New strategic challenges for research and development of renewable energies

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Context

Renewable energy sources have increased considerably in all sectors in recent years. This is especially true for the electricity sector: While 10 years ago, less than 5 percent of the German electricity consumption came from renewable energies, their share has tripled to more than 15 percent today. In 2008, they already generated about 93 billion kilowatt-hours.

This development was primarily the result of the successful and efficient German Renewable Energy Sources Act (EEG). On the one hand, it has enabled private investments to build renewable power plant capacities and on the other, it has served as a strong incentive for technological developments. Regarding renewables, there was an extremely productive relationship between German innovation and research and the young emerging industry.

To date, the **heating sector** lacks a similarly effective instrument like the EEG, so developments in this area have moved on at a far slower pace and have been less continuous. The Renewable Energies Heat Act, which entered into force at the beginning of this year, now sets out a fixed portion of renewable energies for new buildings. However, the larger segment of the existing buildings is still slow to be upgraded to higher energy efficiencies and renewable energies. In the heating sector, the share of renewables therefore only doubled from 3.5 to 7.4 percent in the same time period. Expressed in absolute numbers, however, this is a similar order of magnitude as seen in the electricity sector. For example, a total of about 104 billion kilowatt-hours of renewable heat was generated in Germany in 2008.

In the **transport sector**, development was erratic. This is due to the lack of reliability on the part of the political framework. Initially, the Red-Green government supported the rapid expansion of the biofuel industry and created a strong investment incentive for the sector with the tax exemption for pure fuels. In 2006, the grand coalition then decided to terminate the tax exemption for pure fuels and to start to gradually fully tax them instead. To compensate for the expected capacity crunch in the industry, the same government then introduced a quota system for biofuels. Nevertheless, this system change massively slowed down the dynamic development of the market. Added to that, the overall quota was lowered to 5.25 from initially 6.25 percent at the end of the grand coalition government in 2009. The share of biofuels in fuel consumption, which had started from almost zero percent in 1998 and had increased to 7.2 percent in 2007, fell sharply in 2008. Today, the share of biofuels is only about 6 percent. This is equivalent to an energy supply of around 37 billion kilowatt-hours.

Industry forecast 2020

What is going to happen with renewable energies? The industry has set itself ambitious goals. The BEE member companies want to significantly exceed the requirements of the EU and the federal government for 2020. In order to succeed, we the need the right political framework conditions. This means, for one, a successful mix of administrative law and market incentives for the rapid expansion of renewable energies in all three sectors – electricity, heat and transport. By 2020, we could then cover 28% of the total final energy consumption in Germany with renewable sources.

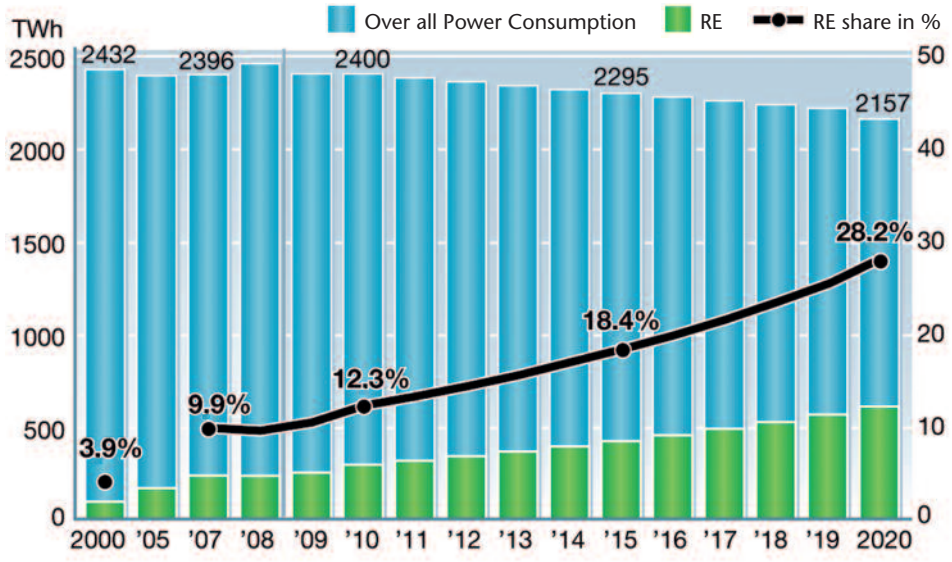

Figure 1
Projected percentage of renewables of total final energy consumption

It also means appropriate research promotion. This is a matter of supplying the excellent capacities of the German Renewable Energy Research Association and others in Germany with adequate resources and appropriate targets so that we can lay the foundations for further growth and continued technological development to 2020 and beyond.

Electricity generation forecast

We still expect a continuation of the dynamic developments in the electricity sector. With sufficient efforts targeted to efficiency and with a slight decline in consumption of 620 billion kWh in 2007 to 595 billion kWh in 2020, renewables will already cover 47 percent of the German electricity demand in 2020. This corresponds to about 280 billion kWh of generated electricity. Slightly more than one half of this is wind energy (149 billion kWh), followed by bioenergy (54 billion kWh), photovoltaics (40 bil-

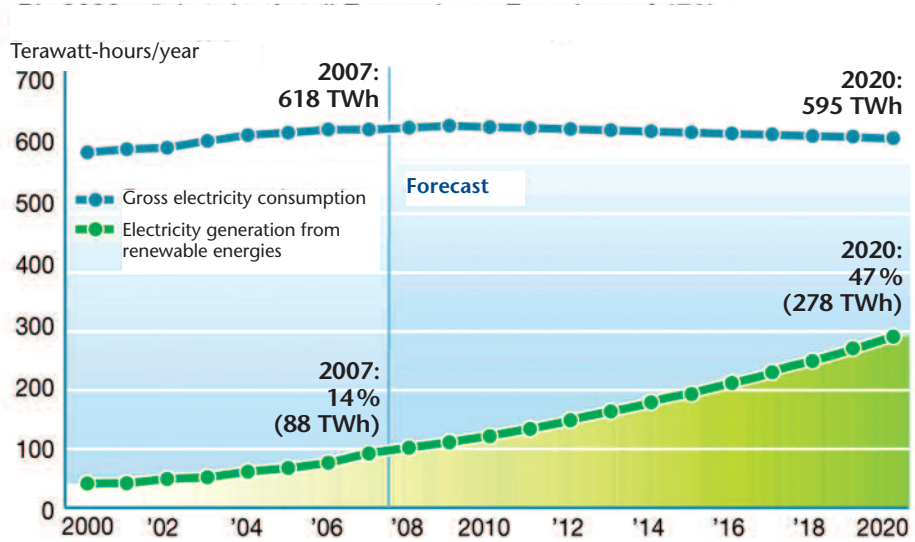

Figure 2
Share of renewable energy in electricity consumption in Germany will increase to 47% by 2020

lion kWh), regenerative hydropower (32 billion kWh) and geothermal energy (4 billion kWh).

As of yet uncertain remain the effects of the life extension for nuclear power plants as announced by the new federal government, a decision we consider to be wrong. It unsettles investors, impedes competition on the electricity market, reduces pressure for innovation in the energy industry and hinders developments in research and, ultimately, progress in the field of renewables. Depending on the final formulation of the life extension, its negative effect on the expansion of renewable energies will be weaker or stronger. From the industry's point of view, the decisive factor is that the priority for electricity supply remains on renewables and is not undermined in practice.

Heat generation forecast

There need to be more causes for renovation in the heating sector as the biggest potential lies in the insufficient energetic quality of heating systems in Germany; only 12 percent of German heating systems are state of the art. We therefore are in favour of a new instrument. It could be an energetic quality standard that is raised at fixed intervals and requires renovation in all buildings that fail to meet this new standard.

In a second step, renewables should then be a binding part of these renovations. In addition to this regulatory approach, especially financial incentives are still required to promote a faster transition to renewables. To this end, the market incentive programme requires at least 1 billion euro a year and has to be independent from the financial situation of the federal budget. This instrument is a very effective stimulus programme. After all, one euro from public funds triggers private investments eight to ten times that amount. As a result, renewables could achieve a share of 25 percent of the heat supply in Germany by 2020.

Biofuels forecast

In the transport sector, only biofuels are available to any significant extent as to limit the use of fossil fuels and replace them. Therefore, a funding re-start of this sector is necessary. The new federal government has taken the first steps towards this goal within the framework of its Growth Acceleration Act. It contains a change in taxation which is to help rehabilitate the pure fuel market for biofuels.

The increase in the overall rate, the next important step, is still pending. The proposed suspension of the planned tax bracket is not sufficient either. The tax rate for biodiesel and vegetable oil should be limited to a maximum of 10 cents per litre.

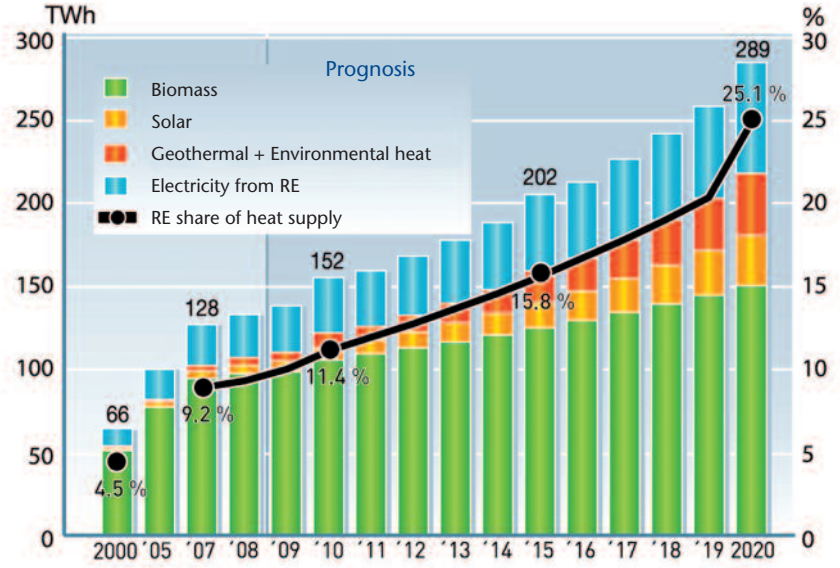

Figure 3
Heat generation from renewable energy sources and share of heat consumption

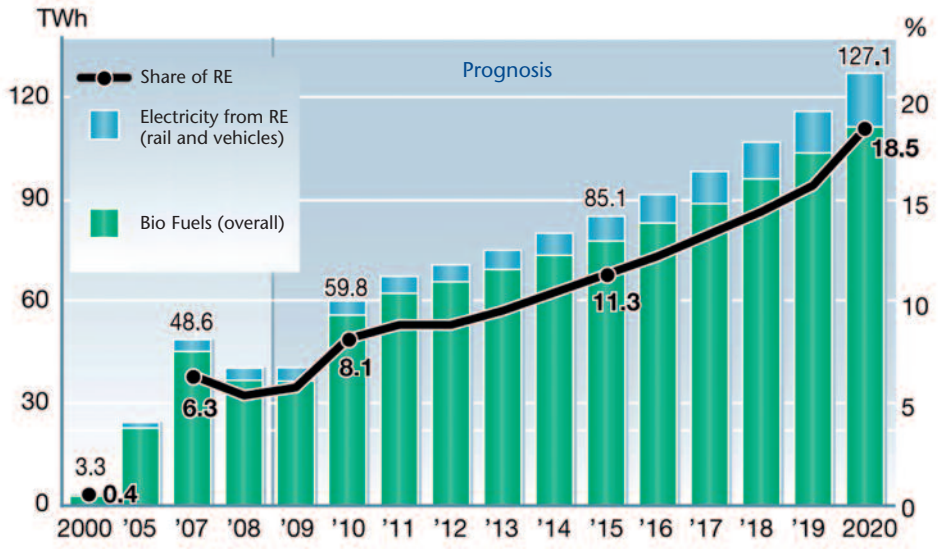

Figure 4
Development and shares of renewables in the transport sector

If the promotion of electromobility is backed by concrete actions – namely, in the field of battery research and during market introduction – the aim of the federal government of putting one million electric vehicles on German roads by 2020 can be achieved in the opinion of the BEE. Overall, the share of renewables in the transport sector's energy consumption could then rise to 19 percent.

A share of 100 percent renewables is only possible with R&D. But the year 2020 only represents an intermediate step in transforming our energy supply. The long-term goal must be switching to 100 percent renewable energy. Only then can we engage in economic activities in an environmentally friendly way while escaping ever rising fossil raw material prices. So after 2020, we will still need a dynamic growth of renewables in all areas. Here, the great importance of research comes into play again. While we are mostly familiar with, and dispose of, the means to promote the expansion of renewables for the next ten years, we still need significant technological and social advances for the years after.

The consequences restructuring our energy supply has on research and development in renewables can be roughly divided into two categories. In the broadest sense, one concerns "technical" and the other "social" issues.

Technical aspects of research

We still require major progresses in our efficiency of energy use. This applies to the entire energy sector, as well as to plant production and the plants themselves in the field of renewable energies. After all, there are also limiting factors in this area, such as the extent of usable land. Regarding plant manufacture, material and energy use have an impact on the remaining balance of CO_2 emissions from renewables.

The main technological challenge, and thus the most important research task, can be described with the term "system integration of renewable energies". This mainly pertains to the electricity sector, but not only. The higher the share of renewable energies in our electricity system, the lower the remaining fossil capacities.

With this, however, there are less capacities initially remaining to compensate fluctuations in solar and wind energy. New and more powerful storage media, technologies and structures are called for. We also need intelligent control systems that on the one hand help balance power generation and demand, and on the other efficiently coordinate several decentralised power plants.

This concerns not only electricity but also the heat sector in which major advances are needed to optimally connect generation, storage and supply to an ever-increasing share of renewables. Here, the major focus is primarily on heat storage, local heating networks and modern efficiency technologies in private and industrial use.

Combining electricity, heat and mobility is becoming ever more important because the utilisation of renewable technologies is increasingly cross-sectoral in nature. Prototypes such as the hybrid plant in Prenzlau (Brandenburg) that combines electricity, heat and fuel production, point in the right direction. The important thing in the relatively young field of renewable energies is research that is diverse and open to new technologies because setting course too early towards a certain goal would hinder promising developments in other sectors. The best technologies and concepts can only be proven in practice. In addition, different technologies also have different time horizons in which they mature and become fully effective.

In the field of electricity supply, smart grids and smart metering will play an important role in the future. There are a number of problems that research has yet to solve to allow for their extensive and successful application. In the future, the electricity infrastructure must therefore allow for both an increased decentralisation of power generation and improved networking over longer distances in order to make power plants feasible for regional supply on the one hand, and on the other to redirect large amounts of power from, for example, offshore wind farms to more remote consumption centres.

A key strategic issue for the energy supply of the future are the regenerative combined power plants. They link various regenerative production units and combine the specific strengths of the individual applications. In order to ensure that the operators of, for example, wind turbines and biogas plants cooperate on a large scale in the future, an appropriate stimulus for regenerative combined power plants has to be integrated into the EEG as soon as possible. In the past, valuable impetus for such an instrument also came from the Renewable Energy Research Association. The increasing proliferation of regenerative combined power plants will then have to be accompanied by research that is in step with actual practice. The therein employed IT components have to be optimised and the communication between plant and grid operators has to be improved.

Sociological and economic aspects of research

Now to the socio-political aspects. In this case, too, will the restructuring of our energy supply entail a considerable demand for research. First, there are the business sciences: Existing value-added models have to be advanced and refined for the area of energy generation and supply with regard to renewable energy sources. This is the only way to establish precise distinctions within the production chains and to provide reliable information on business costs and the economic effects of renewables. In this context, new models for technology assessment and evaluation of specific funding instruments are required.

An important research field – also beyond the interests of the renewable energy sources industry – is the question of monetising external effects of energy supply.

Only someone who knows how high the costs of coal and nuclear power are for climate, environment, health and for the availability of resources can properly value the benefits and advantages of expanding renewable energies. Scientific assessment and mathematical models are prerequisites for politicians if they are to develop and apply effective management instruments, thereby promoting the transformation of our industrial society into a sustainable economy.

In social sciences, the expansion of renewable energies opens up new fields in acceptance research. Phenomena such as the contradiction „Renewables yes – but please not on my lawn“

call for scientific investigation. Using the results, appropriate communication and action strategies can be derived, allowing for an expansion of renewables that is in line with the involved locals. Here, it could be possible to develop new public participation models and evaluate the effects of various methods and communication strategies.

Renewable energies depend on an effective legal framework while its formulation is significantly influenced by jurisprudence. This raises the question of how to proceed adjusting legal instruments to promote renewable energies and illuminating hidden obstacles in existing statutory provisions hindering their further advancement. As science, in the field of energy law, has been previously dominated by the perspective of traditional energy production from fossil and nuclear sources, it is now required to increasingly incorporate renewables' point of view into this area and to close the strategic gap by establishing think-tanks promoting the advancement of renewables.

Conclusion

Overall, renewables have grown steadily since their introduction and have long left their niche. With continued growth, they will become an increasingly dominant factor in our energy supply – with significant consequences for the whole power generation infrastructure, the grids, and ultimately the consumers.

Research has a central role in ensuring a smooth transition towards a new, safe and sustainable energy supply with the goal of 100 percent renewable energy.

German research and development has a top position in the field of renewable energies. So far, the excellent results have been quickly implemented and efficiently applied to technology. A globally leading industrial sector with a high export potential has formed in Germany that is also able to contribute successfully to job and value creation. Despite the previous achievements, research and development in this sector continues to be necessary at a high level in order to increase the considerable potential for innovation and to enable the rapid and complete transformation of our energy supply.

This requires constant impetus from an active research community which rapidly transfers innovative technological developments to the mainly medium-sized companies of the industry. The required research capacity has to correspond to the growth of the markets and has to be guaranteed by an increasing flow of research funds. Research and development of a renewable energy mix must therefore be given priority in energy research.

FVEE and BEE recommend raising funds for research and development of renewable energies and energy efficiency by 20 percent annually, as done so in the last three years, in order to achieve at least a doubling in the medium term. This is the only way Germany can keep up with global market dynamics and meet requirements of the EU as well as its own energy policy objectives for 2020 and beyond. This is the only way the German industry can maintain its leading position in the face of the rapidly increasing international competition.