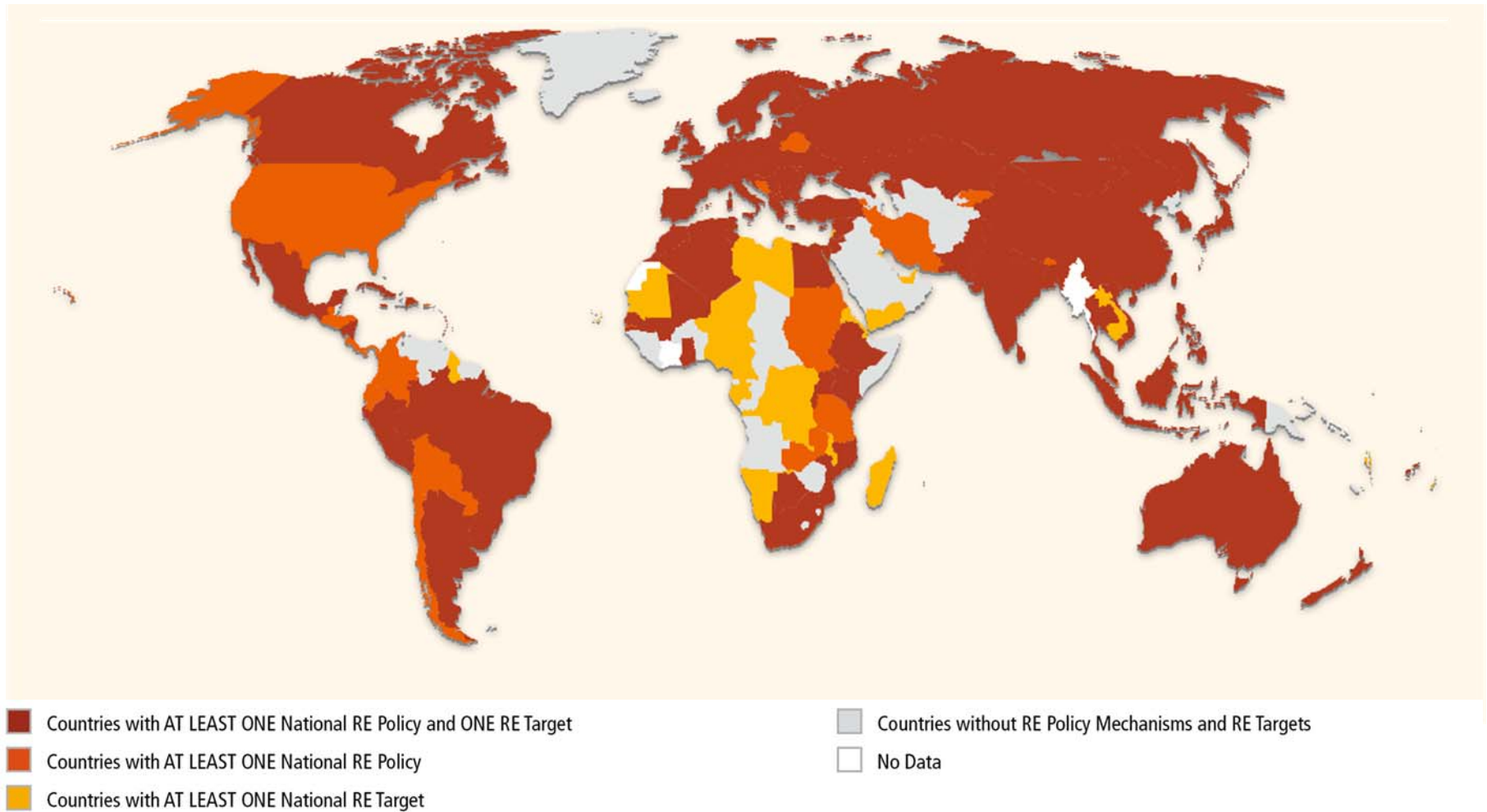
- Demand management
- Network expansion
- Improvement of weather forecast
- Flexible power plants
- Energy storages

CCX

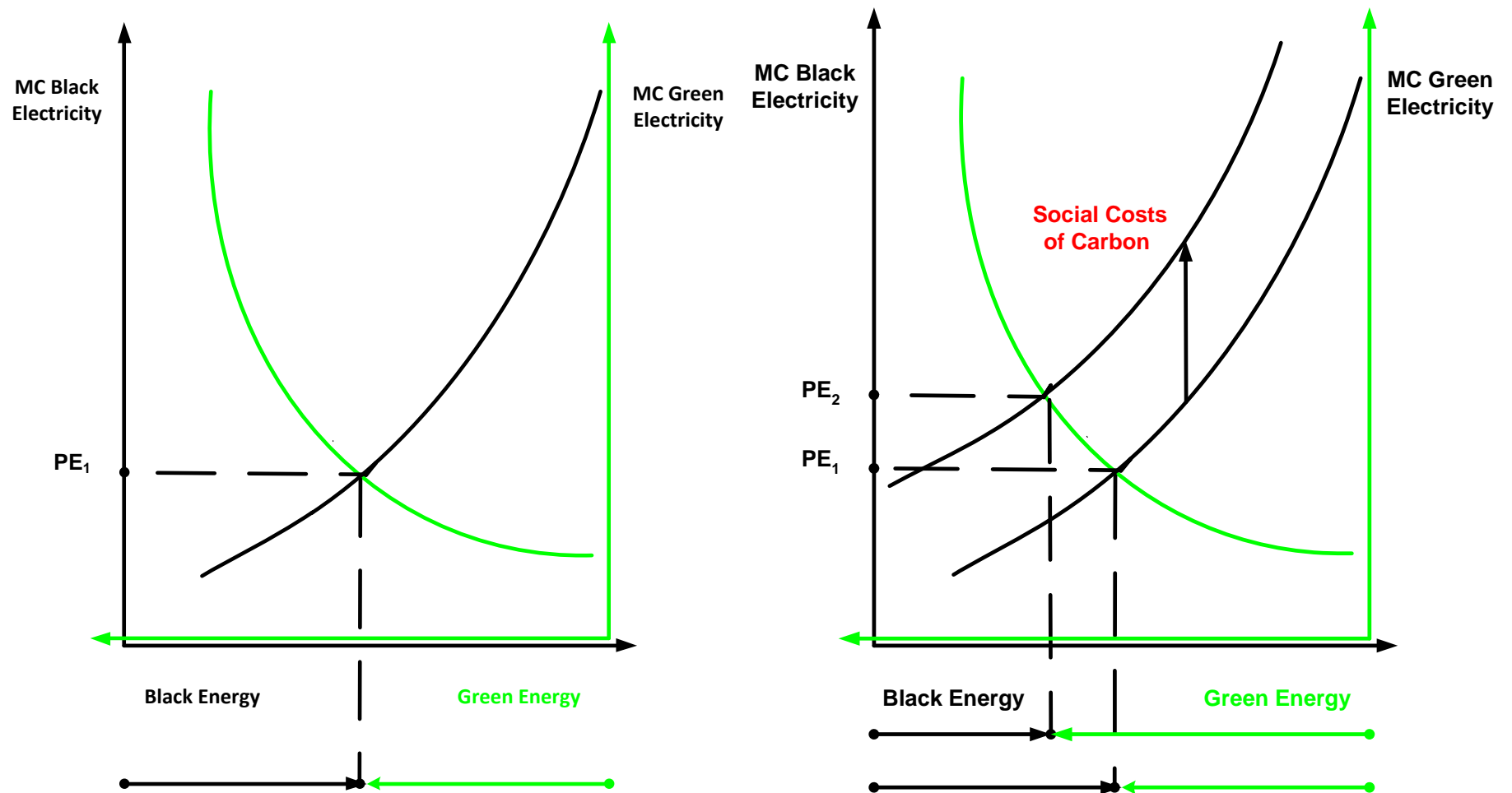
X = **C**ycling, **S**torage, **U**tilitization



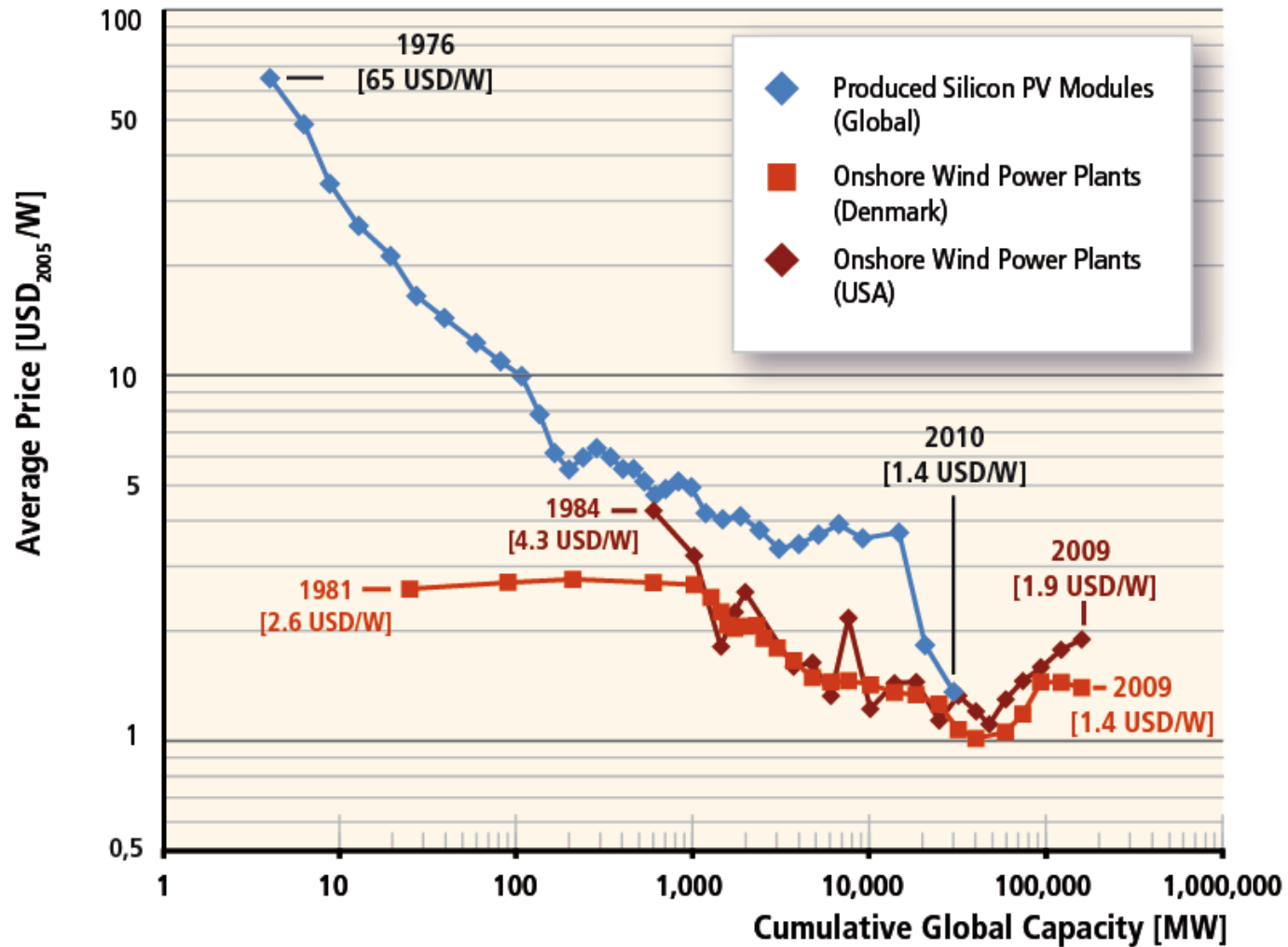
RE-Specific Policies and RE Targets (2011)



Case 1: Emissions Trading is Necessary and Sufficient

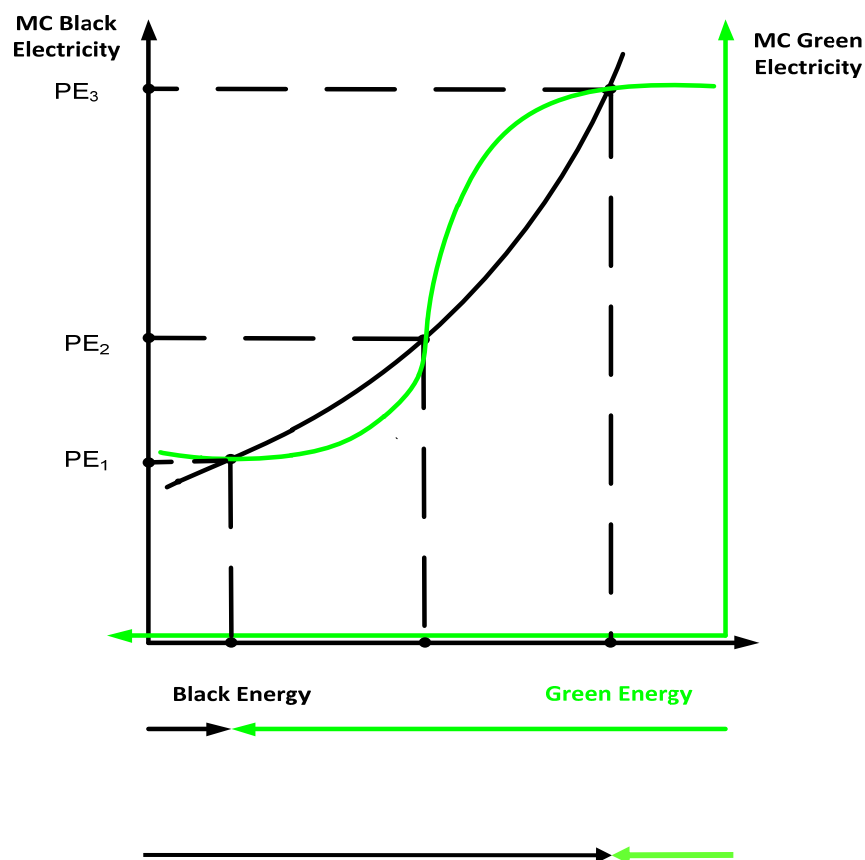


Renewable Energies Have a Potential to Lower Costs



SRREN, Edenhofer et. al. 2011

Promotion of Renewable Energies Is Worthwhile!

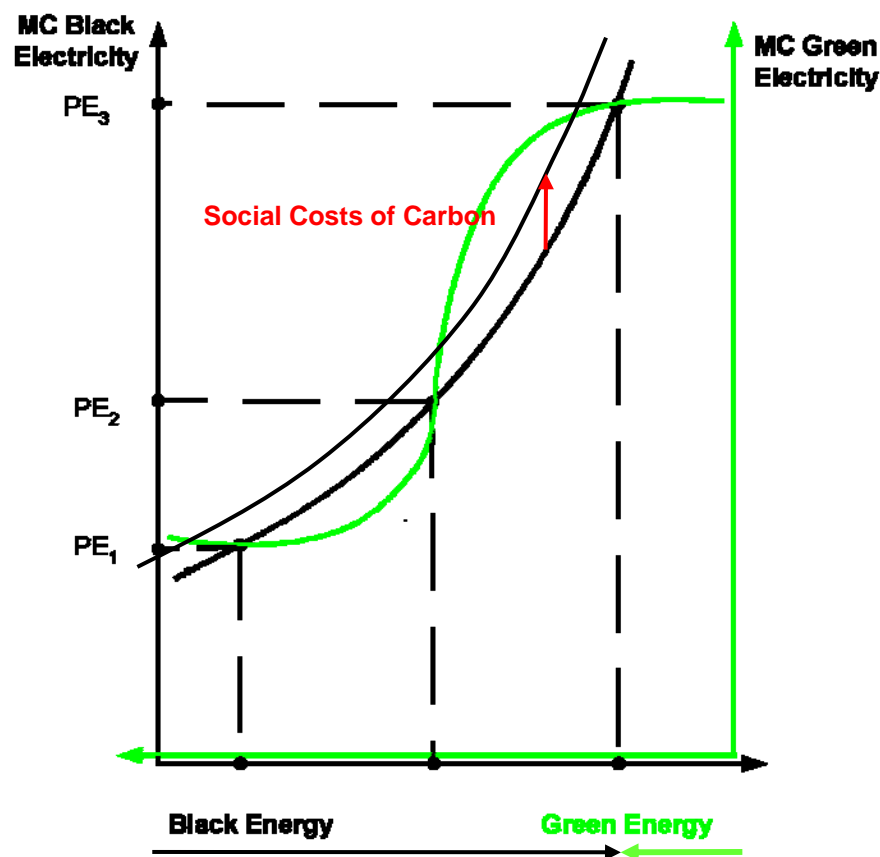


► Several stable equilibrium points (PE_3 and PE_1) are possible if the supply curves show a non-convex behavior (PE_2 is not stable).

► Without additional policy support, the system will steer towards the neighboring equilibrium point PE_3 .

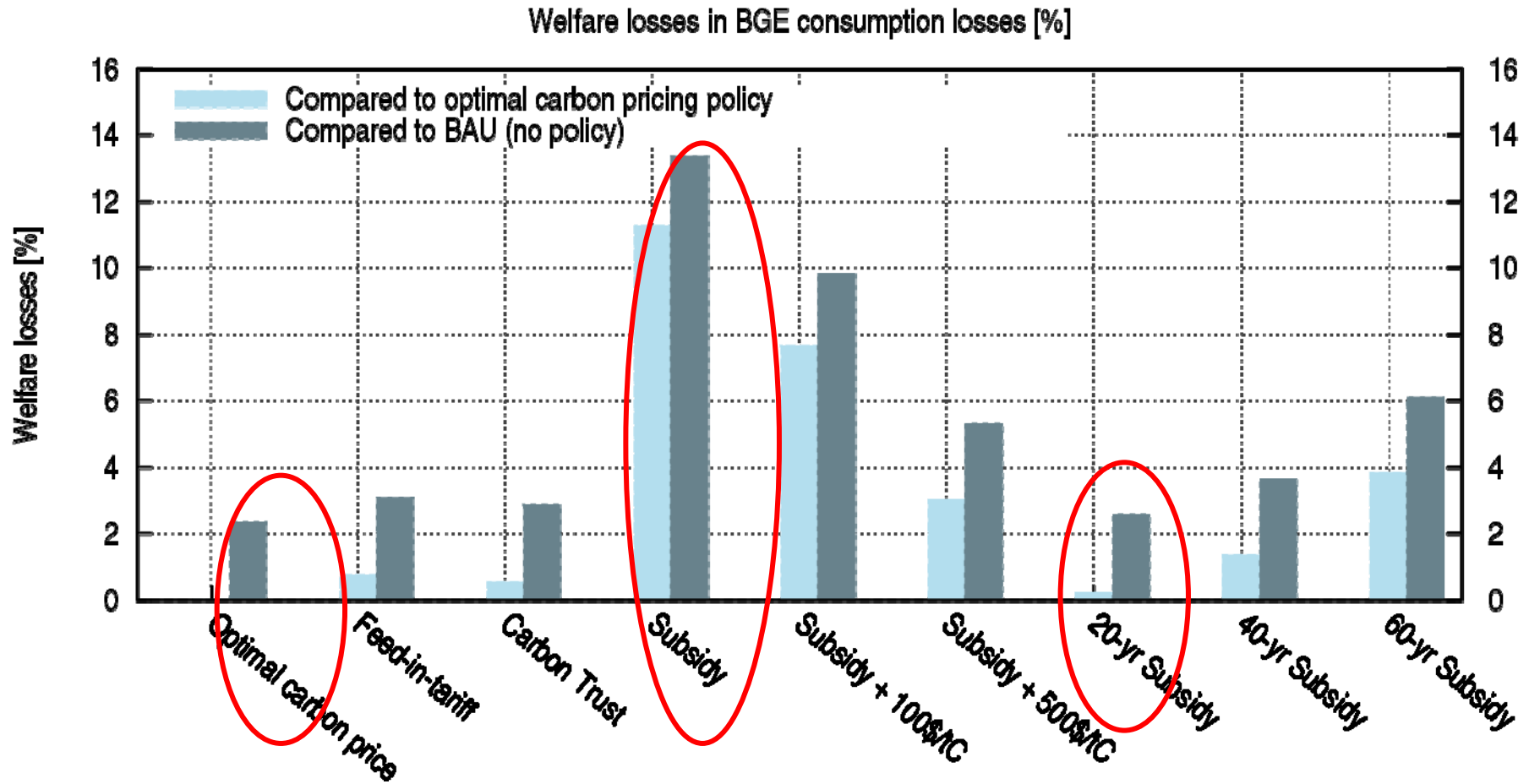
► $PE_3 > PE_1$: the system is **efficient**.

Promotion of Renewable Energies is Worthwhile!



- ▶ The internalization of the social costs of energy supply (e.g. via a cap and trade system) improves the competitiveness of renewable energies
- ▶ As long as the cross-over point PE_3 does not vanish, this, however, still results in an inefficient state.
- ▶ *Trio infernale*: a) learning spillovers, b) high substitutability between carbon-free technologies, c) increasing returns to scale

Efficient Technology Politics



Recommendable Literature

<http://srren.ipcc-wg3.de/report>