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Facts for the energy decisions of tomorrow

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ENERGIE-SPIEGEL

FACTS FOR THE ENERGY DECISIONS OF TOMORROW

IN FOCUS: THE SWISS ELECTRICITY MIX

The Swiss electricity mix is currently much under discussion. How clean, environmentally friendly and economical really is the current combination of 40% nuclear energy and 60% waterpower? Additional questions inevitably emerge. Are there real alternatives to the present power supply now or in the near future? Do they make more ecological, economical and social sense? Can they be financially achieved? Put another way: How does the current electricity mix agree with the needs of sustainable development, and how can it be improved?

Sustainability has many facets. Many of these have already been covered in previous editions of the Energy-Spiegel. If one wishes to factually judge the different technologies for electricity generation, one needs to consider them comprehensively and compare these different facets. Different criteria show competing technologies' relative strengths and weaknesses.

This issue of the Energie-Spiegel addresses points that should play a role in a scientifically-based plan for Switzerland's energy future, and deals with options for the future Swiss electricity supply. Particular attention is paid to the potential size and cost of renewable energy sources and energy conservation measures.

The facts show that there is no ideal technology that fulfills all our most important criteria – clean, safe and affordable. It follows therefore that one should not abandon any option in building the best possible electricity mix for Swiss conditions. Compared with the realistic alternatives that are available in the short and medium term, the current mix stands up quite well.

What is the "Optimum" Electricity Mix

Natural conditions and socio-economic structures form a framework, within which an optimal power supply must be designed. If one holds to the principles of sustainable development, there emerge three main criteria for an electricity mix: It must be ecologically justifiable, economically bearable, and socially compatible. However sustainable development also demands the step from an isolated point of view to a global perspective – and the obligations that come from being an industrialized country with above average consumption.

Greenhouse Gases It is today well agreed that our electricity mix should be ecologically bearable. Everyone wants clean air and water, the more so because the atmosphere is already heavily burdened by pollutants from heat and transportation demand. The criterion of greenhouse gas emissions must therefore be regarded as elementary. On this point, the current Swiss mix of water and nuclear power is convincing: a more exact look at the energy chains shows that it is practically free of CO_2 as well as other health and environment endangering emissions (Figure 1). Any radical change in this mix would work against the declared goal of Switzerland to reduce CO_2 emissions (according to the Kyoto Accord and the CO_2 law). If our electricity demand continues to grow slowly, it will however only be possible to keep a CO_2-free electricity sector by maintaining it on the basis of the currently available carbon-free energy carriers, i.e. water and nuclear energy. At the same time, 'new' renewable energy sources (biomass, solar, wind, etc.) must be implemented and, above all, energy savings measures strongly demanded.

Potential The potential for new hydropower in Switzerland is largely exhausted. Large new storage dams are relatively expensive, and rarely acceptable on the grounds of environmental protection. An increased use of new, renewable energies is therefore thoroughly desirable. However their medium-term potential for generating electricity in Switzerland is greatly limited, because the climatic conditions for widespread use of solar and wind energy are relatively poor. Renewable energy resources have significantly more potential for providing heat, e.g. solar energy can be sensibly and affordably used to provide warm water. In the best case, new renewable energy sources can provide about 5-6% of our current electricity demand in the next 20 years – providing their use is strongly encouraged. This compares to an increase in the electricity demand of 8% in the last 5 years alone.

The potential of energy saving measures is much larger (see Figure 2). However the present trend shows how difficult it is to fully utilize. If one wants to significantly raise the share of new renewables in the electricity demand and to really demand energy saving measures, it is necessary to reckon on large investments – and a genuine will to save. A future share of 5% from new renewables would demand investments of about 5 billion Francs. It would cost 10 to 15 billion to save 15% of current electricity demand – an investment that would be repaid in large part by savings of fuel and operating costs.

Decentralized cogeneration would be a partially attractive alternative, but limited due to its greenhouse gas emissions and higher costs (see Energy-Spiegel 2).

Renewable Energy and Energy Efficiency: Potential and Costs

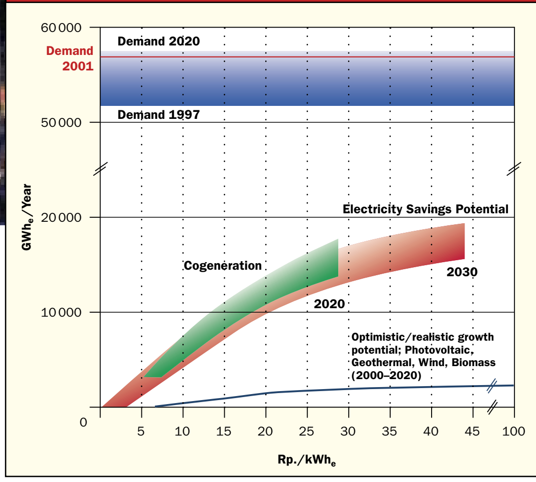


Figure 2 Potential und costs of "new" renewable energy, electricity savings measures and decentralized cogeneration

A Safe Supply A stable and affordable electricity supply is a fundamental element of public service - and a sustainable energy balance. The safety of supply depends on the availability, the short-term capacity to expand, and in the long-term on the global resources of the energy carriers, which should not be exhausted.

The performance of new renewable energy sources like the sun and wind fluctuates greatly, depending upon the time of day and season of the year. Therefore an increased use of renewable energy is only practical if dependable storage systems are simultaneously available – which makes it accordingly more expensive.

Seen in a geopolitical light, a strong dependence on imported energy (oil or gas and the corresponding transportation capacity) is undesirable. The current electricity mix clearly meets this goal. Small amounts of nuclear fuel last for many years, they are imported predominantly from politically stable countries, and can be easily and safely stored.

Greenhouse Gases from the Electricity Mix

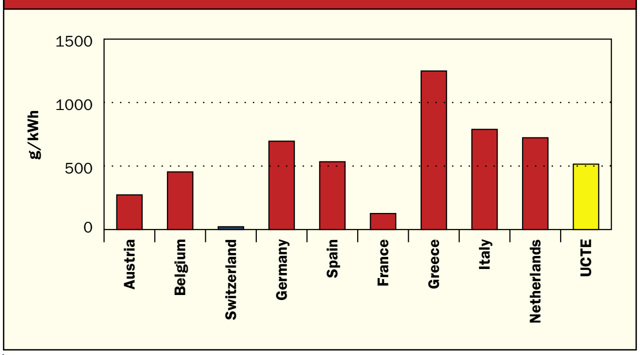


Figure 1 Average greenhouse gas emissions of European countries (UCTE), based on life cycle analysis.

SETTING CRITERIA FOR SWITZERLAND?

Cost True costs in the area of energy mean that internal costs (extraction, production, transport and waste disposal) are calculated together with external costs, i.e. the costs that an energy carrier causes over the entire energy chain (health and environmental damages, as well as global climate warming).

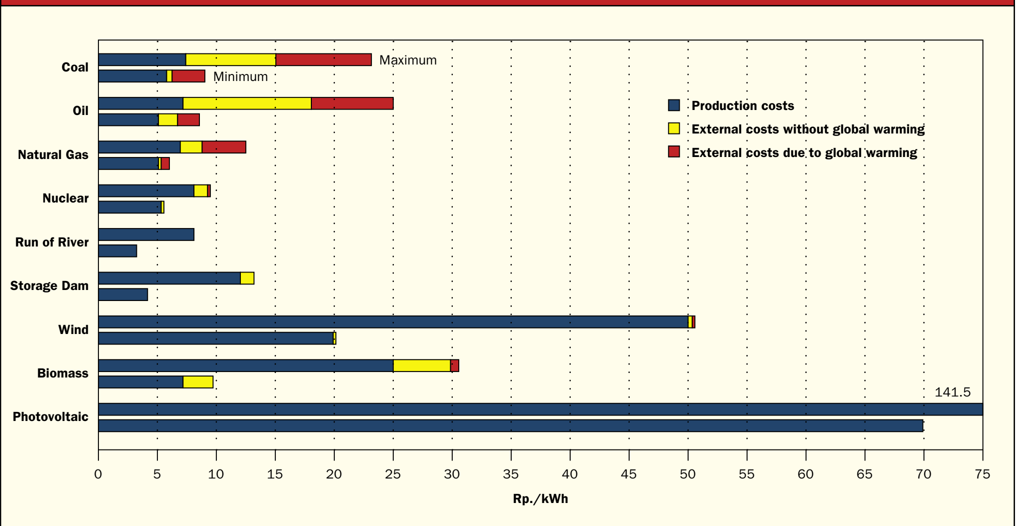
The total of internal and external costs is a real measure of the economic and ecological performance of individual options (see Figure 3). The low total costs of the current electricity mix speak in its favor, and also reflect the low environmental burdens of these technologies. An internalization of external costs would further raise the competitiveness of hydropower and nuclear energy, and would also be very advantageous for some renewable energy sources.

Risks & Wastes Accidental risks and wastes damage the social acceptance of technologies. These problems reduce the relative sustainability of nuclear energy, but are not limited only to it. The quantities of waste from the nuclear chain are relatively very small, but must stored for very long times in a secure, final storage facility. With regard to waste, the hydropower chain is superior to all other options.

The risk of severe accidents, for example like a large dam break or a nuclear core meltdown with the release of significant quantities of radioactivity is extremely small in Switzerland. The statistical number of expected accidental deaths per kWh of electricity generated is much higher for fossil energy chains than for hydropower and nuclear energy in the OECD countries. A hypothetical accident in a hydro or nuclear power plant could certainly cause very large damages. Although very small, the risk of such an accident also goes along with the advantages of our current electricity mix

If one comprehensively evaluates all the existing options available, trade-offs are in general unavoidable, and for certain advantages one must also accept disadvantages in other areas. A single optimal option for electricity generation that will fulfill all the requirements of sustainable development, is significantly better in the most important criteria, and has no risks does not exist.

Production and External Costs: Current Systems



Future Systems

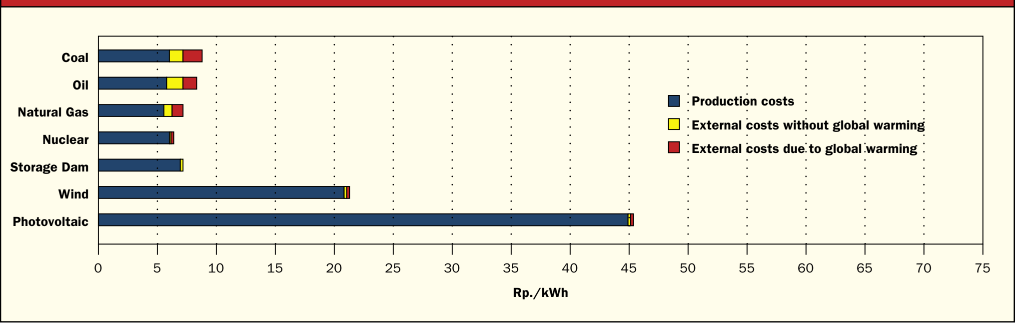


Figure 3 A comparison of present and future systems shows that external costs drop strongly, due to the large technological improvements expected and new knowledge about the dose-response-relationship.

INTERVIEW

Prof. Alfred Voss studied engineering at the RWTH Aachen. After 12 years of work at the Jülich research center, he assumed the professorship for energy economy and energy systems at the University of Stuttgart in 1983. Since 1990 he also leads of the Institute for Energy Economics and Rational Energy Use (IER) located there. He is a member of the Enquête-Commission on Sustainable Energy Supply under the Conditions of Globalization and Liberali-

"Broaden Our Energy Base, Not Limit It"

Can science deliver today's decision-makers with firm grounds for deciding energy questions? Clearly, yes. In the last 20 years methods and models have been developed in interdisciplinary cooperation, which make essential contributions to the basis of complex technical and socio-economic decisions. By these means it is possible to identify the sensible next steps on the path to a sustainable energy supply. This process is marked by uncertainties, e.g. price trends in international energy markets, necessary decreases in greenhouse gas emissions, as well the targetable advances in different energy technologies.

Can one measure the sustainability of specific energy technologies? To do this it is necessary to make more concrete the content of our model of sustainable development, bearing in mind the laws of nature. The core determinant of the relative sustainability of energy technologies is based on their relative resource consumption (including limited environmental resources). The full costs of energy technologies – including the respective costs of their environmental demands – are sensible measures for this.

What would be a clear step in direction of a sustainable energy supply? First, the costs of the environmental demands must be correctly calculated and charged, so that the prices of energy carriers and readily available energy services reflect their actual resource use. One must also re-strengthen energy research, which has been drastically reduced in the last 20 years. R&D is the only systematic way to make the necessary advances and innovations required for the sustainable development of our future energy supply, i.e. higher resource use efficiency and smaller environmental effects of energy systems, as well as a broadening of the economically available energy base.

What potential does renewable energy have? The technical potential for electricity generated from wind, hydro, solar and geothermal resources is on the order of magnitude of current electricity demand. But except for hydropower, the costs for the use of this potential are still so high today that a contribution to a sustainable power supply is not currently possible. Continued research and development efforts are necessary to reduce these costs.

Can wind energy from Germany be imported on a large scale to Switzerland? It is not conceivable in the foreseeable future that wind energy imported to Switzerland will be competitive with Switzerland's own generation resources.

Can individual sources of energy be renounced today? A sustainable energy supply for a growing world population is a great challenge, which we must meet. In this perspective it would be counterproductive to abandon any of the possible options foreseeable today for further development in technologies for the use of fossil, nuclear and renewable energy sources.

What influence does scientific input have on the political decision of energy issues? Frequently the mantle of science covers not only scientific knowledge, but also subjective value judgments that bear on energy policies. Advice on energy polices must become scientifically more assertive and politically more modest to reach a more appropriate influence on energy policy decisions.

IMPRESSUM

ENERGIE-SPIEGEL, or Mirror On Energy, is the newsletter of the GaBE project at PSI. GaBE is the abbreviation for Ganzheitliche Betrachtung von Energiesysteme, which translates as Comprehensive analysis of Energy Systems. The Energie-Spiegel appears every four months. Contributors to this edition include Dr. S. Hirschberg, Prof. Dr. A. Wokaun und K. Foskolos

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Energy Systems Analysis at PSI
The goal of energy systems analysis at the Paul Scherrer Institute in Villigen is to analyze present and future energy systems in a comprehensive and detailed way, considering in particular health, environmental and economic criteria. On the basis of Life Cycle Assessment (LCA), energy-economic modeling, risk analysis, pollution transport models and finally multi-criteria decision analysis, it is possible to compare different energy scenarios to create a basis for political decision-making.

GaBE works closely with other institutions, including:

- ETH Zürich
- EPF Lausanne
- Massachusetts Institute of Technology, MIT
- University of Tokyo
- Europäische Union, EU
- International Energy Agency, IEA
- Organisation für wirtschaftliche Zusammenarbeit und Entwicklung, OECD
- Organisation der Vereinten Nationen, UNO