Long term scenarios and options for sustainable energy systems and for climate protection: A short overview

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Abstract
Within one decade a fundamental choice will have to be made: Should the energy system follow the historical trends of risky and unsustainable energy use patterns? Or should it take the course towards sustainable development and climate protection, giving top priority to energy efficiency and to a broad mix of renewable energies? Both roads are technically feasible. “Back-casting”-scenarios could help to answer the question, what technological options are available for climate protection and how societal goals can be achieved in a cost-effective way. Lessons learned from world energy scenarios and possible implementation options will be discussed. A case study of the German Parliament’s Enquete Commission on Sustainable Energy Systems will be taken as illustration. The analysis shows that sustainable energy systems can be financed and that economic growth can be decoupled from absolute levels of non-renewable energy consumption by stepping up energy productivity.

Key words: Sustainable energy systems, back-casting-scenarios, German Parliament’s Enquete Commission on Sustainable Energy

Introduction
A turnaround in energy policy on a global scale is an elementary precondition to sustainable development. Energy wastage in the North and challenging energy shortages in the South are signals of the unsustainable trends in the global energy system. If the current global trends of primary energy consumption and increasing CO₂-emissions are not changed and if the developing countries (DC) try to copy the industrialized countries (IC) and their unsustainable production and use patterns of energy systems, the risks of climate change, of nuclear accidents and of resource wars will increase. Taking the latest Reference Scenario of the International Energy Agency (International Energy Agency, 2004) as an example and as an indicator for possible developments of the world energy system, the perspectives would be frightening: If current policies were not changed, the world’s energy demand in 2030 would be 60% higher and the CO₂ emissions would increase by even more than 60%. Though a cumulative amount of $ 16 trillion would have been invested between 2003 and 2030, the number of people without electricity will fall only slightly (from 1.5 bn to 1.4 bn) and those using only biomass for cooking and heating in unsustainable ways will even grow from 2.4 bn to over 2.6 bn in 2030. On the other hand, a look into the future based on alternative scenarios and a growing number of good practices in many countries show that this gloomy development does not have to happen. Putting only a recently considered set of new policies into practice, the perspectives could be changed to a “more sustainable” world energy system (e.g. IEA’s “World Alternative Policy Scenario”). As other scenarios for the world energy system show (see below), this “Alternative Policy Scenario” of the IEA does not include all cost effective potentials offered by a more efficient use of energy and by the huge potentials and learning effects of decentralized technologies based on renewable energies and co-/trigeneration (WEC, 1998). Mankind is at the crossroads: Within the next 10 years it has to be decided whether we want to rely on the current risky and unsustainable patterns of energy use. Or if we decide to switch to sustainable energy paths, giving first priority to energy end use and supply efficiency and fostering the market introduction of a broad mix of renewable energies. Sustainable energy paths should be based on the following principles:
- Access to energy services and fair shares for all, including fair partnerships with developing countries
• Effective conservation of resources and protection of environment, climate and health
• Social acceptability now and in accordance with the needs of later generations
• Low risks, fault tolerance and contribution to mitigate international conflicts
• Cost-effectiveness including external costs

Based on the principle of common, but differentiated responsibilities, industrialized countries (IC) should take the lead in climate mitigation: To reduce the global CO₂-emissions by about 50% up to 2050 according to the UNFCC, an even more ambitious reduction target of 80% for IC seems to be necessary in the long run. These targets are in line with a „tolerable window“ of climate change: The rate of temperature change should not be more than 0.2 °C/decade; the mean global temperature increase should not be more than 2 °C and CO₂-concentration should stay below 450ppm (WBGU, 2003)

Enhancing energy productivity: The key to sustainable development

The recent scenarios of the IEA are only one example out of many others. More than 400 long-term global energy scenarios (2050/2100) have been charted out. They differ greatly in terms of methodology (e.g. forecasts, projections, scenarios), technology mix, economic and population growth, as well as CO₂-emissions. What are their messages for decision-makers: Everything is possible in an uncertain future? Wait and see, let the markets find the right solutions? Should we rely on the conventional wisdom of recent energy policies and a “laissez-faire” style of politics? The answer is no, because “business as usual” (BAU) would be a disaster. The purpose of scenarios and the strategies change when we ask “How do we want to live in future and how do we get to agreed societal goals?” founding new politics on a “back-casting” scenario analysis and cost-effective energy services. As an example: As soon as societal goals for climate protection have been decided by parliament (e.g. a reduction of CO₂ by 40% up to 2020 in OECD countries) “back-casting”-scenarios could help to answer the question whether and how this goal can be reached in a cost effective way (Bleischwitz and Hennicke, 2004).

Of course, with this methodology we cannot avoid future uncertainties and surprises, but we can change known unsustainable trends now and base our long-term decisions on precautionary and safety principles. In short: it should be tried to decouple the increase of living standards and energy services as much as possible from the use of non renewable and risky energy supply (Miketa, et al., 2002). This could be done by a global convergence strategy: Cut per-capita energy consumption in IC (at least by half) through more efficient use of energy without decreasing living standards. Keep the necessary development-related increase of per capita energy consumption in DC as low as possible from the very outset by deploying state-of-the-art energy conversion technology, while standards of living can grow rapidly. How is that possible?

More wealth with less energy consumption: A global “Factor Four”-scenario

What would the world of energy look like in 50 years if all efforts were based upon maximised end-use efficiency and the consumer needs (in all sectors including industry and transportation) for cost-effective, risk-minimising energy services? The user seeks the utility derived from energy (e.g. warm housing, electric power, mobility), the kilowatt hours of final energy are merely the means to these ends. The ultimate economic goal of energy use is not cheap and risky kilowatt hours, which can be expensive when external costs are added. Instead, the economic rationale of sustainable energy systems aims to deliver least cost energy services, which are calculated on a life cycle cost base (including a pragmatically calculated adder for external costs) plus the incremental costs of efficient conversion technologies.

This concept of least cost energy services is closely connected to the “Factor Four” formula and the report to the Club of Rome (Weizsaecker, et al., 1998). The “Factor Four”-Scenario produced by the Wuppertal Institute (Lovins and Hennicke, 1999 and Lovins, et al., 2004) has taken up the basic ideas of the Weizsaecker-Lovins report and investigated whether the subtitle of the book – “Doubling Wealth, Halving Resource Use” – could be taken as the guiding concept for a worldwide energy strategy. The “Factor Four”-scenario is based on the assumptions of the WEC-scenarios (Nakicenovic and Riahi, 2001 and German, 2002) concerning the main drivers (GDP and world population growth) and regional differentiation. The overall message coming out of this complex modelling analyses is the following: Up to 2050 a factor of three in efficiency improvement is possible and would suffice, in combination with vigorous market introduction of renewables, to pave the way for a sustainable world energy system (50% CO₂-reduction; necessary increase of living standards; gradually phasing out