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Re-thinking our Energy Future

9 – 11 October, 2006 in Engelberg

Energy Use in Transition – Scarcity in this century, sustainability later ?

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Acknowledgement: most of the research was supported by the Board of Swiss Institutes of Technology, the Swiss Federal Office of Energy, Novatlantis, BMBF, BMWi, and Axpo

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Content

- Challenges faced by the energy system, by the global society
- The technological answers to the scarcities –
  - efficiency from services to primary energy demand (2000 Watt/cap) – the central solution, but so far mostly lip services
  - renewables: 50 to 70 years toward full market penetration
  - coal and carbon capture & storage – seems unavoidable
  - nuclear fission – societal acceptance of extreme damages limited
- Why is the transition so slow ? Science System, Technology producers
  Voters of fun societies – the prisoner dilemma in democratic systems
- Conclusions – sustainable energy use feasible, lemmings cannot envisage it
- Some suggestions for action – overcoming the threats of scarcities

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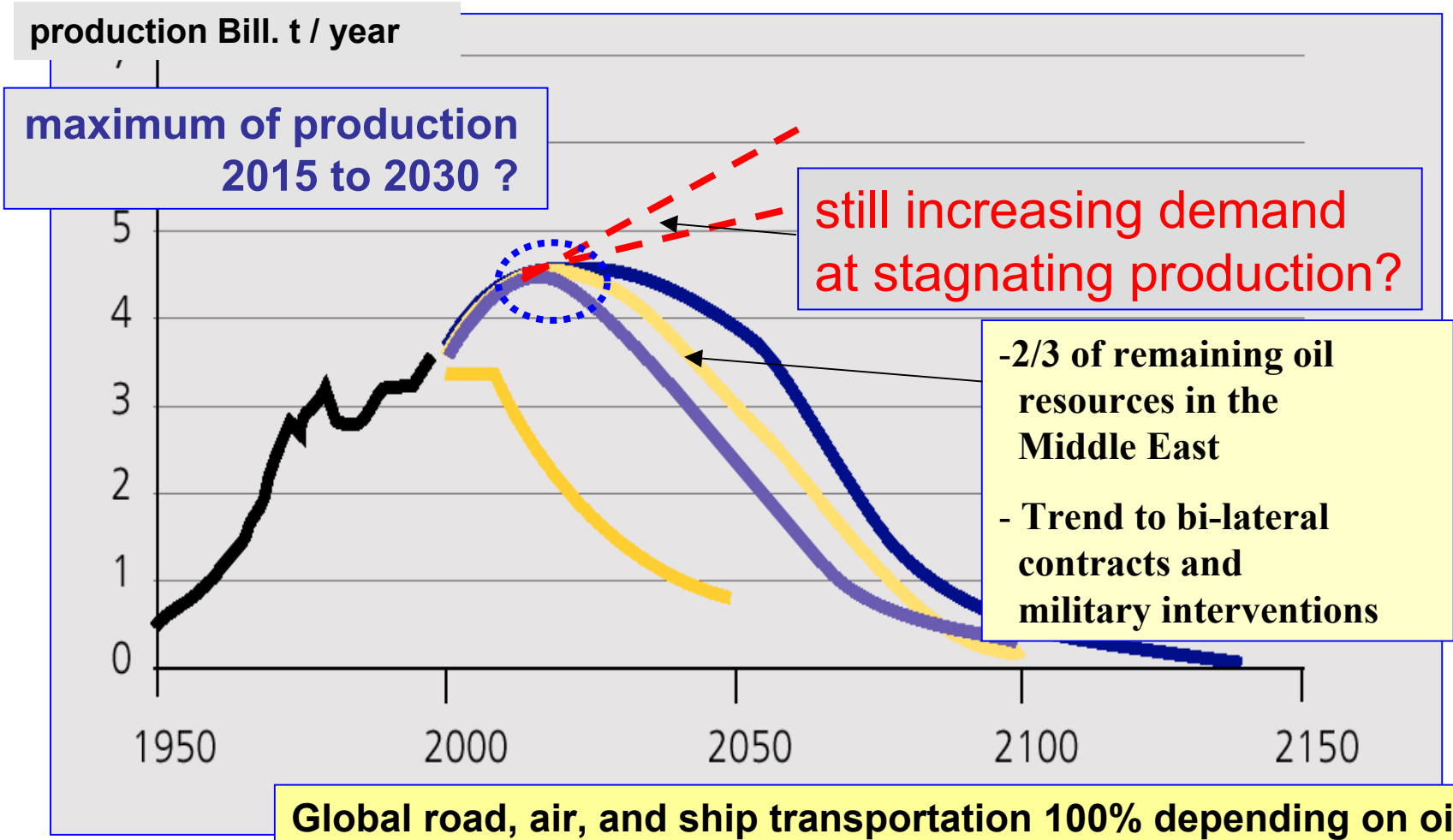
Challenge No 1: maximum of oil production at still increasing oil demand

Risks of future energy prices: How demand and supply could simultaneously peak?



source: P.Kehrer "Das Erdöl im 21.Jahrhundert – Mangel oder Überfluss?" presentation Hanover, 10.March 2006

Global road, air, and ship transportation 100% depending on oil

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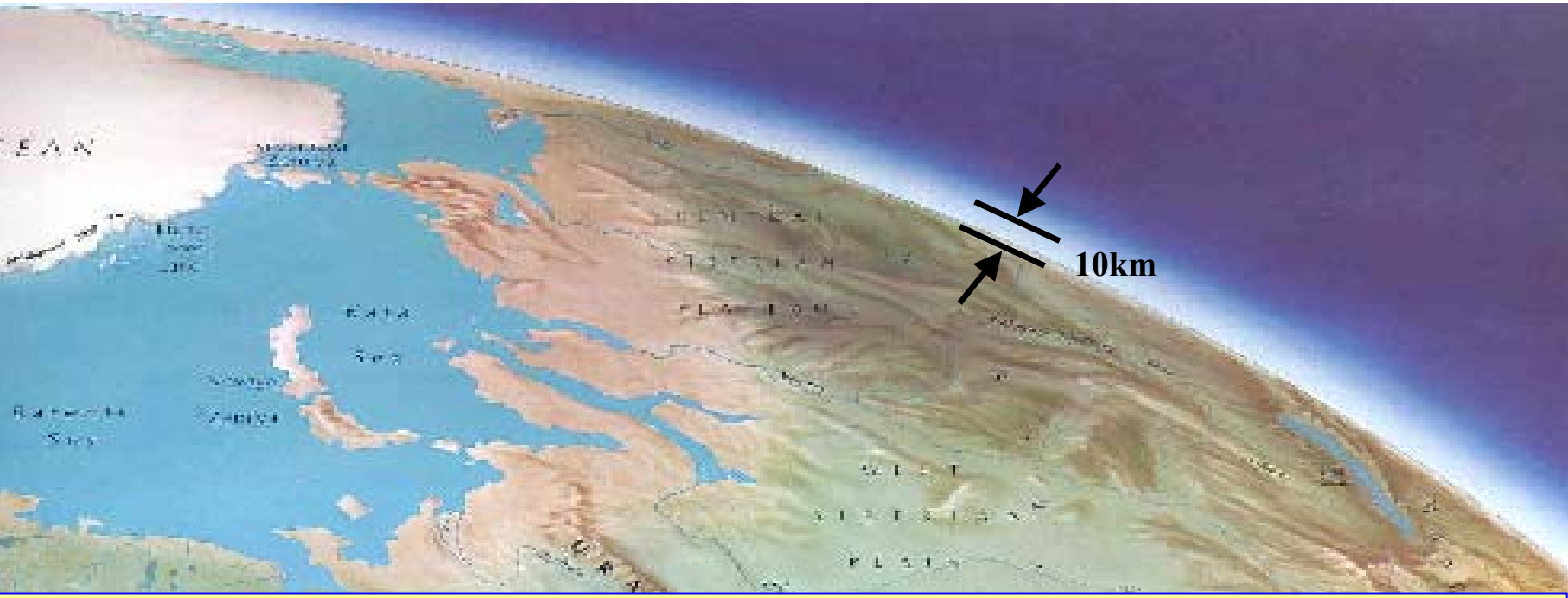
The atmosphere – too slim to be used as "land fill" of mankind



- 13 Bill. tonnes CO_2 per year emitted by OECD-countries
- adaptation cost of the energy system not clear, but substantial:
  - 5% more electricity demand by 2035 in Switzerland (cooling, air conditioning)
  - more dry cooling towers for power plants, less production in dry summers
  - carbon capture and storage for centrally operating fossil fuel converters

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How and why 2°C during this century?

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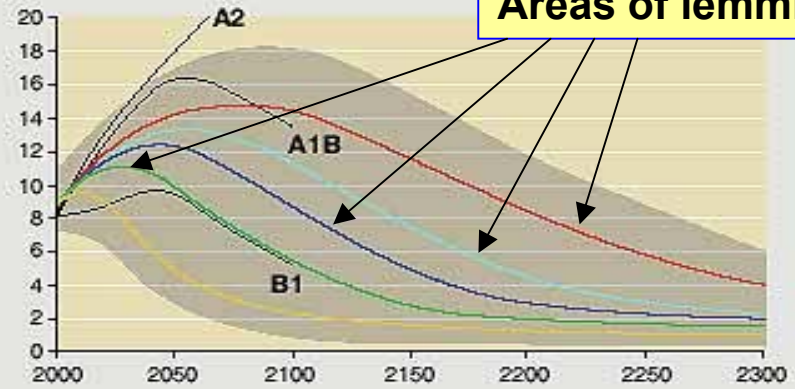
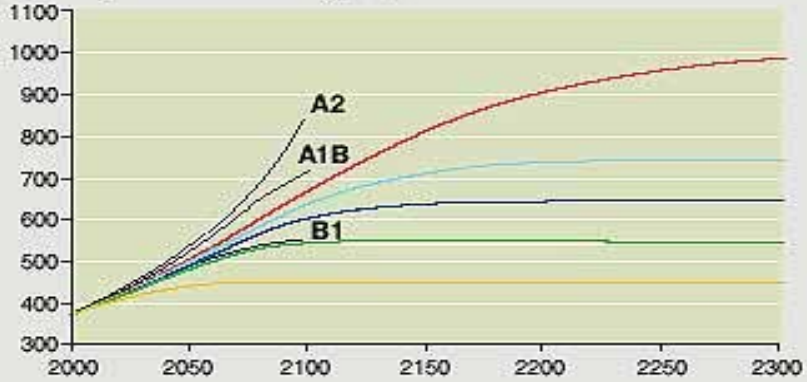
Emissions, concentrations, and temperature changes corresponding to different stabilization levels for CO_2 concentrations

(a) CO_2 emissions (Gt C)

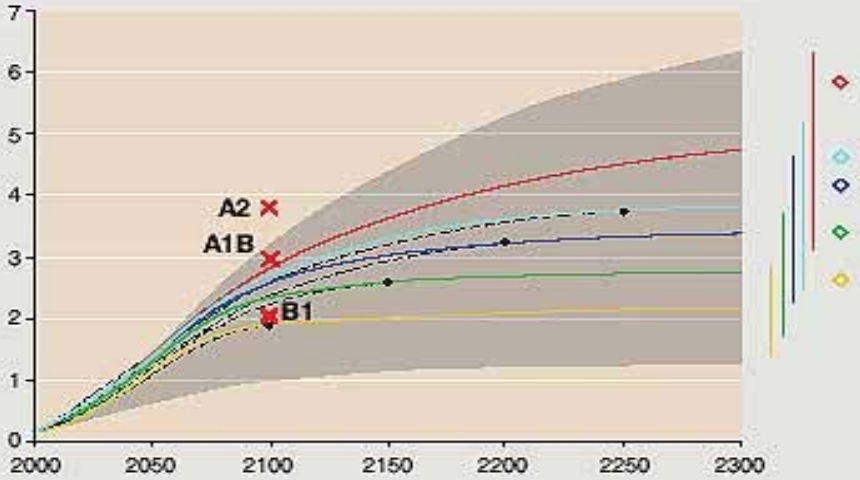


Areas of lemmings

(b) CO_2 concentration (ppm)

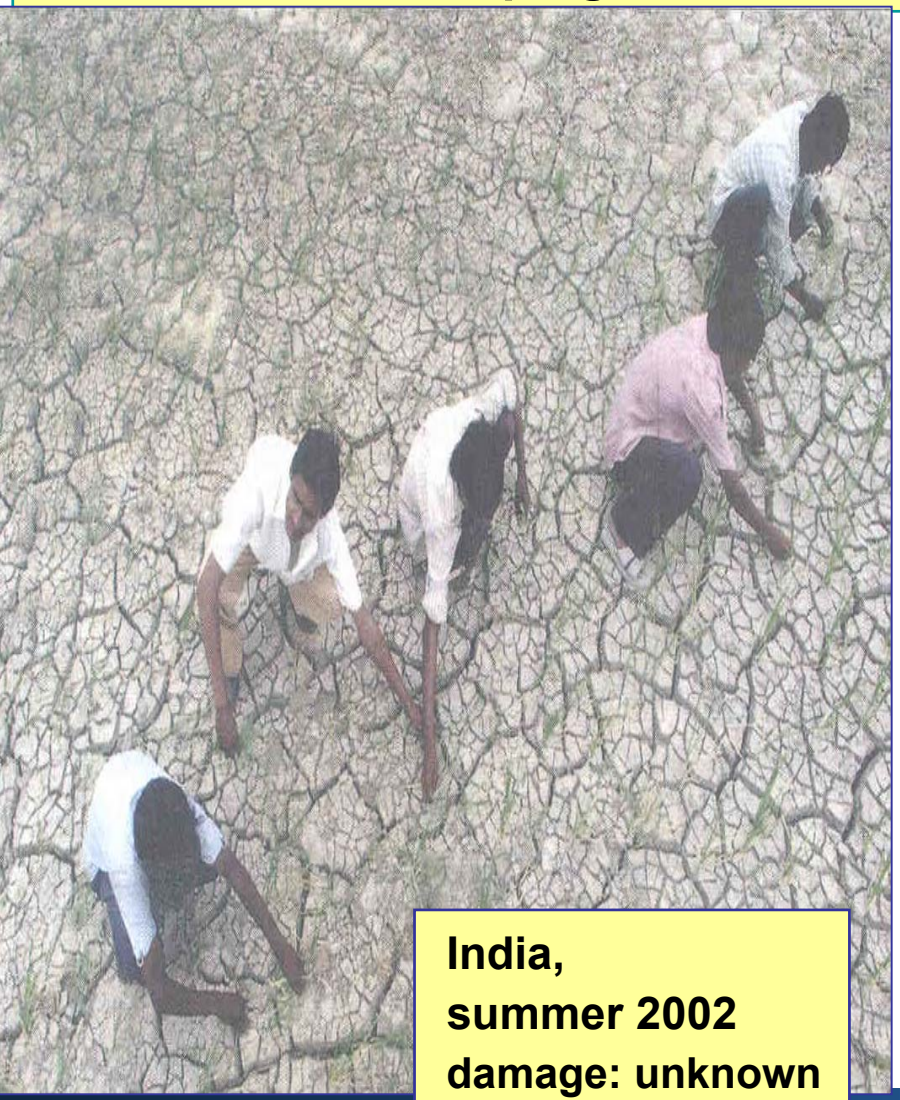


(c) Global mean temperature change (°C)

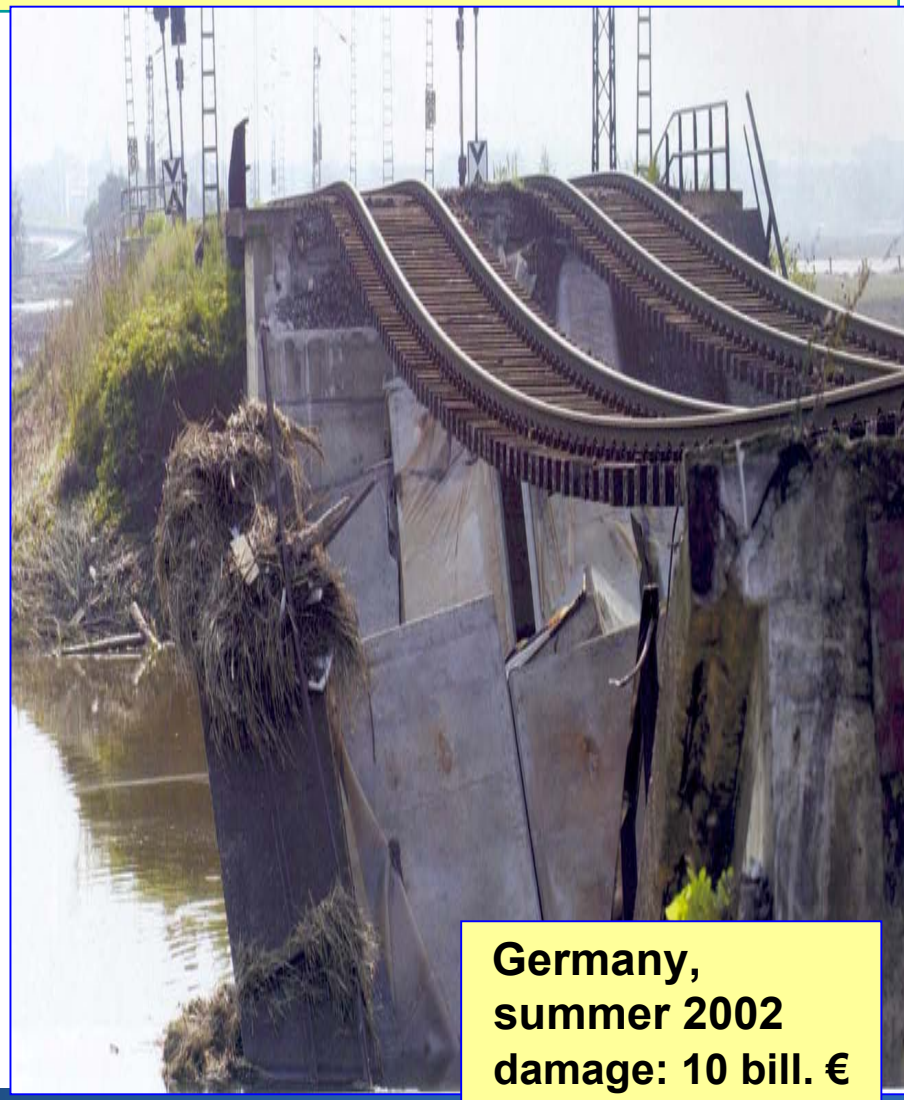


If mankind does not manage to limit temperature increase to 2°C, there is a high risk that boreal forests emit additional CO_2

Social cost of climate change : - heat waves, draughts
- intensive rain falls and storms
Will hit the developing countries more than the industrialised world



India,
summer 2002
damage: unknown



Germany,
summer 2002
damage: 10 bill. €

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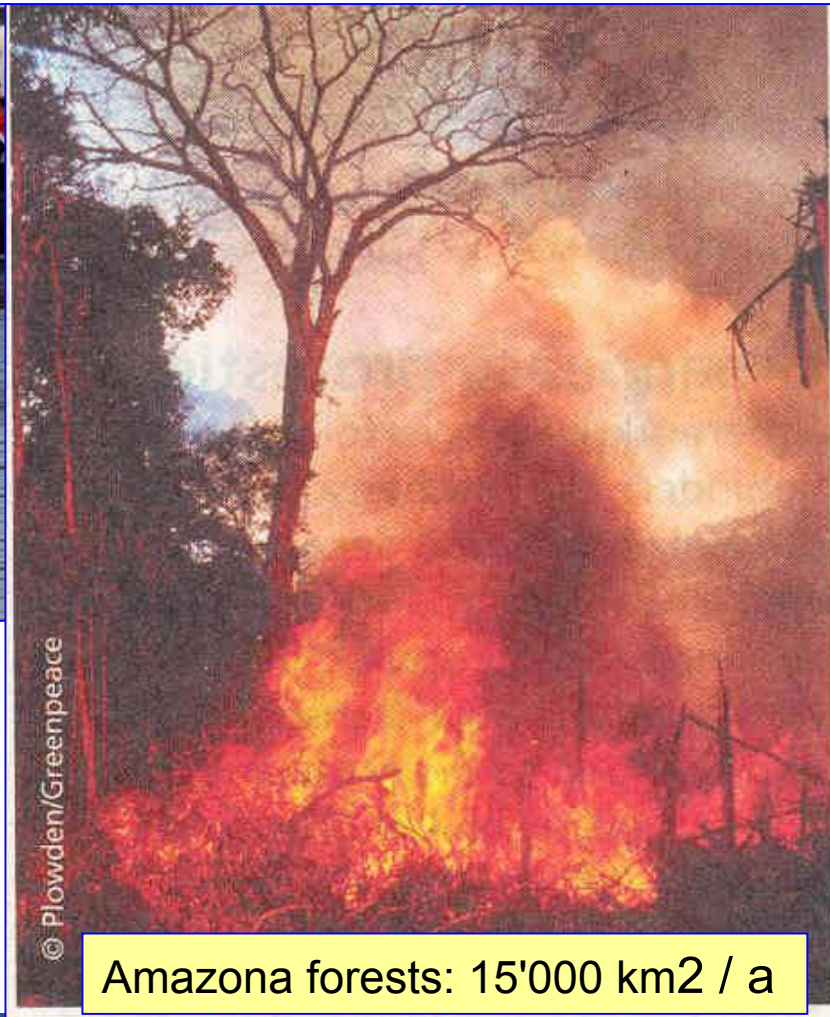
damage and adaptation cost – even substantial today already



Amazona forests: 15'000 km2 / a

Re-Insurance companies are warning
- **reducing their maximum compensation per extreme event**
- **non-insurable risks in river basins etc**
- **increasing the tariffs (insurance companies: additional 100 € per house in 2006 in Europe)**

Energy flow diagram of the world 2003 – losses, losses, …

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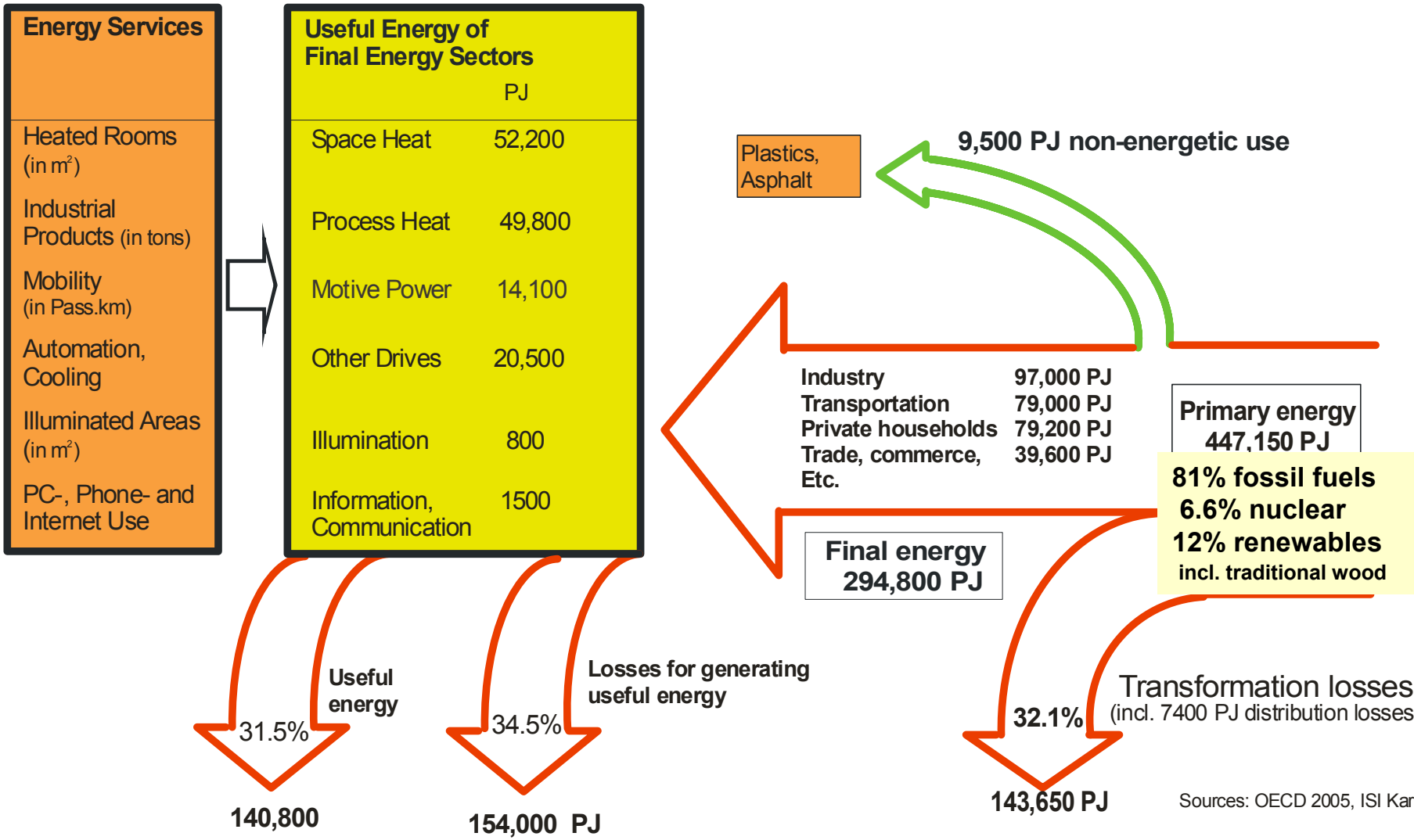
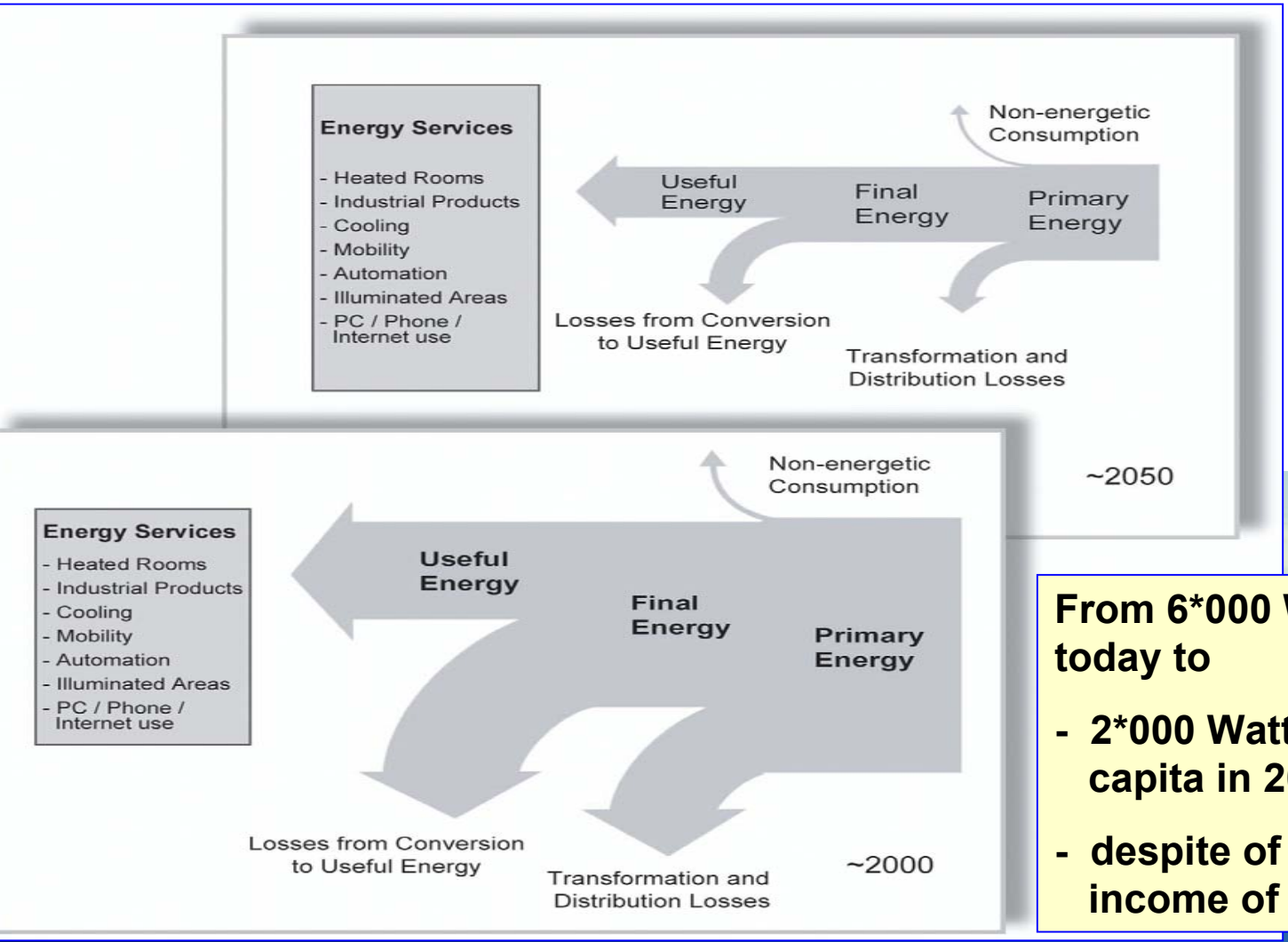


Sources: OECD 2005, ISI Kar

The vision of the Board of Swiss Institutes of Technology of a 2000 Watt/cap Society – the long term efficiency potential in 2060 to 2070



From 6*000 Watt (190 GJ/a) today to

- **2*000 Watt (65 GJ/a) per capita in 2060**
- **despite of an increase of income of 70% in 2060?**

The technological answers – efficient use of energy & materials

- **the reduction of the losses of useful energy by 50 to 90 % is the message:**
  - **passive houses and buildings (60 to 90 %)**
  - **substitution of thermal processes by biotechnology, membranes, impulse drying, absorption, extraction, etc. (50 to 90%)**
  - **lighter vehicles, recovery of braking power (30 to 50%)**
- **further efficiency improvements of the two conversion steps (any kind of co- and tri-generation, high temperature turbines, fuel cells etc.)**

Efficient use of energy & materials – the largest (2/3 solving potential) and most profitable potentials for the next decades

- **efficient use and substitution of energy-intensive materials**
  - **can be doubled relative to autonomous progress by new or improved materials, changed design (bionics), recycling**
  - **fossil fuel based chemicals and plastics can be substituted to some (and increasing) extend by biomass, natural fibres etc.**

  reduce energy demand along the whole energy chain (- 0,5 % PEC/a)

- **entrepreneurial innovations: pooling, sharing, etc.**

The renewables: 50 to 70 years toward full market penetration

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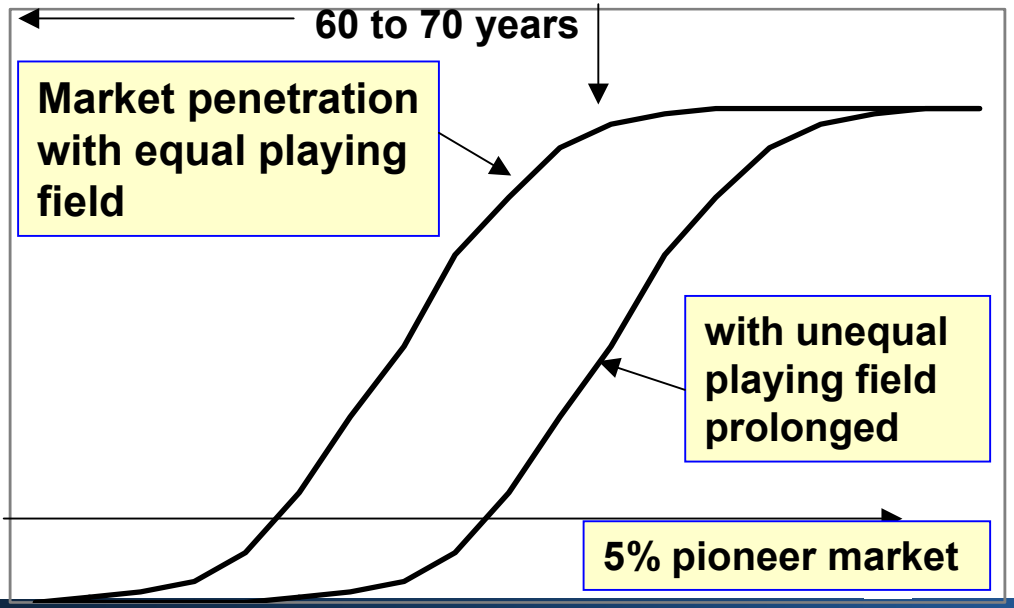
- **Renewable energies**
  - have a limited share in total primary energy demand: 12 % (half of which is conventional, presently unsustainable wood use)
  - can make a limited contribution in the next three decades due to small market shares (<3%), high investment cost, lack of capital in LDCs, unequal market signals (external cost of fossil fuels and nuclear), market power
  - have to reduce the high cost of new technologies by learning and economies of scale (high adaptation cost or "subsidies" for sustainability)



Coal and carbon capture & storage – seems unavoidable

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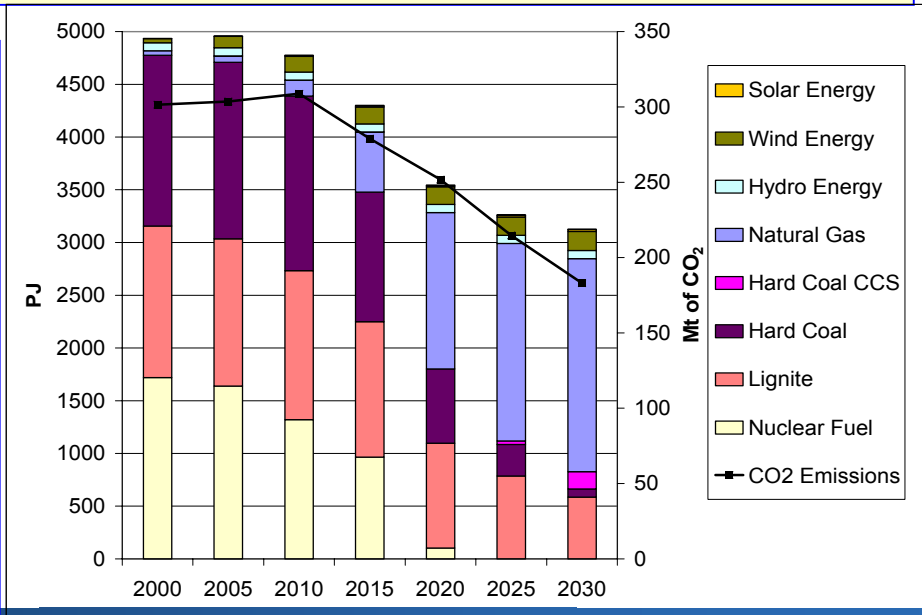
- **Coal use and carbon capture and storage technologies**
  - hard coal use is very likely to increase (+50% until 2030), CO2 emissions would increase to half of today's emissions to 13 billion t (not acceptable)
  - Carbon & capture of CO2 suited for large central conversion plants and countries with available aquifers or other CO2 storage capacities
  - CO2 re-injection in oil fields started in 2005, demonstration plants off CCs will start operating in 2010 to 2012
  - additional cost of electricity: about 2 to 3 cts/kWh (adaptation or mitigation)
  - open questions: Leakage of aquifers, acceptance by population



nuclear fission – societal acceptance of extreme damages limited

- **Nuclear energy: very low share in primary energy (6.5%)**
  - similar to the renewables' situation
  - highly capital-intensive and know how-intensive
- **Reasons of limited societal acceptance**
  - very large maximum damage (although attached with very small probability),
  - limited insurance coverage by law (implicit subvention)
  - risk of proliferation (North Korea, Iran, ..?), tax payers pay precautious diplomatic and military measures, not the electricity consumers
  - no systemic comparison by voters ("yes" or "no" are not the options)
- **Perspectives – increasing use, but shrinking shares**
  - IEA: less expanding than renewables due to limited acceptance
  - avoids (and will avoid) less than 2 Bill. t of CO_2 out of presently 26 Bill. t
  - nuclear fusion is likely to be too late and too expensive relative to

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How much does survival at 2°C cost in per cent of GDP until 2050 ?

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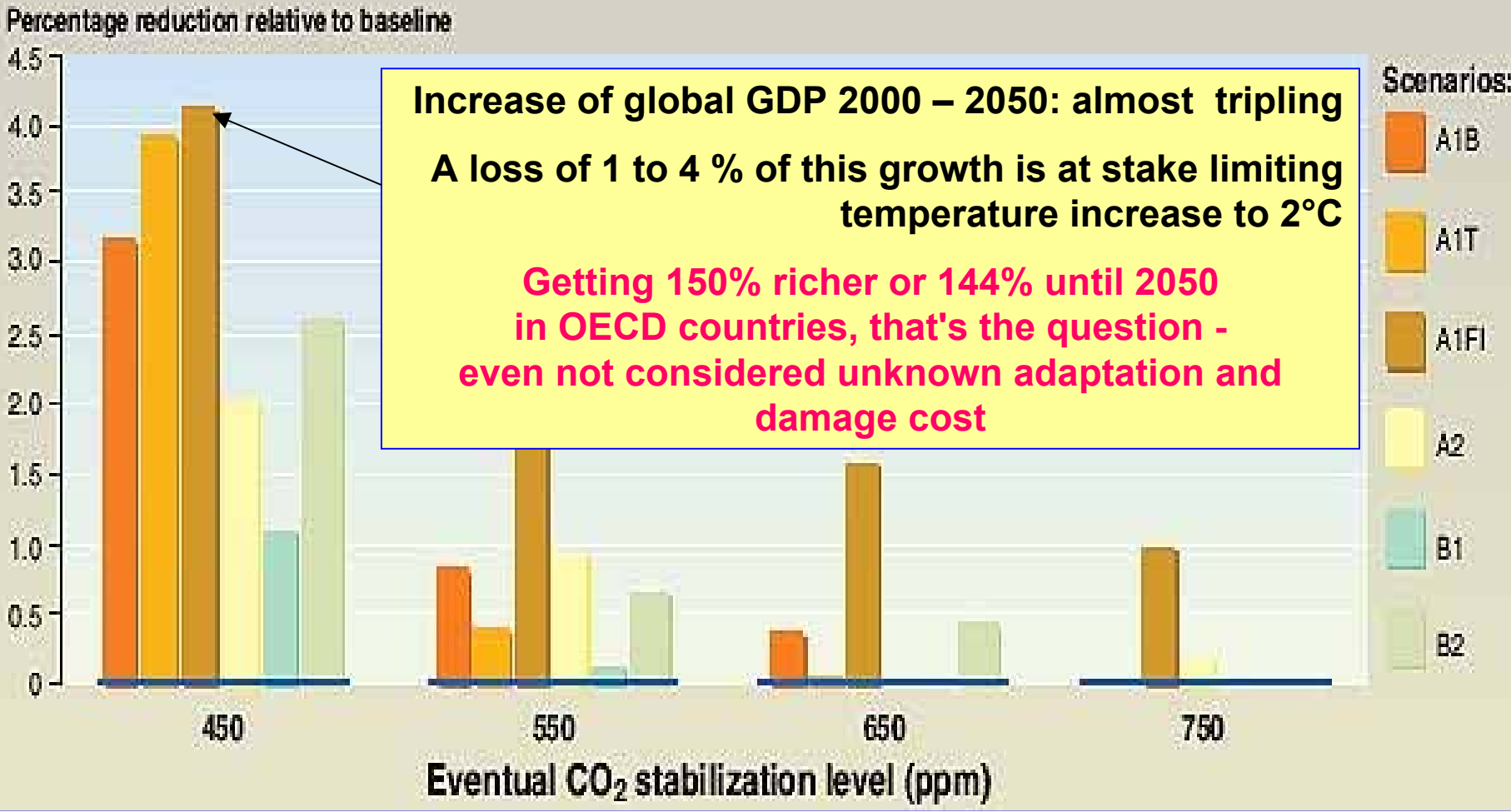
Global average GDP reduction in the year 2050



Increase of global GDP 2000 – 2050: almost tripling

A loss of 1 to 4 % of this growth is at stake limiting temperature increase to 2°C

Getting 150% richer or 144% until 2050 in OECD countries, that's the question - even not considered unknown adaptation and damage cost

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Why is the transition so slow ? – the illusion of markets & politics

- **Traditionally mentioned obstacles and market imperfections:**
  - **lack of knowledge, lack of capital,**
  - **investor-user dilemma, high transaction cost, legal obstacles**
  - **differences in external cost of different energy carriers (fossil versus wind),**
  - **mixture of social and energy policies (particularly in developing countries)**
- **Partial policies and their optimisation: no sustainability policy approach:**
  - **conflicting/contradicting policy targets in Switzerland, the EU, the OECD**
  - **200 Bill. $/a trade of second hand investment goods & vehicles from OECD to developing countries & CET (Development aid fixing the problem?)**
  - **liberalisation of electricity markets in EU: more market power than before?**
  - **the most profitable and largest opportunity, efficiency option: little attention**

Why is the transition so slow? –

Science and technology research – still following traditions

Decisions in business – short term – following traditions and fashions

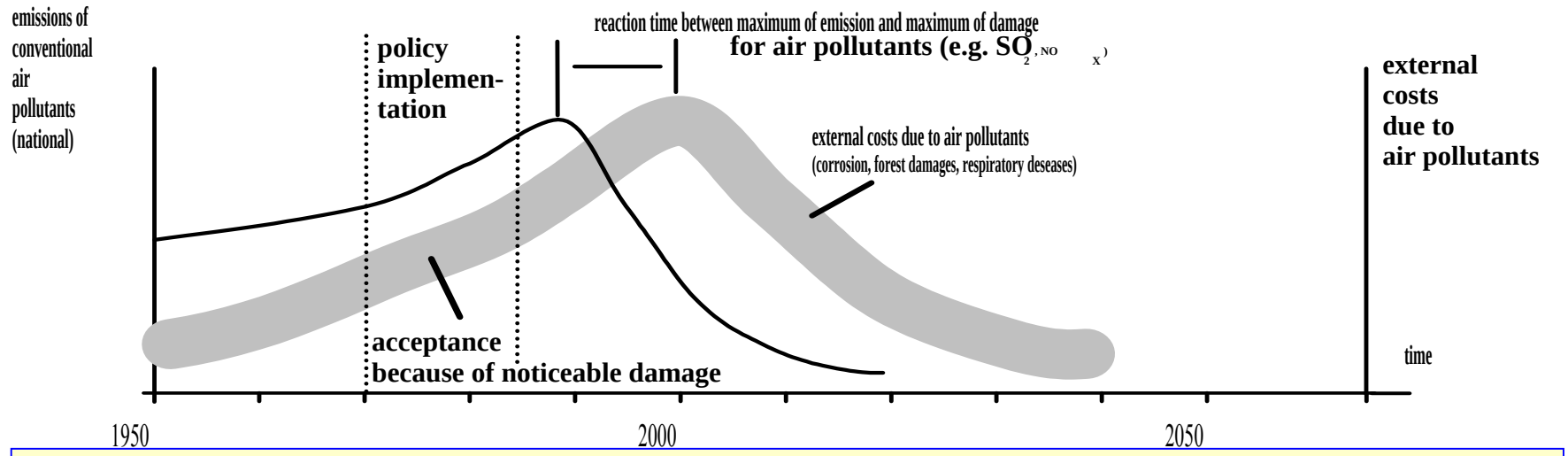
- **Science-internal reputation and career system to be adopted**
  - **oriented on number of publications in peer reviewed journals ,**
    but not towards present and future societal needs
  - **oriented to research frontiers, often methodological frontiers,**
    but not to interdisciplinary solutions or understanding

- **Technology research – potentials for speeding up TP**
  - **lack of development targets and of analysis of bottlenecks (technical and cost)**
  - **lack of analysis of user needs and preferences**

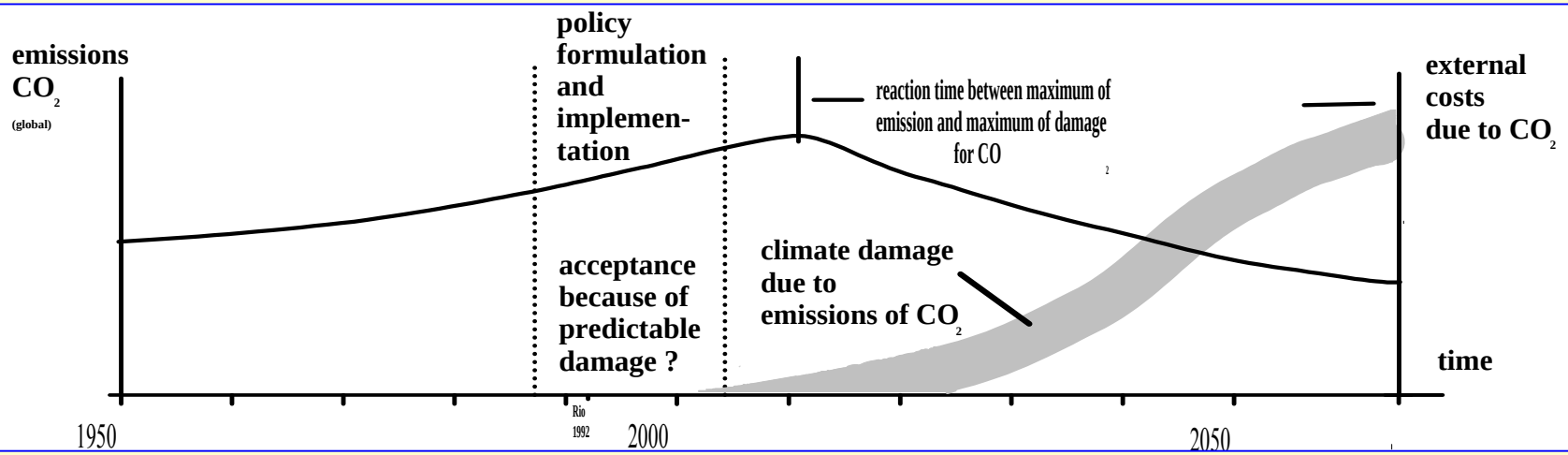
- **Investment and staff decisions – based on rationale or fashions**
  - **Orientation on three months cash flows – sustainable?**
  - **Decision on payback periods for long lasting investment goods?**

Why is the transition low? –

Voters of fun societies – the prisoner dilemma in democratic systems



Calling for policy action because of anticipated long term damage that will not be experienced



Short term oriented lobbyism of energy-intensive industries on administration and politicians

Conclusions – sustainable energy use now to overcome scarcities

- **Present trends of energy use: unsustainable for mankind**
- **If the 2000 Watt/cap society in focus, the role of renewables will be substantial. Coal use at even increased levels with CCS very likely; the role of nuclear: limited; a path at 2°C is feasible, but action now**
- ***economic analysis*: under pure cost/benefit aspects – feasible: a 4% reduction of a 50% increased OECD-GDP until 2050**
  (Adaptation and damage cost of climate change likely to be more)
- ***Reasons for lemmings' behaviour:* the illusion of well functioning markets; the short term view of voters and of lobbying industries, the experience of the powerlessness of the "few concerned"**
- **Besides resource scarcities:**
  scarcity of creativity & positive visions, of power to swim against the current

Some suggestions - overcoming the threats of scarcities

- **Intensified co-operation cooperation among countries and gobal players,** besides others on the following principles:
  - **avoiding lock-ins (e.g. painting of buildings, trading second hand investment goods to emerging countries, over-sizing of air transport)**
  - **abolishing direct and indirect subsidies for coal use, air and road transport**
  - **negotiate long term objectives and supporting joint measures for post-Kyoto period (e.g. CDM, global efficiency campaigns)**
- **Swiss economy and governments:**
  - **more consciousness of technology producers of the global opportunities; build a new lobby "Swiss Efficient"**
  - **make research for new, resource-efficient technologies more efficient (focus on technical and cost bottle necks)**
  - **support more creativity, more long term thinking, more constructive visions**

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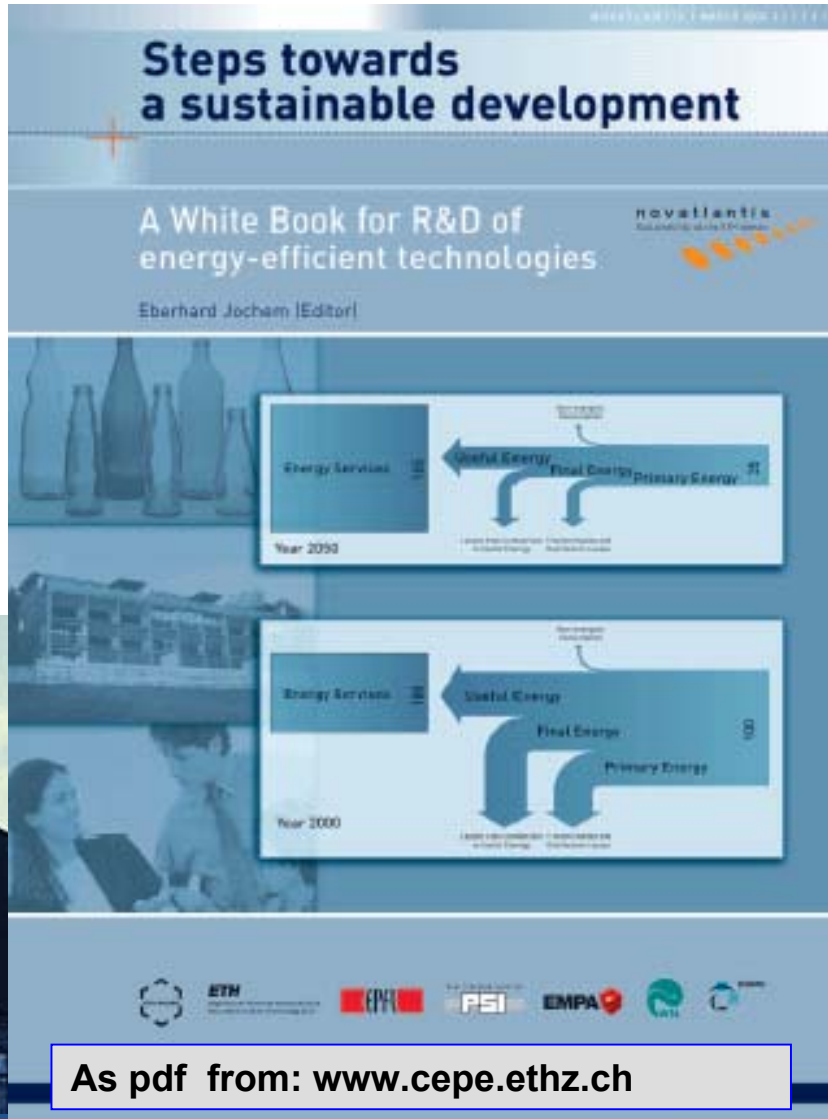
keep in mind closing windows of opportunities by climate change – let's be realistic: let's try the impossible!

Thanks for listening

and for your hints during the discussion, also in the break



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