


Re-thinking our Energy Future**9 – 11 October, 2006 in Engelberg****Energy Use in Transition –
Scarcity in this century, sustainability later ?****Eberhard Jochem****Centre for Energy Policy and Economics (CEPE), ETH Zurich, and
Fraunhofer Institute Systems and Innovation Research (ISI), Karlsruhe,
Member of the Council of Sustainable Development of the German Government**

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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**

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

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

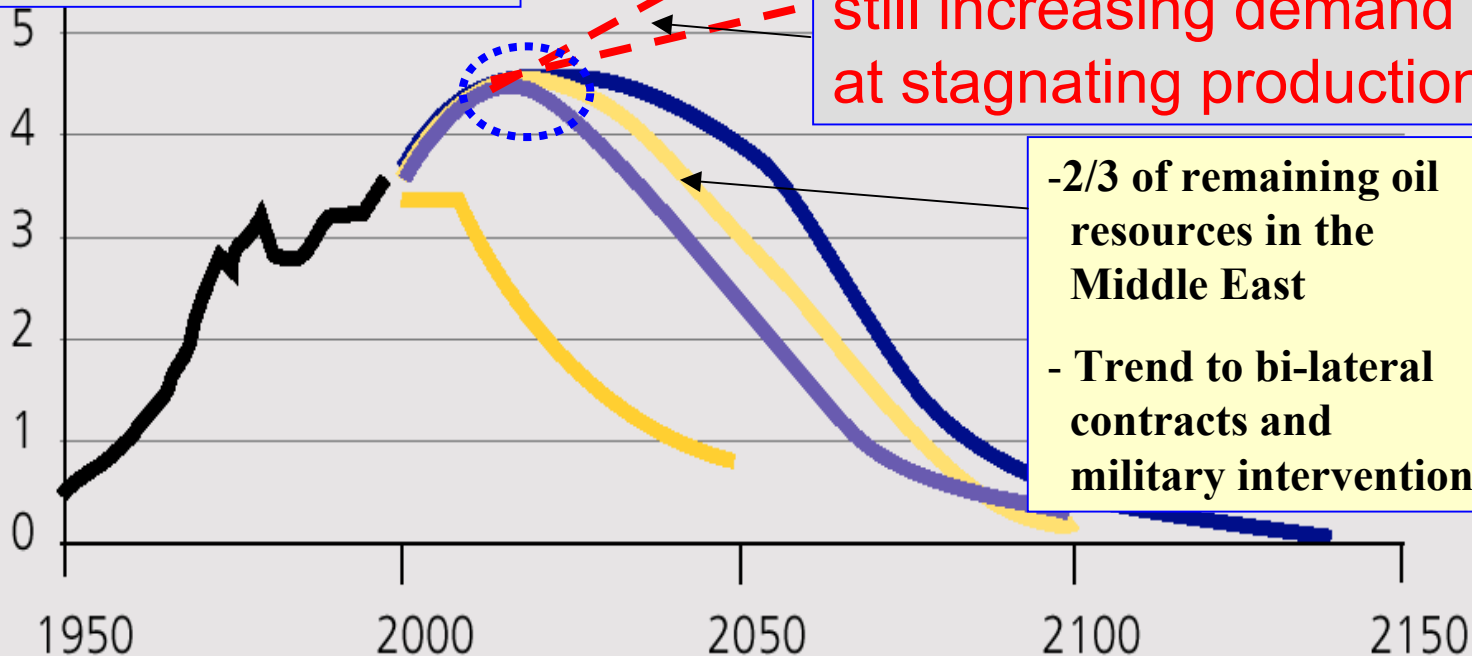
production Bill. t / year

maximum of production
2015 to 2030 ?

still increasing demand
at stagnating production?

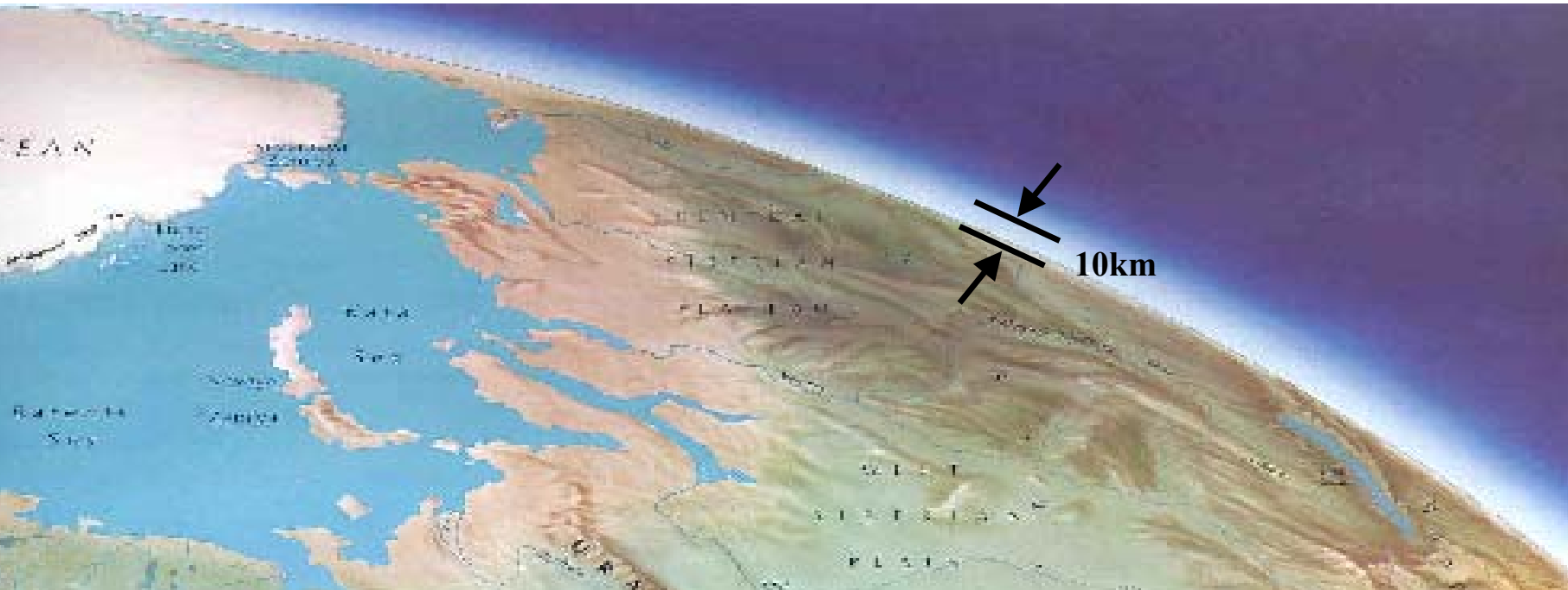
-2/3 of remaining oil
resources in the
Middle East

- Trend to bi-lateral
contracts and
military interventions



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

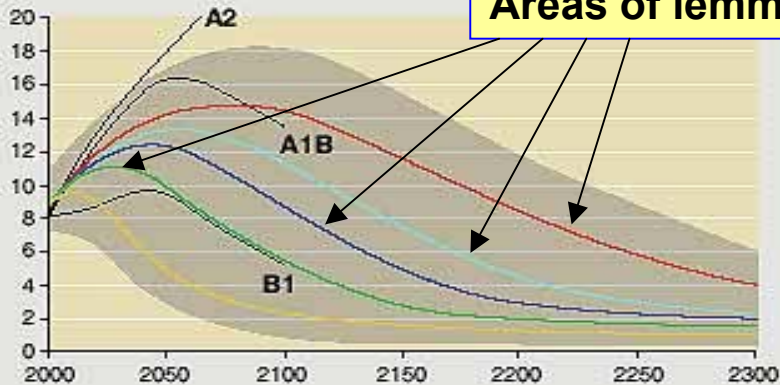
The atmosphere – too slim to be used as "land fill" of mankind



- 13 Bill. tonnes CO₂ 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

Emissions, concentrations, and temperature changes corresponding to different stabilization levels for CO₂ concentrations

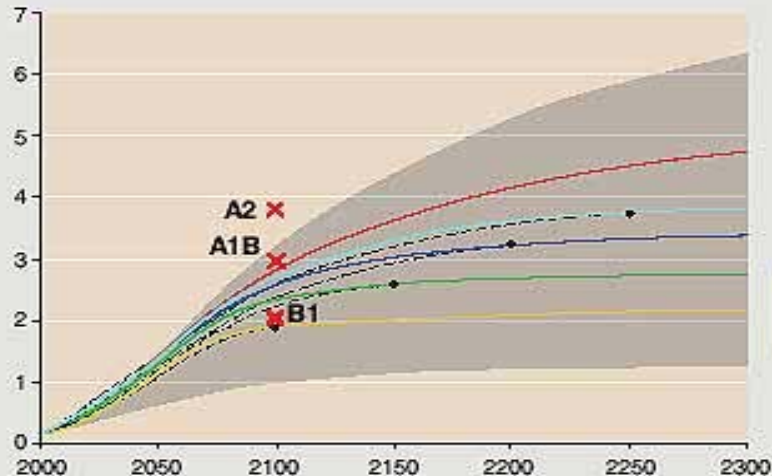
(a) CO₂ emissions (Gt C)



(b) CO₂ concentration (ppm)



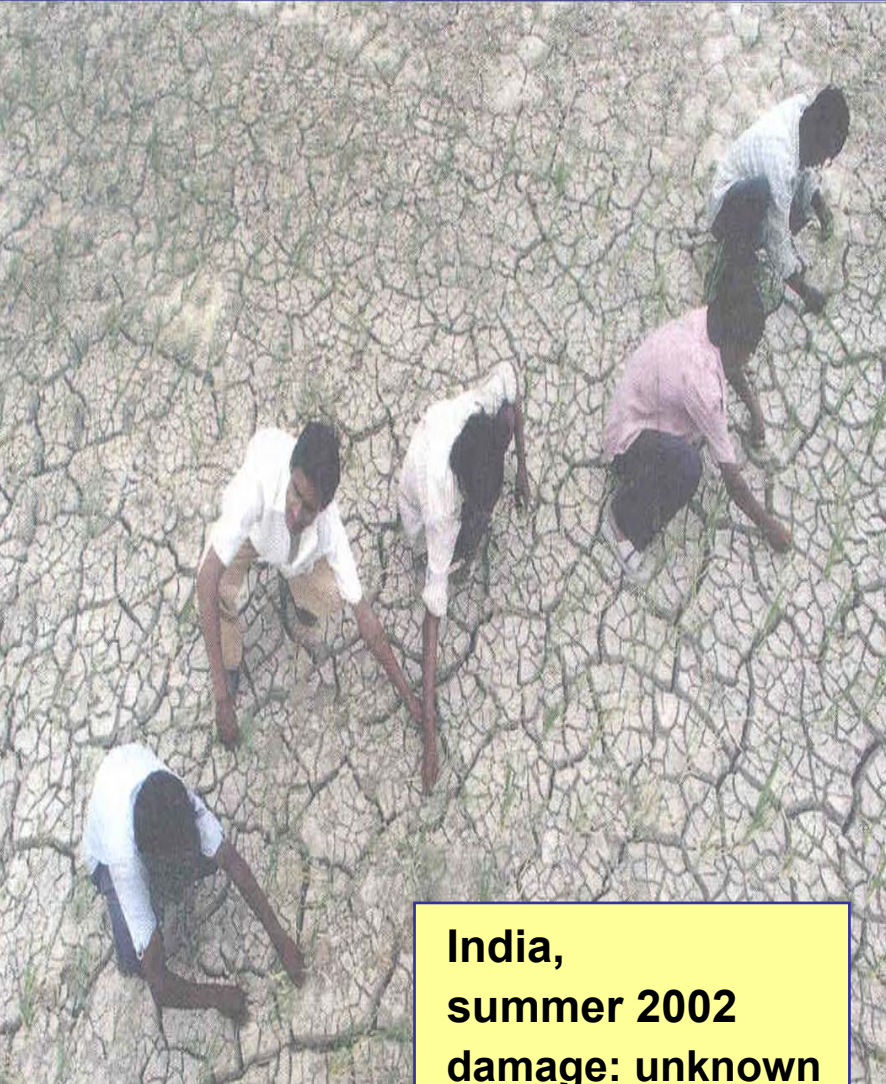
(c) Global mean temperature change (°C)



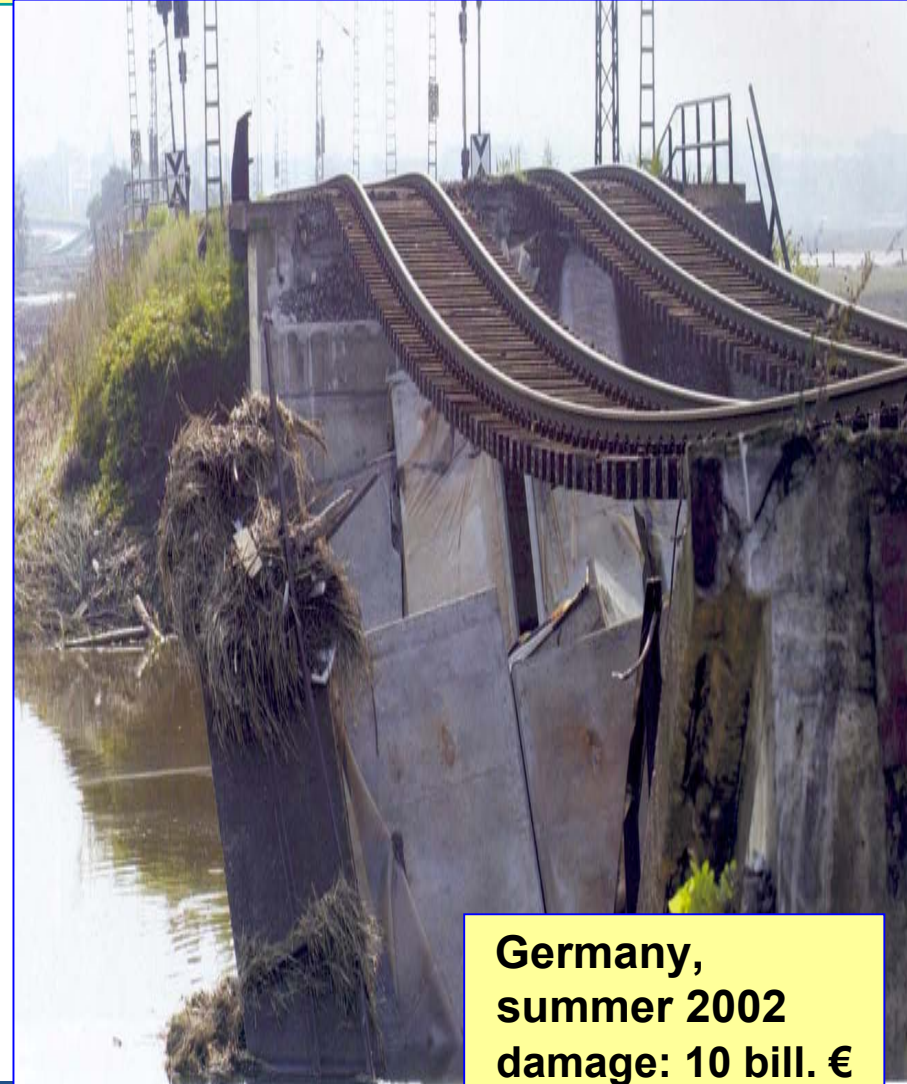
If mankind does not manage to limit temperature increase to 2°C, there is a high risk that boreal forests emit additional CO₂

SRES scenarios

**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. €**

damage and adaptation cost – even substantial today already



© Plowden/Greenpeace

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)

Amazona forests: 15'000 km² / a

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

Swiss Federal Institute of Technology Zurich

Department of Management, Technology and Economics

Energy Services

Heated Rooms
(in m²)

Industrial Products
(in tons)

Mobility
(in Pass.km)

Automation,
Cooling

Illuminated Areas
(in m²)

PC-, Phone- and
Internet Use

Useful Energy of Final Energy Sectors

PJ

Space Heat	52,200
Process Heat	49,800
Motive Power	14,100
Other Drives	20,500
Illumination	800
Information, Communication	1500

Plastics, Asphalt

9,500 PJ non-energetic use

Industry	97,000 PJ
Transportation	79,000 PJ
Private households	79,200 PJ
Trade, commerce, Etc.	39,600 PJ

Primary energy
447,150 PJ

81% fossil fuels
6.6% nuclear
12% renewables
incl. traditional wood

Final energy
294,800 PJ

Useful energy

31.5%

140,800

Losses for generating useful energy

34.5%

154,000 PJ

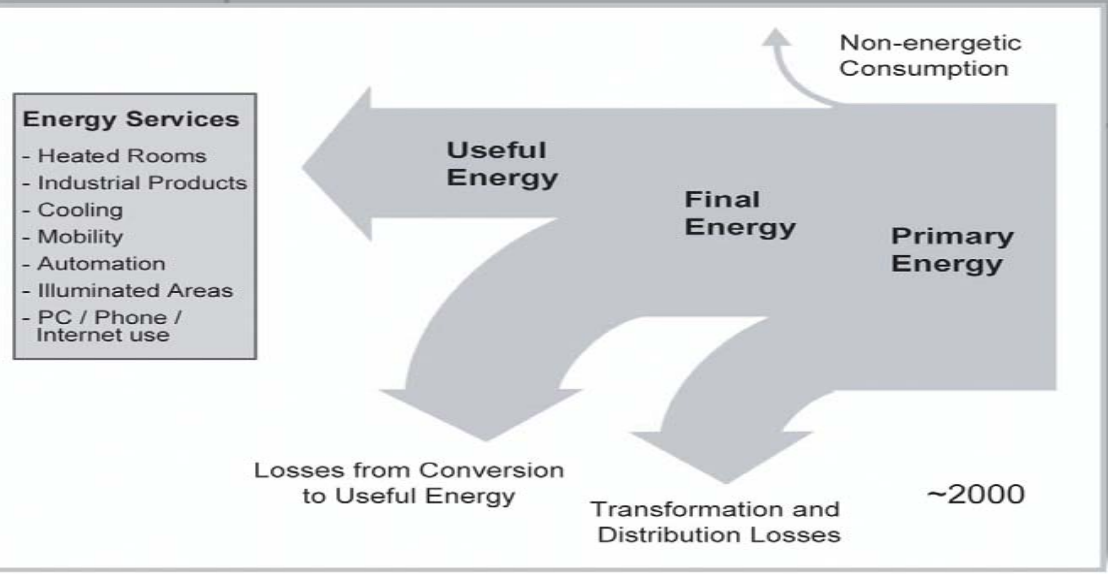
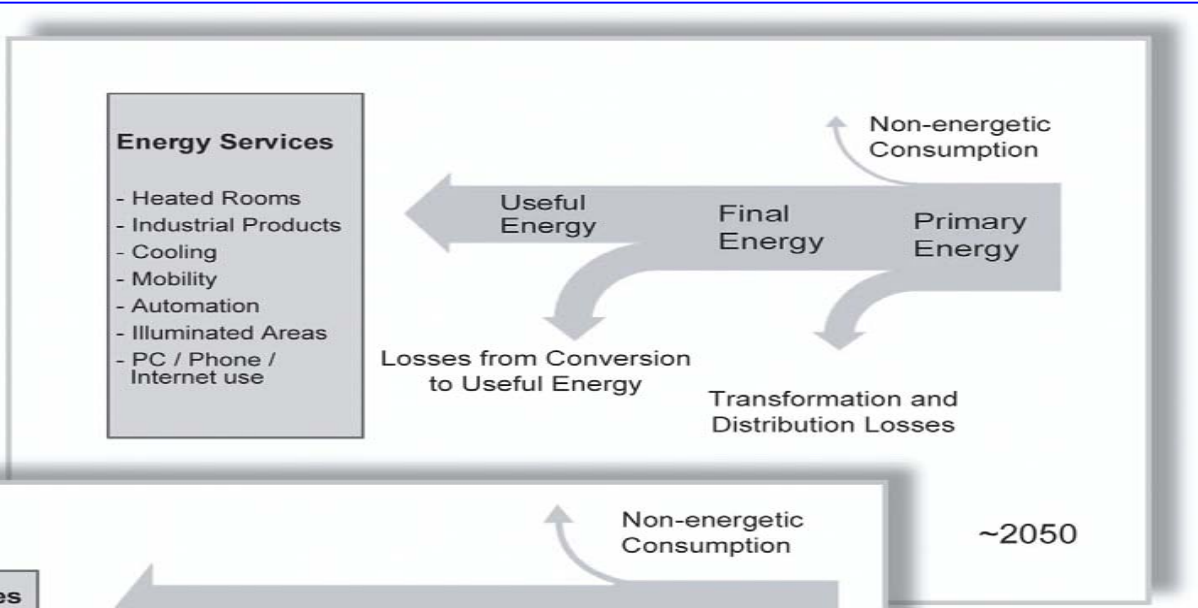
Transformation losses
(incl. 7400 PJ distribution losses)

32.1%

143,650 PJ

Sources: OECD 2005, ISI Karlsruhe

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

ETH ZÜRICH

Centre for Energy Policy and Economics

- 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) extent by biomass, natural fibres etc.
- **reduce energy demand along the whole energy chain (- 0,5 % PEC/a)**
- **entrepreneurial innovations: pooling, sharing, etc.**



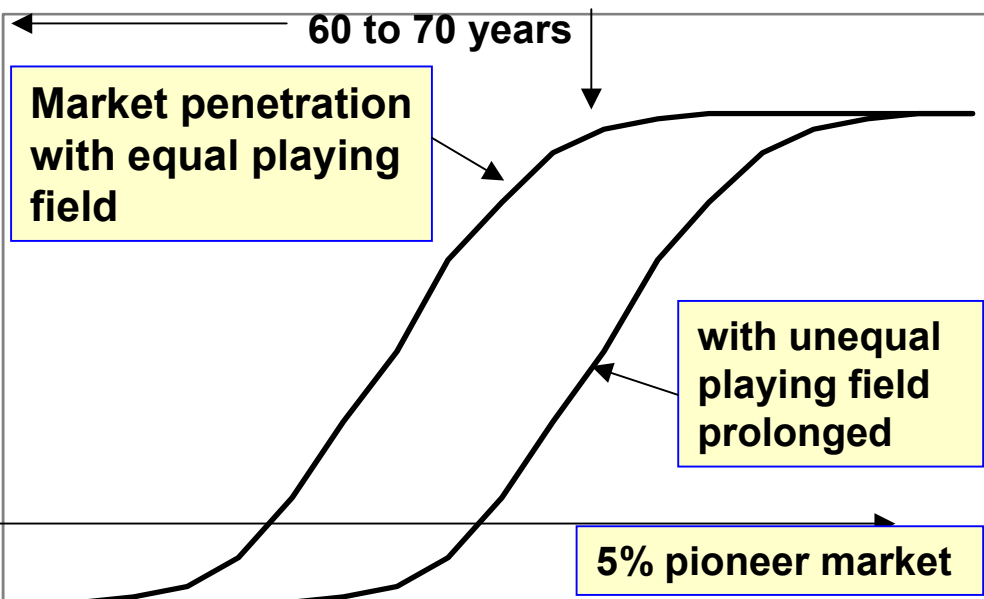
The renewables: 50 to 70 years toward full market penetration

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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**)



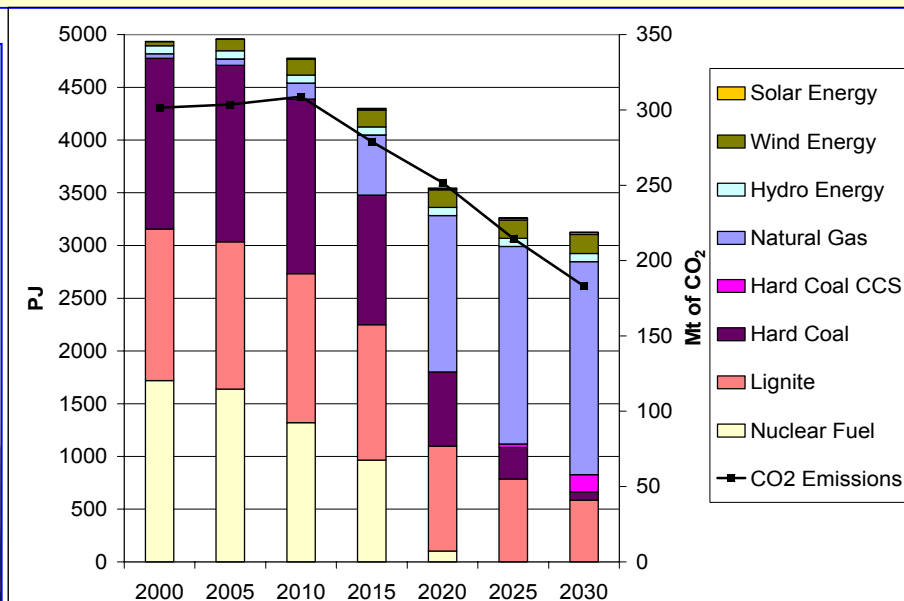
Coal and carbon capture & storage – seems unavoidable

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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



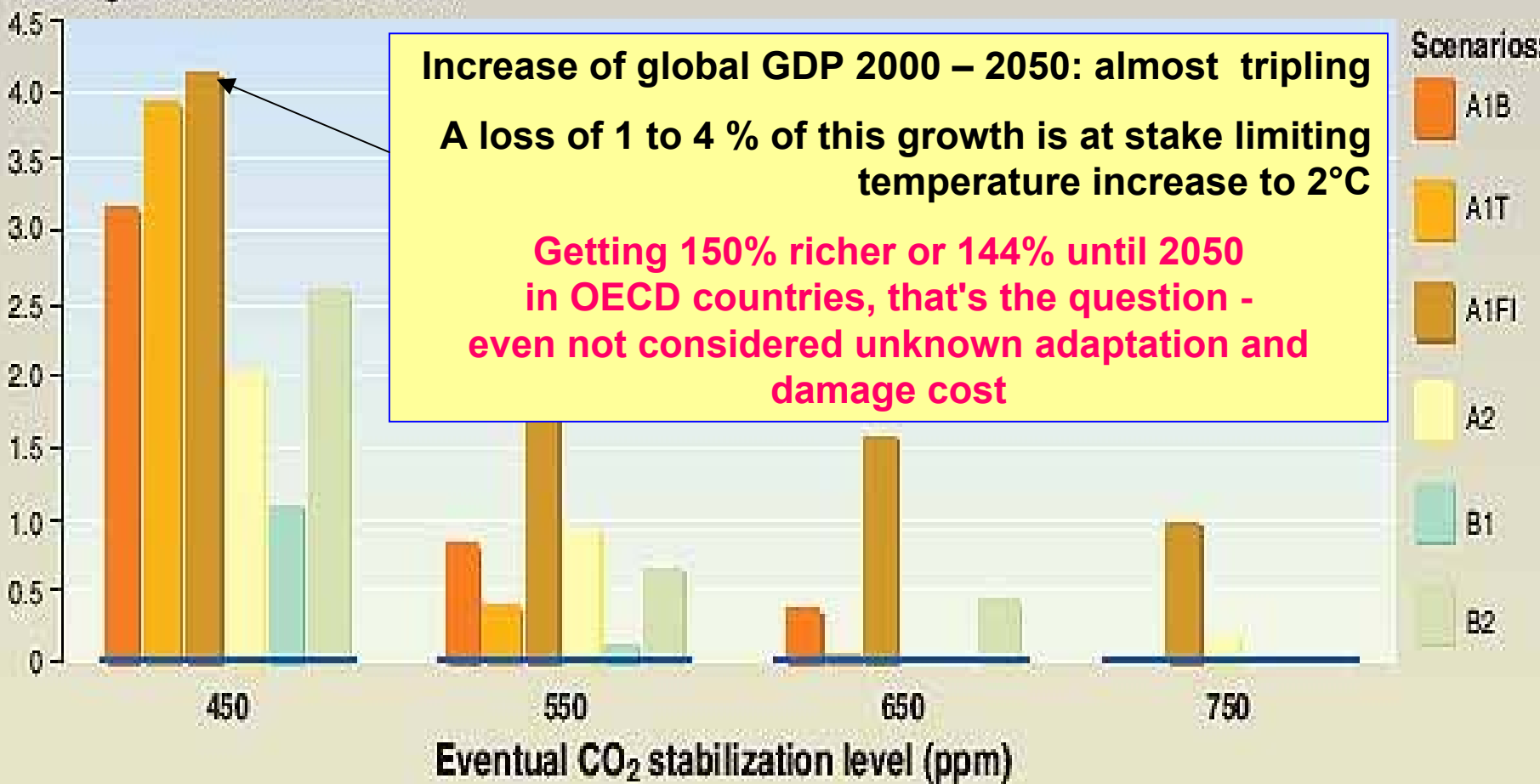
nuclear fission – societal acceptance of extreme damages limited

- **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 precautionary 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 CO₂ out of presently 26 Bill. t
 - nuclear fusion is likely to be too late and too expensive relative to

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

Global average GDP reduction in the year 2050

Percentage reduction relative to baseline



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? –

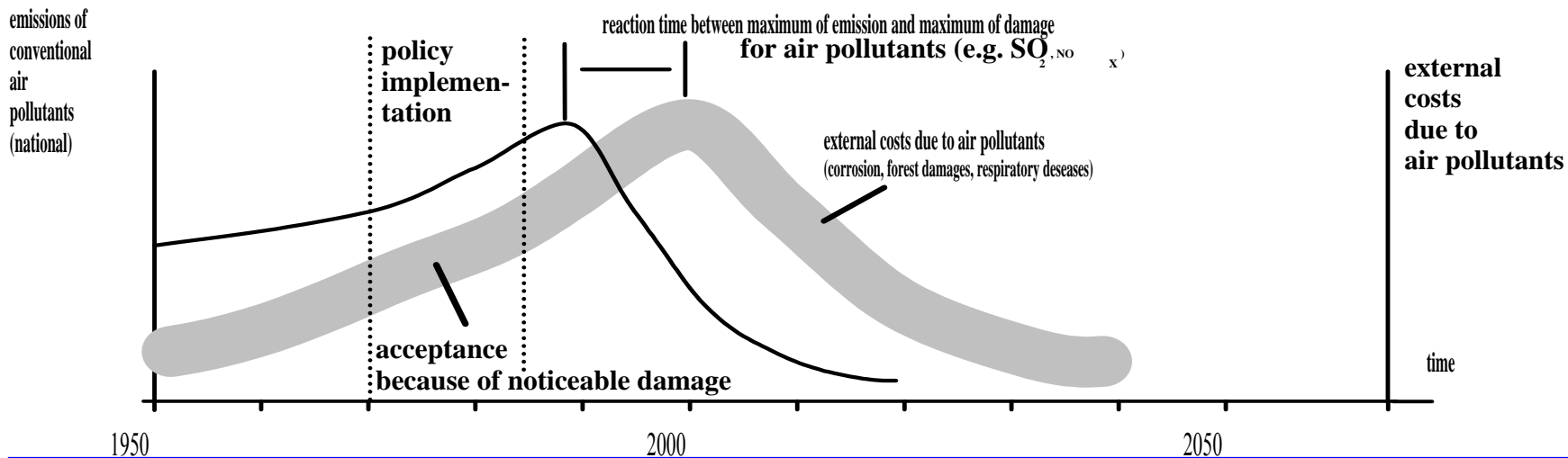
Science and technology research – still following traditions

Decisions in business – short term – following traditions and fashions

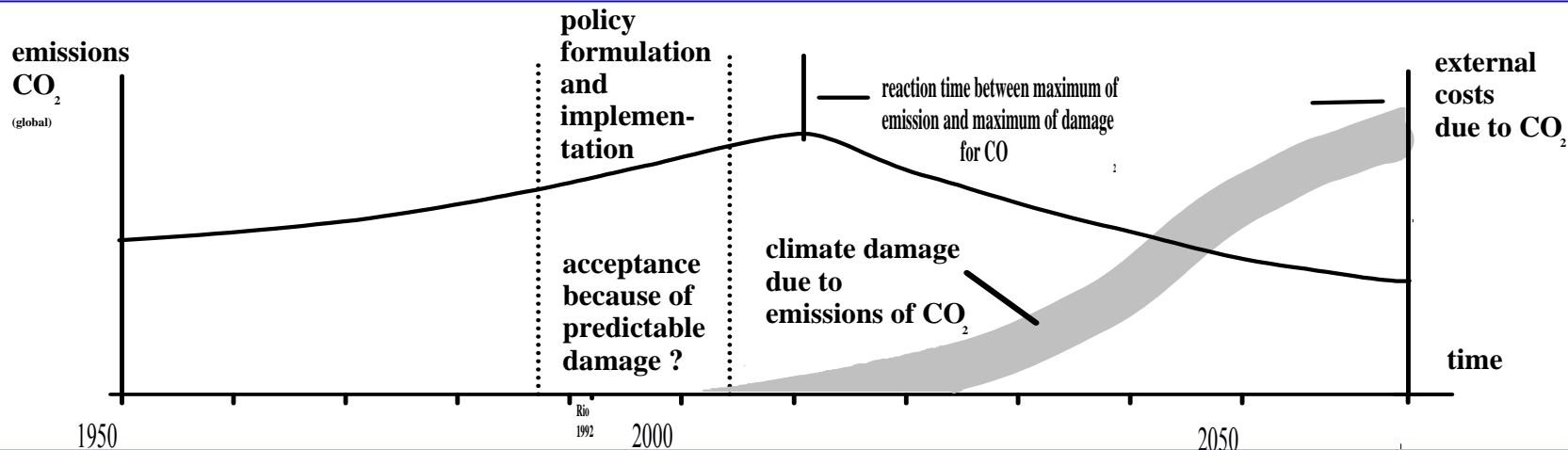
- **Science-internal reputation and career system to be adopted**
 - oriented on number of publications in peer reviewed journals ,
but not towards present and future societal needs
 - oriented to research frontiers, often methodological frontiers,
but not to interdisciplinary solutions or understanding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

**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**



**Steps towards
a sustainable development**

A White Book for R&D of
energy-efficient technologies

novatiantis
Sustainable Energy Efficiency

Eberhard Jochem | Editor |

Year 2050

Year 2000

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