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Sustainable energy supply for Germany – Results of the Enquete Commission of the German Parliament

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Summary of the report of the "Enquete Commission on Sustainable Energy Supply Against the Background of Globalisation and Liberalisation" by Harry Lehmann, Director of ISUSI and Chairman Eurosolar

Short summary of the Final Report

The consensus view is that Germany's current energy supply system is not sustainable. The Commission confirms that a sustainable energy supply, based on renewable energy resources and efficient energy technologies is technically feasible and economically beneficial. A sustainable energy supply represents an opportunity for Germany. Sustainable development is a technical, economic, social and institutional challenge and a political response to globalisation. Liberalisation is a supporting measure to achieving sustainable development.

Sustainable development requires observing the barriers imposed by nature. This leads to a hierarchy of sustainable development objectives that are not consistent with the factual priority still granted to economic objectives today: Any irreversible damage to natural life support systems must be prevented because intact natural resources are the prerequisite to economic and social development.

Objectives of a sustainable energy system

The production and consumption patterns that currently predominate worldwide create major environmental problems. The release of substances into the environment due to non-closed material cycles, the high energy consumption associated with these production and consumption patterns, the resulting emissions and the nuclear risks, as well as the vast areas of land used, are not compatible with the concept of sustainable development.

In its First Report, the Commission stated that the current consensus was that the model of "sustainable development" encompassed three dimensions: the conservative use and preservation of natural life support systems, as well as the social and economic development. Bearing this in mind, the Commission wanted to define ecological, social and economic objectives that should be largely compatible with each other.

The majority of the Commission's members felt that it is possible to identify natural barriers for ecosystems and the atmosphere – barriers that as a matter of principle impose limits on human activities. The term "natural barrier" is used metaphorically to indicate that nature imposes limits on man-made interventions in natural cycles, and that going beyond these limits is associated with unacceptable risks for the individual and society at large. However, these "natural barriers" are not rigid boundaries; they can be identified in terms of ranges, rather than clearly defined limit. This leads to a hierarchy of sustainable development objectives that are not consistent with the factual priority still granted to economic objectives today: Any irreversible damage to natural life support systems must be prevented because intact natural resources are the prerequisite to economic and social development. For this reason, the Commission first defines the requirements to be met by a sustainable energy supply system from an ecological perspective. This leads to the emergence of a corridor of objectives, within which it is then possible to define social and economic objectives.

- **Ecological objectives**: The global reduction of energy-related greenhouse gases is the core of energy and transport policies designed to achieve sustainable development. The goal must be to stabilise the global climate. The concentrations of harmful substances must be reduced below the so-called critical loads in all regions worldwide. By the year 2050, the quality of water resources should not drop below water quality grade II as defined in Germany. The net use of land for residential settlement and transport purposes and for the extraction of raw materials should be reduced to zero by the year 2050. The global energy supply system must be designed in such a way that they will no longer generate any highly radioactive waste in future. The risk of extremely serious accidents occurring in energy generation facilities must be minimised as quickly as possible

- **Social objectives**: All citizens must be given free and reliable access to services in the energy sector. The percentage share of money spent by private households on energy costs should not be allowed to increase. The energy supply system must be subject to democratic decision-making structures. The lives and health of employees in the energy sector must be protected and the interests of workers should be safeguarded. Increased training in renewable energy systems is required.

- **Economic objectives**: Energy productivity is expected to increase by a factor of 2.5 between 1990 and 2020, and by a factor of 4 by the year 2050. Energy efficiency activities will also reduce the external costs of the energy supply system. A long-term and sustainable approach is required to energy. Reliability is vital, therefore combined heat and power and renewables must be promoted. Renewables have to be promoted in Germany to offer a “First-mover advantage”. Improve competitiveness and reliability of supply and reduce dependence on imports esp. oil. It will be necessary to find solutions that decouple transport services from fuel consumption. Stabilise the total mileage in the fields of motor vehicle road transport and in aviation by the year 2010. Limit the increase in the volume of road freight traffic and air traffic.

The development in Germany: Potentials and scenarios

In order to be able to design strategies aimed at developing a sustainable organisation in the future energy industry, it is necessary to develop concepts regarding the possible effects – up to the year 2050 – of a continuation of current trends and future trends to be expected in the development of demographic, social, technological, economic and political variables. Three groups of scenarios were used to study the concrete implementation of a GHG reduction target of 80%, which is necessary to stabilise the global climate.

The first group of scenarios (UWE) is primarily focused on reducing emissions in the conversion sector, including the separation and storage of CO2 in repositories. The “RES/EEU Initiative” group of scenarios assumes that nuclear power will be phased out completely by the year 2030 and that, by the year 2050, fossil fuels will be phased out as much as is required to attain the global warming management targets. By way of compensation, efforts to increase energy efficiency and to use renewable energy sources will be substantially stepped up. According to the targets, at least 50 per cent of the primary energy consumption should be covered by renewable energy sources by the year 2050. In addition, a variant of this scenario – called “Full Solar Supply” – was modelled in which energy supply is ensured exclusively by renewable energy sources by the year 2050. In response to the events on 11 September, a third variant was examined to find out whether the use of nuclear power could be phased out within a very short period of time.

At the suggestion of the minority of the CDU/CSU and the FDP, the Commission defined a third group that permits an increase in the use of nuclear energy in order to attain the reduction target of 80 per cent, which in the final analysis will lead to the construction of between 50 and 70 new nuclear power stations. The scenarios were calculated independently by two institutions.

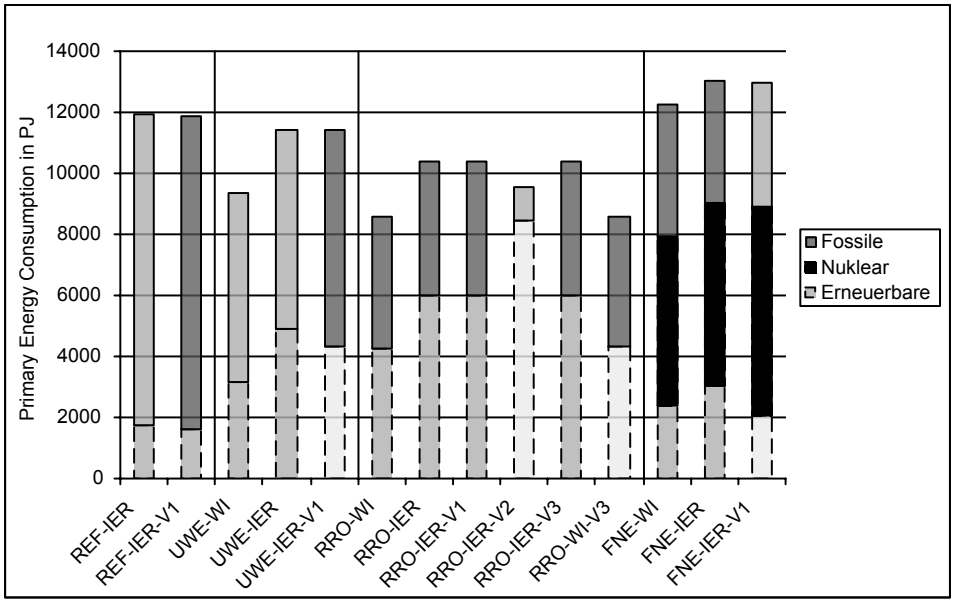

Chart 1-1: Primary Energy Consumption by the Year 2050, According to the various scenarios

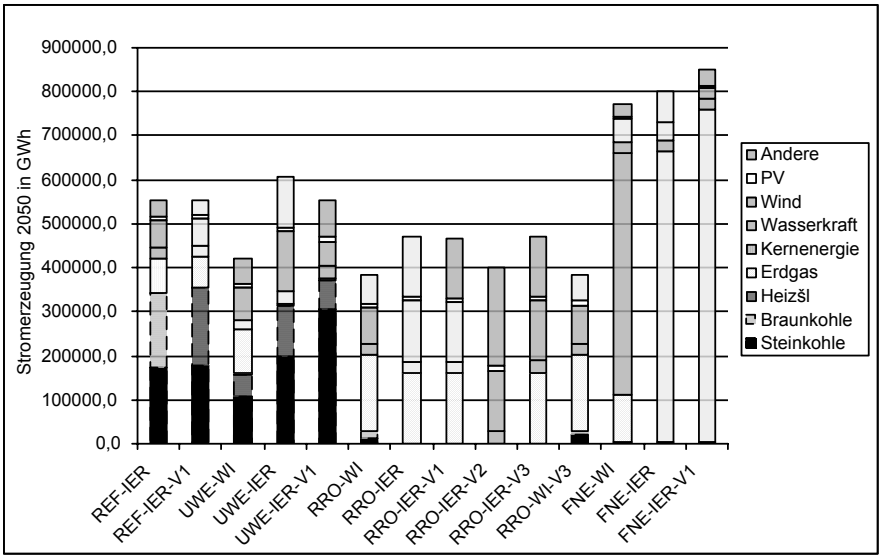

Chart 1-2: Net Electricity Supply by the Year 2050

Chart 1-2 shows the power plant portfolios by the year 2050 as predicted by the simulations. Table 1–1 provides a summary of the scenario results.

The results of an analysis of the various development paths can be summarised as follows:

- It is possible to phase out nuclear power.
- A major role for hard coal and lignite is only sustainable if a technological and cost-effective solution is found for the separation and permanent storage of CO_2.
- In some scenarios, natural gas has an important bridging function to facilitate the final transition toward CO_2-free energy sources.
- It is possible to cover the total energy demand by means of solar energy.
- The scenarios of the RES/EEU Initiative (RRO) is a development path that permits other development options, also beyond the time horizon under review in the report.

			REF-IER	UWE-WI	UWE-IER	RRO-WI	RRO-IER	RRO-IER Var. 2*	RRO-IER Var. 3	RRO-WI Var. 3	FNE-WI	FNE-IER
End-point energy	Total	PJ	8.208	5.918	6.656	5.156	5.910	5.531	5.909	5.183	6.140	7.229
		GJ/cap	121	100	87	82	87	76	87	91	76	107
	Transport	PJ	2.299	1.247	1.975	1.122	1.669	1.894	1.667	1.122	1.409	2.115
	Households		2.221	1.632	1.732	1.352	1.654	1.474	1.653	1.368	1.651	1.814
	CTS		1.389	1.075	1.169	950	1.057	1.065	1.057	952	1.093	1.275
	Manufacturing		2.299	1.964	1.779	1.732	1.530	1.099	1.532	1.742	1.987	2.026
End-point energy by source of energy	Renewables	PJ	334	796	1.220	1.142	1.437	2.136	1.424	1.204	690	1.065
		EEC share	4%	13%	18%	22%	24%	39%	24%	23%	11%	15%
	Other	PJ	152	718	34	252	78	675	81	44	906	7
		EEC share	2%	12%	1%	5%	1%	12%	1%	1%	15%	0%
	Total renewables	PJ	486	1.514	1.254	1.394	1.515	2.811	1.504	1.247	1.596	1.072
		EEC share	6%	26%	19%	27%	26%	51%	25%	24%	26%	15%
	Fossil	PJ	5.539	2.277	2.644	1.864	1.989	300	1.988	1.864	2.465	2.634
		EEV share	67%	38%	40%	36%	34%	5%	34%	36%	40%	36%
	Electricity	PJ	1.816	1.542	1.935	1.368	1.563	1.495	1.564	1.368	1.793	2.628
		EEC share	22%	26%	29%	27%	26%	27%	26%	26%	29%	36%
	Heat	PJ	368	427	823	286	843	925	853	286	240	761
		EEC share	4%	7%	12%	6%	14%	17%	14%	6%	4%	11%
Primary energy	Total	PJ	11.937	9.348	11.400	8.552	10.397	9.547	10.396	8.599	12.266	13.048
		EEC share	176	138	168	126	153	141	153	127	181	192
	Renewable	PJ	1.765	3.130	4.896	4.266	5.998	8.420	5.993	4.318	2.381	3.041
		EEC share	15%	33%	43%	50%	58%	88%	58%	50%	19%	23%
	Fossil	PJ	10.172	6.218	6.504	4.285	4.398	1.127	4.404	4.281	4.321	4.009
		EEC share	85%	67%	57%	50%	42%	12%	42%	50%	35%	31%
	Nuclear	PJ	0	0	0	0	0	0	0	0	5.563	5.997
		EEC share	0%	0%	0%	0%	0%	0%	0%	0%	45%	46%
System costs	Cumulative cost difference vs. reference (€ 19,182.6 billion)		€/cap	3.333	5.134	2.966	9.106	25.383	9.954		2.077	-4.928
	Cumulative cost difference vs. reference discounted to 1998 (€ 9,280.1 billion)		€/cap	527	1.158	596	2.094	6.136	2.560		227	-1.345
	Cost difference vs. reference in 2050 (€ 5,201.6 billion)		€/cap for 2050	298	323	170	605	1.225	616		175	-144
	Cost difference vs. reference in 2050 discounted to 1998 (€ 676.7 billion)		€/cap für 2050	39	42	22	79	159	80		23	-19
External costs	Cost difference vs. reference in 2050 (€ 5,074.8 billion)		€/cap for 2050	-1.848	-2.338	-2.201	-2.649	-2.700	-2.647		14.717	17.515
	Cost difference vs. reference in 2050 discounted to 1998 (€ 660.2 billion)		€/cap for 2050	-240	-304	-286	-345	-351	-344		1.915	2.279

Total percentages may be greater than 100 per cent due to rounding errors.
* For reasons inherent in the model, renewables cannot cover full demand. The balance relative to 100 % in the primary energy share is due to the use of energy sources for non-energy purposes.

Table 1-1: Overview of the Results of the Various Scenarios

It is technically and economically feasible from today's perspective to reduce greenhouse gas emissions by 80 per cent by the year 2050 (relative to the 1990 level). All the technology paths examined in the target scenarios make it possible to achieve the ambitious greenhouse gas reduction targets. The results predicted in the scenarios can only be achieved if the technological developments assumed in the models are supported and promoted by the necessary framework conditions and energy policies. Structural changes such as the transition from an energy supplying industry to a solar energy services industry, or even higher conceivable rates of improvement in resource efficiency (e.g. by a factor of 10) were either not taken into consideration at all in the scenarios, or only to a very limited extent.

It was possible to identify three robust trends that are common to all scenarios:

- **Energy efficiency** All scenarios the predict increases in efficiency go beyond the trend. Major energy conservation potentials are found in buildings so energy saving measures in this area is vital, but all sectors will have to make their contribution.
- **Renewable energy sources** All the scenarios including the (fossil) Conversion Efficiency scenario involve a much greater use of renewable energy sources than the reference scenario (see chart 1-3). The mix of renewables will be determined by need for reliability.
- **Secondary energy sources** In all scenarios, hydrogen is introduced as a new secondary energy source by the year 2050 at the latest. Considerable efforts will have to be made to develop a sustainable energy supply system in general and to achieve the global warming management targets in particular Early decisions are therefore required.

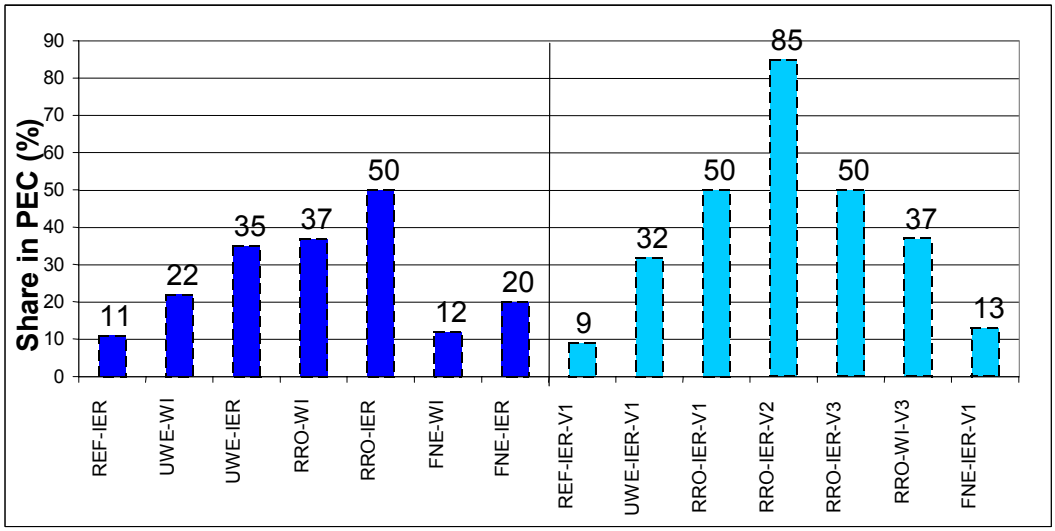

Chart 1-3: Share of Renewable Energy Sources in Total Primary Energy Consumption

Note: In the "Full Solar Supply" scenario, an analysis of the remaining shares shows that these can also be covered by renewable resources.

Scenarios vary widely in terms of their sustainability

The scenarios vary as far as the implementation of the principles of sustainable energy supply is concerned. While all scenarios achieve the reduction of emissions by 80 per cent, most of them have shortcomings in other areas, such as carbon storage, nuclear power and land use.

Only a development path that is oriented toward the RES/EEU Initiative scenario can be qualified as sustainable.

Greenhouse gas reduction costs are tolerable for Germany

Costs are a major criterion, but uncertainties exist. Costs are in the range of 10% of GDP depending on the scenario. This is roughly equivalent to energy costs today.

Conclusions:

The Commission confirms that a sustainable energy supply, based on renewable energy resources and efficient energy technologies is technically feasible and economically beneficial.

Some goals of sustainable energy supply to be pursued up to the year 2020

- To improve the macroeconomic energy productivity by 3 per cent p.a. in the next 20 years,
- To reduce national greenhouse gas emissions by 40 per cent by the year 2020,
- To increase electricity generation from renewable energy sources by a factor of 4 by the year 2020 and to increase the use of renewable primary energy sources by a factor of 3.5 by the year 2020,
- To increase electricity generation from CHP by a factor of 2 by the year 2010, and by a factor of 3 by the year 2020,
- To decrease the average specific end-point energy consumption of recently modernised older buildings to 50 kWh/m^2 by the year 2020,
- To decrease the fleet consumption of new passenger cars to between 3.5 and 4 litres per 100 km by the year 2020,

- Providing more funding for activities that will help tap the potential for efficient energy supply and use (as a first step, so-called “no-regret” measures), and the use of renewable energy sources should be systematically increased.
- Stepping up efforts to transfer capital, technology and know-how from the industrialised nations for the energy sector and to engage in fair energy-related co-operation with developing countries, newly industrialised countries, and countries in transition.

Political strategies and instruments for the development of a sustainable energy system

Policies aimed at implementing a sustainable energy supply system are subject to conflicting requirements imposed by environmental protection and global warming management, economic efficiency and social needs.

The Commission proposed a policy mix that is suitable for initiating the structural changes needed to develop a sustainable energy supply system.

- **Future development of liberalisation.** The process of liberalisation should be backed by regulations that facilitate and safeguard competition.
- **Sustainable energy management.** Clearly quantified targets, for assessing the implementation of global warming management measures are required. A 40% reduction in CO2 levels by 2020, 50% by 2030, and an 80% reduction by 2050 (compared to 1990). The decentralisation of energy supply structures is also considered vital. Stronger temporary incentives should be provided in order to achieve a breakthrough in the fields of energy efficiency and solar energy. Increase energy efficiency on the demand side. Develop eco taxes. Implement a system of tradable emission permits. Establish an Energy Efficiency Fund. Introduce an integrated research, demonstration and further education programme on “Efficient and Cost-Effective Electricity Use”. Promote the retrofitting of existing buildings with thermal insulation materials and to introduce efficient space heating and water heating technologies. A variety of regional energy generation sources should be fostered. A research and education initiative should be launched, centred on energy efficiency aspects and renewable energy sources.
- **Transport.** “Sustainable Mobility” should be the subject of further research.
- **European policies** Create energy markets with transparent and equal framework conditions and systematically to remove obstacles that impede the substitution of efficient technologies for energy. EU legislation should be amended to include the promotion of efficient and renewable energy. EURATOM should be terminated. The EU enlargement states should be supported in energy terms and nuclear power phased out in those states.
- **International policies** The industrialised nations should develop a special partnership with developing countries, newly industrialised countries and countries in transition; the industrialised countries should set an example and play a pioneering role in the design and development of future energy supply systems. National efforts should be supported by a transfer of funds, technology and know-how to other countries. This will also help develop export markets. An initiative should be launched to export renewable energy and efficiency technologies to developing and newly industrialised countries. Renewables and efficient technologies should also play a greater role in the framework of development co-operation and project funding programmes. Co-operation with today’s and future energy-supplying countries and regions will play an important role. Due to the global energy markets, the world has become highly interdependent. As a result, political instabilities in energy-supplying countries and regions can have major economic and political repercussions on a global scale. The primary concern is the consequences of price turbulences for the increasingly integrated world energy markets. The promotion of co-operation to preserve economic and political stability and to foster a sustainable development in the energy-supplying regions, as well as helping countries cope with the economic and political consequences of a global transition to more efficient and renewable energy supply systems give rise to a new foreign-policy dimension in energy policy.

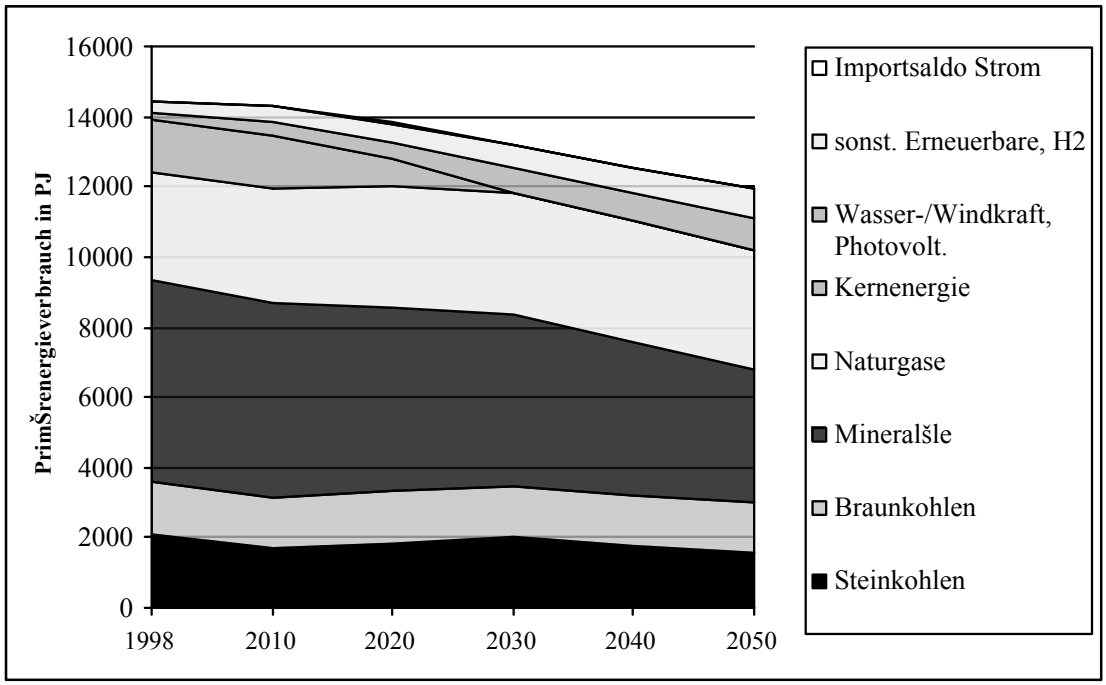

Chart 1-4 REF-IER primary energy demand in PJ (Reference Scenario)

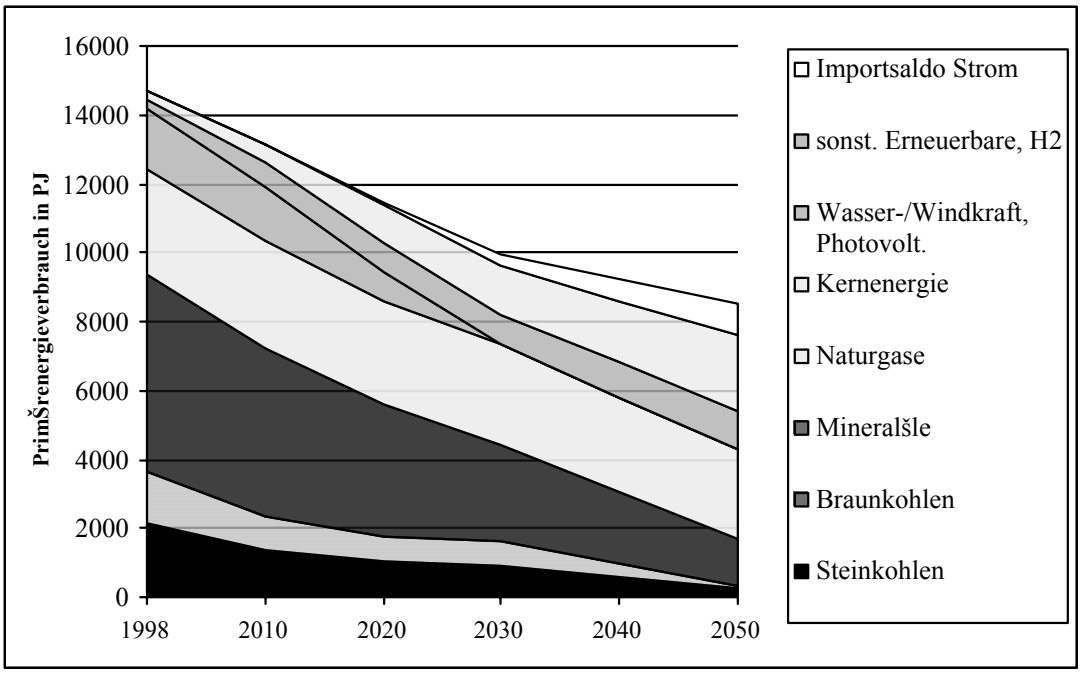

Chart 1-5 RRO-WI primary energy demand in PJ (Scenario of the RES/EEU Initiative)