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# The Promotion of Renewable Energies and Sustainability

## A Critical Assessment of the German Renewable Energies Act

*The Renewable Energies Act (Erneuerbare-Energien-Gesetz – EEG) is the German government's main instrument for implementing the energy objectives of its sustainability strategy. Is the EEG really an adequate instrument for this purpose? Does it consider both effectiveness and efficiency? Are the different aspects of sustainability evenly addressed? What possible alternatives are there regarding changes towards other promotional systems or shifting from a national to a European framework?*

Economists are concerned with the question of how to allocate scarce resources in the most efficient way. This is also the criterion for the assessment of current policies and their setting of secondary objectives, in the case considered addressing ecological objectives by the promotion of renewable energies.The objective of sustainable development in Germany is broadly recognised and forms part of the official agenda of the German government, defined in the Sustainability Strategy of the German Government (SSGG). In the context of the SSGG the question arises whether the instruments applied and secondary objectives chosen are adequate to reach a high degree of sustainability. The paper focuses on the aspects related to energy policy. First, an overview will specify the meaning of "sustainability" and the relevant aspects on which the SSGG focuses. As this paper shows, promoting electricity from renewable energy sources (RES) forms part of this strategy. The German Renewable Energies Act (EEG) is the main instrument designed to implement the energy objectives of the SSGG.

Bringing together the objectives of the SSGG and the EEG the paper intends to answer in its principal part the following questions. Is the EEG really an adequate instrument for the promotion of the requirements of the SSGG? Does the EEG consider both aspects, effectiveness and efficiency? Are the different aspects of sustainability evenly addressed? Finally, possible alternatives regarding changes towards other promotional systems or shifting from a national to a European approach are outlined briefly.

### The Concept of Sustainability

In the definition by the World Commission on Environment and Development (WCED) sustainability means the maintenance of a capital stock sufficient to secure a certain level of consumption for future generations. "Sustainable Development is a form of development which meets the needs of the generation of today without jeopardising the chance for future generations to meet their own needs."[1] Securing chances for future generations means at least preserving the capital stock, with a very broad understanding of capital, including natural capital and man-made capital

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[1] World Commission on Environment and Development: Our common future, Oxford 1987.

as well as knowledge. The concept of sustainability incorporates three aspects.

- Ecological sustainability means the preservation of the natural environment.
- Social sustainability means social cohesion, the opportunity for individuals to lead a self-determined life within the framework set by institutions.
- Economic sustainability is closely linked to the concept of efficiency, in both its static and dynamic aspects, and is to be understood as the search for instruments to reach a determined goal in a way which is less resource-intensive than other alternatives.

Regarding *ecological sustainability*, the preservation of the environment is indispensable for maintaining human well-being.[2] The environment cannot be substituted in its four essential functions.[3]

- Firstly, the natural environment supplies resources. Raw materials are the basis for industrial production and any form of economic activity.
- Secondly, the natural environment serves as the receptacle for emissions from economic activity.
- Thirdly, the intrinsic value of the mere existence of nature increases the quality of life.
- Lastly, the natural environment is necessary for the ecosystems in general, being the basis of life on earth.

The basic idea of ecological sustainability is to keep the scale of economic action below the "carrying capacity"[4] of the environment. If the limit of assimilative capacity is ignored, damage might not be reversible. Disregard of the assimilative capacity could take place either by depleting natural resources or by overloading the natural environment as a receptacle. In addition to the concerns about the already known "old" scarcity, the general depletion of basic resources[5] which cannot be substituted easily, there is a "new" scarcity within the function of natural assets to store waste from human activity, e.g. the limited capacity of the atmosphere to store $CO_2$.[6]

The reduced ability of natural assets to fulfil their ecosystem-function could have severe effects on human well-being. One example is deforestation and its negative impacts on the ecosystem, due to the function of forests as "green lungs". For assumptions regarding the possibility of substituting for natural capital, the distinction between substantial and functional substitution is important. While substantial substitution might be possible, the functional substitution of environmental assets is often difficult: wood can be substituted for in its substantial function as a raw material, but the forests cannot be substituted for in their function as green lungs of the earth.[7]

The following "management rules" for natural assets have been formulated in order to postulate conditions for political decisions aiming at the sustainable use of the environment.[8]

- The harvest of resources should not exceed the natural regeneration rate.
- Waste flows should always stay below the assimilative capacity.

If these management rules are taken into account, the stock of non-renewable resources should not be reduced at all, because their regeneration rate is zero. But, to the extent that the natural assets do not fulfil basic functions in the ecosystem, the strict conservation of raw materials has no intrinsic value.[9] Pearce

[2] The concept of strong sustainability stresses the necessity of conserving the natural capital stock, due to the multi-functionality of natural assets. Cf. G. Klaassen, J. Opschoor: Economics of sustainability or the sustainability of economics: different paradigms, in: Ecological Economics, Vol. 4, 1991, pp. 93-115. Neo-classical economics resolves the problem by means of the assumption that (external) technological progress will supply the necessary substitutes.

[3] Cf. D. Pearce: Economics, Equity and Sustainable Development, in: Future, Vol. 20, 1988, pp. 598-605.

[4] Cf. H.-J. Harborth: Dauerhafte Entwicklung – Zur Entstehung eines neuen ökologischen Konzepts, WZB-Papier FS II 89-403, Berlin 1989.

[5] E.g. coal, oil and natural gas. The near future of exploitation is more a matter of cost considerations, as the raw materials are less accessible. Another concern is the concentration of the remaining energy raw materials in the Middle East and the former Soviet Union due to the depletion of petroleum and natural gas in Europe and Northern America. The assumption of the development of backstop-technologies, which substitute raw materials, is the subject of controversy. Cf. ibid., p. 55.

[6] In 1972 the Club of Rome, in "The Limits to Growth", already mentioned the restrictions caused not only by the depletion of raw materials, but also by the environmental assimilative capacity. Cf. D. Meadows et al.: The Limits to Growth, New York 1972. In contrast to the predicted shortages of raw materials, the latter argument has not been refuted.

[7] Cf. K. Löbbe: Substituierbarkeit versus Komplementarität von Umweltgütern, in: G. Pfister, O. Renn (eds.): Indikatoren einer regionalen nachhaltigen Entwicklung, Stuttgart 1996, pp. 138-157.

[8] Cf. D. Pearce, K. Turner: Economics of Natural Resources and the Environment, New York 1990; H. E. Daly: Toward some operational principles of sustainable development, in: Ecological Economics, Vol. 2, 1990, pp. 1-6. More detailed management rules have been formulated by H. Bartmann: Anliegen und Aspekte der Ökologischen Ökonomie, in: Das Wirtschaftsstudium, Vol. 27, 1998, pp. 275-280.

[9] Especially as coming generations cannot use these resources either, if they also follow the principles of sustainability.

and Turner outline two possible solutions: compensation of the exhaustible resources by an increased stock of renewable raw materials or raising efficiency with the objective of maintaining a certain standard of living from a declining resource basis.[10]

*Social sustainability* means the possibility of individual self-determination within a social structure which impedes social disruptions. In order to guarantee social sustainability, institutions are indispensable. In addition to social or public organisations a broad definition of institutions includes the acceptance of policy measures, public participation in political processes, social security etc.[11]

State interventions aiming at the enforcement of political decisions must be justified because of the interference with individual self-determination; therefore the degree of public approval is an indicator of social sustainability. If it is communicated to the public that the consequential costs of a lack of political interference might be enormous, policy instruments will earn more support. Social acceptance depends, further, on the implications of state intervention for individual situations (e.g. job losses) and their repercussions on social institutions (e.g. social security systems). Efficient solutions to clearly specified problems are more likely to gain public support for a longer period of time.[12]

The third aspect of sustainability is *economic sustainability*. In economic theory market solutions are considered the most efficient way to reach favourable results. However, environmental problems are examples of external effects, where market prices, which refer to the individual costs, do not reflect social costs. Consequently, possible adverse effects on the natural environment require state intervention in order to correct market failure.

Like the economic concept of efficiency, economic sustainability requires the achievement of a specific goal with a minimum of resources. In a long-term view, the efficient allocation of resources is also required for the maintenance and public acceptance of institutions and policy measures. This also means the search for policies which are in line with the market-based economic system and do not exceed the capability of existing institutions.

Furthermore, efficient resource spending is central for preserving and increasing the man-made capital stock. Thereby, efficiency incorporates two aspects. The concept of static efficiency means applying the least costly instrument to reach specific objectives. To obtain dynamic efficiency, in a long-term perspective policies must also foster the development of new solutions for environmental and social challenges, giving leeway to private enterprise.

### The Sustainability Strategy of the German Government

The sustainability strategy of the German government [13] is based on the following principles:

- fairness to forthcoming generations or intergenerational justice (preserving the functions of the environment, social institutions and capital for future generations)
- quality of life (ecological, social and economic requirements for human welfare)
- social cohesion (individual self-determination and efficient resource employment)
- international responsibility (intragenerational justice).

The ecological, social and economic aspects of the sustainability debate described above are incorporated in these policy fields.

The SSGG does not deny the possibility of using substitutes for exhaustible resources. The relevant management rules stress:

- the use of renewable energy sources has to stay below their regenerative capacity;
- exhaustible materials should only be used within a framework allowing for their substitution;
- the assimilative capacity of the ecosystem should not be exceeded;
- energy and resource use have to be decoupled from economic growth.[14]

In contrast to the definition by Pearce and Turner mentioned above which aims to sustain a fixed living-standard with a reduction in the use of exhaustible resources, the German government applies a rather soft rule: decoupling resource use from economic

[10] Cf. D. Pearce, K. Turner, op. cit., p. 45.

[11] For considerations of the definition and importance of institutions, cf. D. North: Institutions, Institutional Change and Economic Performance, Cambridge 1990.

[12] Cf. B. Heins: Nachhaltige Entwicklung - aus sozialer Sicht, in: Zeitschrift für angewandte Umweltforschung, Vol. 7, 1994, pp. 19-25.

[13] The considerations of the following section are based on the strategy paper of the German government. Cf. Bundesregierung: Perspectives for Germany: Our Strategy for Sustainable Development, online publication 2002, www.bundesregierung.de. For the historical development of the SSGG cf. German Advisory Council on the Environment: Environmental Report 2002, Berlin 2002.

[14] Cf. Bundesregierung, op. cit., pp. 50 ff.

growth does not necessarily implicate a real decline in resource use.

Regarding social sustainability, the SSGG stresses public acceptance of policy measures by a broad social participation. Social cohesion should be obtained by functioning institutions, especially regarding social security.

In the German point of view economic sustainability is linked strongly with the attempt to reduce public spending in order to avoid additional burdens for future generations, applying the principle of sustainability also to man-made capital.

To measure sustainability the SSGG lists 21 indicators for clarifying the state of sustainability. Among them are subjects as different as the quantity of land use for housing and transport, a balanced budget, air pollution and the number of burglaries.[15] The indicators which are interesting regarding the congruence of reality with the management rules are the productivity of raw materials as well as greenhouse gas emissions and the share of energy from renewable energy sources.

**Effects of Energy Use on the Environment**

The objective of sustainability is to prevent the corollaries of human action from having irreversible effects, affecting the quality of life of present or future generations. From the ecological point of view the functions of the environment have to be preserved in order to obtain sustainability. But the consequences of unsustainable human economic activity are also interesting from an economic point of view when they have repercussions on human health and living conditions because they can create high subsequent costs.[16]

In the use of fossil energy sources, the environment is challenged by

- the supply of energy raw materials for economic activities, both fossil and regenerative;
- emissions to the atmosphere from fossil energy use e.g. greenhouse gases or (nuclear) waste;
- power plants, transmission grids, surface mining, windturbines etc. as they are considered to affect the aesthetic function of landscape;
- possible negative effects on the ecosystem function of the environment (climate change).

**Ecological Implications of the SSGG for Energy Policy**

One focus of the SSGG is energy policy, aiming at the avoidance of irreversible adverse effects on the environment, especially regarding climate change.

- The long-term objective for the energy sector is to increase the efficiency of resource use by the "factor 4".[17]
- Further, the SSGG aims at not exceeding the carrying capacity of the atmosphere; the mid-term objective is a 21% reduction of greenhouse gas emissions by 2008-2012 as compared to 1990.
- As the use of fossil energy sources requires their functional substitution by RES, the structure of the energy supply must be changed.[18] By 2010 the share of renewable energies should amount to 4.2% of total energy consumption and 12.5% of electricity consumption.[19]

Regarding energy efficiency, a distinction has to be made between efficiency of energy use and efficiency of energy production. For energy production, feasible efficiency gains are limited. Regarding energy use, growing energy demand should not exceed efficiency gains.[20]

As long as the use of fossil energy sources is necessary, energy sources with low emissions should be preferred. Among fossil fuels, natural gas leads to fewer $CO_2$ emissions than coal or oil. The consideration of the limited assimilative capacity of the environment requires the employment of renewable energy sources in the long run or the development of clean technologies using fossil energy sources. In view of the unresolved

[15] The German Advisory Council on the Environment criticises this range of themes and the blending of objectives and indicators in its 2002 Environmental Report as inefficient, cf. German Advisory Council on the Environment, op. cit., pp. 168 ff.

[16] For the assessment of potential subsequent costs of global environmental risks cf. e.g. German Advisory Council on Global Change: Annual Report 1998, Berlin 1998.

[17] The vision of a quadrupled energy efficiency stems from E. U. v. Weizsäcker, A. B. Lovins, L. H. Lovins: Faktor Vier: doppelter Wohlstand – halbierter Naturverbrauch; der neue Bericht an den Club of Rome, Munich 1995.

[18] This conclusion, which stems from the third management rule of the SSGG, is important as it answers, for the case of the German government, the essential question of whether the use of renewable energies is considered indispensable for sustainability.

[19] The current share of renewable energies in electricity consumption amounts to 10%. Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Press Release No. 243/04, Berlin 2004.

[20] Cf. Bundesregierung, op. cit., p. 56. Rising international energy demand especially from India, China and Brazil will probably exceed efficiency gains. Since 2003 China has been the second largest oil importer next to the USA. Cf. K. Matthies: Asian Demand Pushes Up Commodity Prices, in: INTERECONOMICS, Vol. 39, 2004, pp. 109-112.

**Table 1**
**Feed-in Tariffs of the EEG**

| Energy source | Tariff depending on | Minimum feed-in tariff, cent per kWh | Annual decline | |
|---|---|---|---|---|
| Hydro<br>EEG §6 | ≤ 500 kW<br>≤ 5 MW<br>5-150 MW | 9.67<br>6.65<br>3.70-7.67* | -<br>1%<br>1% | *Feed-in obligation only for additional electricity obtained by refurbishment. Tariffs depend on the size. Maximum promotion: Up to 5 MW 30 years, > 5 MW 15 years. |
| Gas, Coal mine methane<br>EEG §7 | ≤ 500 kW<br>≤ 5 MW<br>> 5 MW* | 7.67-9.67**<br>6.65-8.65<br>6.65-8.65 | 1.5%<br>1.5%<br>1.5% | *Only coal mine methane.<br>**Depending on extraction procedures. |
| Biomass<br>EEG §8 | ≤ 150 kW<br>≤ 500 kW<br>≤ 5 MW<br>5-20 MW | 11.5-17.5*<br>9.9-15.9<br>8.9-12.9<br>8.4-12.4 | 1.5%<br>1.5%<br>1.5%<br>1.5% | *Depending on origin of biomass and treatment.Maximum promotion: 20 years. |
| Geothermal<br>EEG §9 | ≤ 5 MW<br>≤ 10 MW<br>≤ 20 MW<br>> 20 MW | 15.0<br>14.0<br>8.95<br>7.16 | 1%*<br>1%<br>1%<br>1% | * Only for power plants installed after 2010. |
| Wind (on shore)<br>EEG §10 | - year 1-5*<br>- following years | 8.7<br>5.5 | 2%<br>2% | *Duration of the higher tariff: 5 years for power plants with a 150% average yield. The period with higher tariffs is extended for plants with poorer yields (not below 60%). Maximum promotion: 20 years. |
| Wind (off shore)<br>EEG §10 | - year 1-9*<br>- following years | 9.1<br>6.19 | 2%**<br>2% | *Depending on the distance to the shore and the year of construction.<br>**Beginning 2008. |
| Photovoltaic (not integrated into a building)<br>EEG §11 | | 45.7 | 6.5%* | *Beginning 2006. Maximum promotion: 20 years. |
| Photovoltaic (integrated into a building)<br>EEG §11 | ≤ 30 kW<br>≤ 100 kW<br>> 100 kW | 57.4-62.4*<br>54.6-59.6<br>54.0-59.0 | 5%<br>5%<br>5% | *Higher tariffs for plants integrated into the facades. Maximum promotion: 20 years. |

question of how to store nuclear waste, which cannot be assimilated by the environment, nuclear power is not an alternative although it has very low $CO_2$ emissions.

Applying the ecological management rules as formulated by the German government the main result is that in the long term only renewable energy sources and reduced energy consumption due to efficiency gains are adequate for sustainability. The question is how the incentives to promote RES should be designed in order to obtain a maximum of ecological soundness while also fulfilling the requirements of social and economic sustainability.

### Social and Economic Requirements

The support for policies depends strongly on public perception. Energy prices and the possible consequences for labour markets and economic performance are direct effects of changes in energy policy. Measures which lead to increases in prices, e.g. the promotion of renewable energies, must be especially well communicated to the public. In order to prevent climate change, political decisions have to be taken which are based on a high degree of uncertainty. If political decisions and the underlying concept of the precautionary principle are not broadly understood and accepted, social sustainability cannot be achieved.

Efficiency is the major claim of economic sustainability. If the necessity of promoting renewable energies is recognised for ecological reasons, economic sustainability requires the cost-efficient achievement of the objective of promoting renewable energies. To fulfil social and economic sustainability requirements, efficiency has to be considered, both in the design of the promotional system and in the production and consumption of energy.

### The German Renewable Energies Act

The "Gesetz für den Vorrang erneuerbarer Energien" (EEG), the German Renewable Energies Act, adopted in March 2000, was designed to implement a sustainable energy policy.[21] It follows the "Stromeinspeisungsgesetz", the Electricity Feed-In Act, of 1990 which promoted the supply of electricity from RES. In December 2003 the German government proposed an amendment to the EEG, changing especially the minimum feed-in tariffs for renewable energies. The amended form of the EEG came into force on 1 August 2004.[22] The amendment stems from the necessity to adapt German legislation to the directive 2001/77/EC of the European Union[23] and from adjustments made due to the results of the 2002 monitoring report.

[21] The EEG is not the only instrument designed to promote renewable energies. For the different instruments promoting RES in Germany cf. C. Grotz: Germany, in: D. Reiche (ed.): Handbook of Renewable Energies in the European Union, Frankfurt/Main 2002, pp. 107-121.

[22] The considerations of this paper are based on this current version of the EEG, including the changes of August 2004.

The explicit objective of the law is to develop a sustainable power supply. This objective is explained with the protection of the climate, nature and the environment. As the direct reference to the objective of lowering the social costs of energy supply shows, renewable energies should be promoted with the implicit objective of reducing the use of fossil energy sources and the related harmful effects on environment and health. The precise objective of contributing to the further development of technologies for the promotion of renewable energies also forms part of the first paragraph of the EEG.[24] In addition, the EEG has clear quantitative objectives: a share of at least 12.5% of electricity from renewable energy sources by 2010 and 20% by 2020.

The EEG is based on guaranteed feed-in prices. The local grid operator is obliged by law to buy power from RES.[25] The law sets a minimum price for each technology, ranging in the current legislation from 3.70 cent/kWh for large hydro power to 62.4 cent/kWh for photovoltaic power plants integrated in facades. The average feed-in tariff in 2002 amounted to 8.9 cent/kWh.[26] Feed-in tariffs are set nominally for a determined duration (between 15 and at most 30 years, differing between technologies) and except for small hydro power plants promotion declines gradually.[27]

The four German transmission grid operators[28] are obliged to compensate local operators for the EEG-promoted electricity. With many wind power plants in the north and hydro plants in the south the feed-in of electrical power from renewable sources varies regionally.[29] Therefore the financial burden is equally distributed at the level of transmission grids. The power supply industries which finally provide the power to the consumers are obliged to buy the EEG-power and compensate it at the average rate. Rising consumer prices are a consequence. There is no limit to the total amount of obligatory payments for electricity from RES.

For energy-intensive industries with an electric power consumption exceeding 10GWh and electricity costs of more than 15% of the gross value added, there is the possibility of applying for an exemption. Every second year a monitoring report by the German government on the effectiveness of the EEG is obligatory (§20 EEG). Based on this report, amendments shall increase the efficiency and effectiveness of the EEG.

The underlying idea of differing feed-in tariffs is to level off technological differences between renewable energy sources in order to encourage investment. These predictions about the level, duration and development of tariffs necessary to stimulate investment are necessarily imprecise. Technologies which are less competitive and small-scale power production receive the highest tariffs. For technologies at an early stage of technological development, such as offshore wind power and geothermic plants, the annual decrease of remuneration is suspended for the first years.

**Ecological Requirements of the SSGG**

As pointed out above, the management rules of the German government require a reduction in the use of exhaustible resources, the avoidance of emissions and increasing energy efficiency. To neutralise the ongoing depletion of fossil resources the SSGG requires their replacement by RES. The underlying condition for this is the existence and application of adequate technologies.

The EEG is adequate for promoting high increases in investment in renewable energies. Favourable for the maximal installation of capacities are

- long time horizons of up to 30 years (small hydropower), giving planning security to investors;
- feed-in obligations which release producers from entrepreneurial risks;

[23] Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market. Official Journal L 283 of 27.10.2001. This directive sets a specified contribution to the EU target for each member state. By 2010 a share of 22.1% of total electricity consumption shall be produced from renewable energy sources.

[24] Cf. EEG (Gesetz für den Vorrang Erneuerbarer Energien), BGBl. I, 31.07.2004, p. 1918, §1. The last objective is part of a strategic industrial policy, which means the attempt to promote a certain industry by using regulations, e.g. tax incentives. The motivation for industrial policy is to develop a favourable market position for both national demand and export. For a critical assessment of industrial policy cf. e.g. J. Starbatty: Braucht die Soziale Marktwirtschaft Industriepolitik?, in: Orientierungen zur Wirtschafts- und Gesellschaftspolitik, No. 100, 2004, pp. 33-38.

[25] Included is electricity gained exclusively from photovoltaic, hydro power, wind power, biogas or biomass; state-owned power plants and additional electricity obtained from upgrading large hydro power plants are included as of 2004. Cf. EEG, op. cit., §2.

[26] Cf. VDEW: 1,7 Milliarden Förder-Euro für Ökostrom, online publication 2003, www.strom.de.

[27] The tariff reduction is fixed as a percentage of the original tariff, which means that the absolute reduction of the remuneration is declining annually; inflation is not taken into account.

[28] RWE, E.ON, EnBW and Vattenfall Europe.

[29] An extreme example is the region of Papenburg, Lower Saxony, with a 54% wind power share.

- differentiated feed-in tariffs, taking the poorer yields of less favourable sites (e.g. midland sites) into consideration;
- differentiated feed-in tariffs for each technology, taking the production costs into consideration,
- special promotion for small power plants.

With regard to the effectiveness of the installation of power plants, the EEG is highly successful. Installation rates of wind power plants grew considerably in recent years.[30] These growth rates exceeded most expectations. If the growth rate had been determined by a quota, it is unlikely that the specification of such high growth rates would have been politically possible.

In order to avoid the depletion of exhaustible resources and to reduce the related emissions it is decisive that substitutes for them are found. But regarding the essential role of energy in economic production processes, the constant security of supply must be guaranteed in order to avoid outages of electricity. The contribution of electricity from RES to energy supply is still quite small; the share of consumed electricity promoted by the EEG amounted to 6.64% in 2003.[31]

Nevertheless, the high growth rates of wind power exceed the capacities of the existing grid structure. Unpredictable feed-in caused by seasonal fluctuations and irregularities challenges the existing infrastructure. Grid operators are obliged to hold spare capacities which guarantee uninterrupted supply and help to compensate feed-in fluctuations. At the same time they have to avoid overloads resulting from an unexpected supply of wind energy. These peculiarities could lead to supply being interrupted by blackouts.

Decisive for the substitution of fossil energy sources is not only the installation of power plants but also their technological integration into the grid system and the regular provision of electric energy. The unexpected boom in wind power shows that the EEG is not setting incentives for these requirements: in order to achieve a secure supply based on volatile renewable energies, the problem of energy storage must be resolved. The EEG provides no incentives for regular feed-in. The enhanced promotion of technologies which are adequate for base load, such as electricity from hydro, biomass or geothermal plants, fosters substitution, but does not resolve the lack of incentives for the development of storage technologies.

The immediate substitution of fossil energy sources is impossible, but the gradual substitution should take place in an ecologically effective manner. By promoting renewable energies, emissions should be reduced considerably.

The EEG uses the instrument of the feed-in obligation to replace electricity from fossil energy sources, if the increase in renewable energies exceeds the growing electricity demand.[32] Without other instruments, e.g. emissions trading, it is impossible to control which fossil energy sources are replaced by RES. Not highly polluting but expensive technologies will probably be displaced first. The existence of external effects impedes real social costs from being reflected in the prices of non-renewables. Additionally, state regulation distorts the relative prices between the commodities. One example is subsidies for German coal.[33]

The problem of irregular feed-in diminishes the positive ecological effects of the EEG, because powering up carbon or gas plants if wind supply is lacking causes rising energy costs and greenhouse gas emissions.

Concentrating on climate policy, the ecological efficiency of the EEG can be measured by the emissions abated due to renewable energy promotion. According to the Federal Ministry for the Environment, the application of the EEG reduced greenhouse gas emissions by about 23 million tons of $CO_2$-equivalent in 2003. If the objective of the EEG, namely to at least double the share of renewable energies by 2010, is reached, emission abatement is expected to amount to 42 million tons in 2010.[34] But these figures are controversial. A recent study by the Ministry of Economics and Labour shows that the EEG will no longer be adequate for abating greenhouse gas emissions as soon as the European Emissions Trading Scheme starts in 2005.[35]

[30] According to VDEW, installations of wind power plants in Germany rose from 2,800 MW in 1998 to 14,300 MW in 2003; cf. VDEW: Mehr Strom aus Windenergie, online publication 2004, www.strom.de.

[31] The gap between 6.64% EEG promoted electricity and the 7.9% of electricity from renewable energies stems from the fact that large hydro power plants were not included in the promotion until August 2004. Regarding the future contribution of RES there are differing predictions, e.g. the European Commission expects in its EU-15 Baseline Scenario for 2030 only 18.9% of electricity from RES (including waste) compared to 15.8% in 2000; cf. European Commission: European Energy and Transport Trends to 2030, online publication 2003, www.europa.eu.int.

[32] In Germany energy demand is declining whereas the electricity share of energy consumption rose from 17.4% in 1990 to 19.3% in 2002; cf. www.ag-energiebilanzen.de.

[33] The agreed subsidies in the period 2006-2012 will amount to €15.87 billion; cf. FAZ: Weniger Subventionen für die Kohle, 19.05.2004, p. 13.

[34] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Press Release No. 231/04, Berlin 2004.

Renewable energies should, consequentially, firstly replace the most polluting fossil energy sources. To cope with this objective, changes in the promotional system or the combination with mechanisms which are adequate to internalise external costs are indispensable for maximal ecological effectiveness.

Generally, rising energy prices tend to stimulate energy-saving technologies. Increasing the share of renewable energies will lead to rising energy prices. Considering the ambitious targets of the EEG for the promotion of renewable energies, industries will in the long run opt for energy-saving in order to control energy costs. A favourable side-effect of rising energy prices might therefore be the compliance with the German government's third management rule, which requires the decoupling of energy use and economic growth.[36] But extended exceptions for energy-intensive industries contradict this objective. For large hydro power plants efficiency gains are stimulated by the feed-in of additional electricity obtained by efficiency gains in the generation process.

Summing up, the results of the EEG regarding ecological sustainability show that

- substitution is going to be a very long process, but the EEG contributes to the installation of capacities and the development of a market for electricity from RES;
- secondary effects on the grid structure possibly put security of supply in danger and the positive effects of the EEG are lowered due to the related need of spare capacities;
- the design of the EEG cannot guarantee that the most polluting energy sources are substituted first;
- there are no direct effects on rising energy efficiency.

**Effects of the EEG on Social Sustainability**

Due to the visual effects of wind turbines on the landscape, public support for wind power plants is declining. Inhabitants of coastal areas are especially affected. But two thirds of German citizens are still in favour of further promotion of wind energy by the EEG.[37]

While monthly additional costs for an average household due to the EEG promotion amount to approximately one euro,[38] industrial energy consumers face serious competitive disadvantages due to rising energy prices. Exceptions for energy-intensive industries possibly prevent job losses but are not in line with the polluter-pays principle and hinder efficiency gains in the industries concerned.[39] From the point of view of social sustainability it is positive that the even distribution of additional costs caused by the EEG prevents the inhabitants of certain regions being more affected by the additional costs.

Due to differing figures there is no conclusive evidence as to whether the EEG has the positive effects on labour markets claimed by the German government.[40] The administrative burden of the EEG is quite small, e.g. compared to tendering fixed quotas of electricity from RES where the administrative task is much more complicated.

The EEG is highly mandatory. By setting minimum prices and feed-in obligations, the market mechanism has been suspended and consumer and producer sovereignty is seriously reduced. The political strategy of enhancing specific technologies does not leave room for the implementation of individual or innovative solutions. Apart from efficiency losses the mandatory character of the EEG is hardly compatible with social sustainability. Incentives rather than obligations would be more sustainable from the point of view both of the social consequences of rising energy costs and of the otherwise shrinking leeway for individual decisions.

Ecological consciousness is still high in Germany. The public is willing to raise funds for ecological concerns, but rising unemployment and uncertainty about the effectiveness of political measures tend to

[35] Cf. Federal Ministry of Economics and Labour: Gutachten des Wissenschaftlichen Beirats zur Förderung erneuerbarer Energien, online publication 2004, www.bmwa.de.

[36] This effect of the high costs of promoting RES by a feed-in scheme such as the EEG is certainly an unintended side-effect. A possible consequence is unemployment due to uncompetitive production costs. The exceptions for energy-intensive industries intend to diminish this effect.

[37] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Press Release No. 128/04, Berlin 2004; Die Zeit: Mehrheit der Deutschen für Ausbau der Windenergie, No. 41, 30.9.2004, p. 36.

[38] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Press Release No. 077/03, Berlin 2003.

[39] Thus the costs of the EEG are distributed among other industries and households, but the allowed increase in costs is limited to 10%.

[40] The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety claims that 130,000 additional jobs have been created by the promotion of renewable energies. These numbers refer not only to electricity but also to heat and biofuels. A study of the Bremer Energie Institut comes up with different figures. According to Pfaffenberger et al. the labour displacement due to rising energy costs for industry is higher than the positive labour effects of the EEG. The result is a negative balance of 19,000 lost jobs; cf. W. Pfaffenberger et al.: Ermittlung der Arbeitsplätze und Beschäftigungswirkungen im Bereich Erneuerbarer Energien, online publication 2003, www.bremer-energie-institut.de.

decrease public support. In order to guarantee ongoing support, the efficiency of the EEG has to rise and the possible dangers of climate change must be communicated to the public.

### Static and Dynamic Efficiency

The EEG has to be judged rather critically with regard to the static efficiency of the underlying feed-in system. The feed-in tariffs are based on the anticipation of investment costs and desirable rates of return to investors in order to create investment incentives. As the feed-in tariff is not based on market mechanisms, efficient resource allocation is not obtained. The efficiency of the EEG is subordinated to direct effectiveness, focusing mainly on the maximum installation of power plants. With regard to wind power, promoting maximum installation means that very favourable sites which are nearly competitive are promoted as well as capacities on unfavourable sites which will probably never reach competitiveness. The installation rates of renewable energy plants are very high, but the real costs of the EEG, which amounted to an estimated €1.94 billion in 2003,[41] are high, too. The lack of market mechanisms leads to the inefficient use of these resources. Abating greenhouse gas emissions by the replacing fossil energy sources is very costly from a static point of view. Reducing emissions by raising efficiency in energy use or by cleaner power plants would be more cost- efficient even if in the long run the ecological management rules require a change to renewable energies.

The EEG is not an adequate instrument for enhancing innovations via competition in order to promote future cost reductions. Because of the feed-in obligation, operators of renewable energy power plants do not have to face competition. Investors' security leads to high installation rates, but the different feed-in tariffs for different technologies impede competition among technologies. The declining feed-in tariffs of the EEG are generally adequate to foster innovation, but a sharper decline would be more stimulating and would increase acceptance of the EEG among consumers and industries. At the level of plant producers, the market participants compete internationally, which stimulates innovations.[42]

As a positive incentive for innovation, the long-term horizon of increasing the share of renewable energies gives investors the possibility of adaptation and capacity building. The constant monitoring and changes to the legal framework reflect the political attempt to come closer to an optimal regulation.

### Development Tendencies

The assessment of the EEG has been quite ambiguous. As the act is under constant monitoring and subject to frequent changes, it is important in which direction these changes tend to develop. This will be assessed regarding the changes which took place in the EEG from 2000 to 2004, based on the results of the 2002 monitoring report.[43] Apart from the extension of exceptions for energy-intensive industries, which contradict the polluter-pays principle as well as lowering ecological effectiveness, the trend can be assessed as positive.

- Regarding the replacement of fossil energy sources: biomass, which is agriculturally grown, gets special promotion, geothermic power is included in the EEG, as is the promotion of additional electricity from large hydro power plants. These technologies can provide base load electricity. In order to reduce problems arising from the overload of grid systems in peak situations, the amendment introduces the possibility of a common management among grid operators and power producers (EEG §4).
- Regarding static efficiency: tariffs for wind power plants have been reduced and unfavourable sites, which do not earn 60% of the average yield, will no longer be promoted. In the dynamic view a sharper decline is also a step towards more efficiency. The use of innovative technologies gets additional promotion.
- Furthermore, investors' security is enhanced by a better framework regarding more specified definitions of renewable energies, more transparency and legal regulations which favour producers rather than grid operators.

The enhanced promotion of offshore wind power and geothermal plants cannot be assessed yet as these technologies are still at the very beginning of their development.

[41] Cf. VDEW: 1,7 Milliarden ... , op. cit.

[42] The learning-curve in the production process of wind turbines is especially remarkable regarding the size of the power plants. Following wind turbines with 10-50 kW in the 1980s, the average wind turbine in 1992 had 182 kW and over 1500 kW in 2003, whereas costs dropped by approximately 30% between 1990 and 2000. For photovoltaic power the average costs per kW dropped from 15339 to 6012 between 1990 and 2000; cf. R. Wüstenhagen, M. Bilharz: Green Energy Market Development in Germany: Effective Public Policy and Emerging Customer Demand, IWOe Discussion Paper No. 111, St. Gallen 2004.

[43] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Erfahrungsbericht EEG of 28 June 2002, online publication 2002, www.bmu.de.

## Possible Amendments for More Sustainability

With the beginning of the feed-in system in Germany a policy shift took place. Support policy no longer aimed at financing the development of technologies applying RES by R&D, but at their broad market introduction via stable investment conditions. Regarding wind and photovoltaic power, this objective has been achieved. Politicians must now consider the question whether entering into a new phase of the product cycle would justify a fundamental change of the promotional system. A possibility would be the change to a quota system, combined with certificates. Annually increasing quotas are adequate to guarantee that the aspired share of electricity from RES will be obtained. At the same time market mechanisms provide the efficient achievement of this objective, as the certificates guarantee that producers with the lowest marginal costs supply the required amount of electricity.[44]

In economic theory the existence of negative external effects justifies state intervention. The negative external effects of energy use are multiple, among which some are transnational: the effects of climate change are global, for example, and thus it is unimportant which country or industry reduces emissions. The decisive factor is the total sum of abated emissions. If the marginal costs of reducing emissions differ and reductions take place in the industry with the lowest abatement costs, efficiency and therefore economic sustainability are achieved.[45]

The European Union discusses a common policy with regard to RES in its directive 2001/77/EC.[46] If the promotion is enforced at the European level, certificates could ensure a cost-effective solution as well. Power plants will be constructed first on the most favourable sites. With a rising quota or feed-in tariff the construction of plants in other areas will be profitable, too. Consequently, photovoltaic plants would be built mainly in southern Europe, where yields are higher than in northern countries. Therefore, on a European scale efficiency gains could be realised. In order to guarantee social sustainability transparency and social participation must be realised as well.

## Conclusions

To cope with the ecological requirements of the SSGG, the promotion of renewable energies is necessary. Social and economic sustainability require the efficient use of resources. Promoting renewable energies does not necessarily contradict social and economic sustainability, but neither is it indispensable for the achievement of these aspects of sustainability. The essential aspect is the design of the promotional system.

The EEG focuses mainly on requirements for ecological sustainability. It is highly effective for installing RES capacities. Nevertheless the replacement of exhaustible energy sources is still limited. Reducing emissions might, at least in a mid-term view, be achieved more efficiently by other instruments. Rising energy prices possibly enhance energy-saving technologies, innovations and sustainability.

In order to achieve the ecological aims of the German sustainability strategy the focus should shift from the installation of capacities to a steady power supply and the effective replacement of the most polluting fossil energy sources. Therefore the EEG has to be further amended and combined with other instruments, e.g. the immediate ending of subsidies for fossil energy sources, or by pricing emissions. Nevertheless, the amendment to the EEG is a first step in the right direction, reducing wind power tariffs and focusing more on hydro power and biomass.

Social and economic sustainability require higher efficiency, considering the high costs of the EEG. Market-based instruments could better fulfil these requirements. A change to a quota system with certificates in order to guarantee the efficient production of green power should thus be considered seriously, especially as the German sustainability strategy explicitly requires that, "... the various areas of policy are to be integrated in such a way as to ensure that economic growth, high employment, social cohesion and protection of the environment go hand in hand".[47]

[44] But if the system aims at promoting all different technologies, the market share of each technology has to be politically determined. For an assessment of the promotion of renewable energy sources by quota systems cf. W. Bräuer, H. Bergmann: Ordnungspolitische Bewertung von Quotenhandelsmodellen zur Förderung erneuerbarer Energien im Stromsektor, in: ZfE - Zeitschrift für Energiewirtschaft, Vol. 25, 2001, pp. 205-215.

[45] The design of the European Emission Trading Scheme follows this idea. For a detailed discussion see G. T. Svendsen, M. Vesterdal: How to design greenhouse gas trading in the EU?, in: Energy Policy, Vol. 31, 2003, pp. 1531-1539.

[46] Cf. Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market. Official Journal L 283 of 27.10.2001. For the energy policy of the European Union see N. Eickhof, V. Holzer: Energiepolitische Kompetenzen in der Europäischen Union, in: Wirtschaftsdienst, Vol. 84, 2004, pp. 443-449.

[47] Bundesregierung, op.cit., p. 13.