German Research Policy for Increased Energy Efficiency

Forum Notes from presentation by K. Kübler,
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***Abstract* – These authorized notes, from a talk by the German official responsible for coordination of the German Federal support for energy R&D, include the analysis of the status of energy supply in Germany, comparison of energy-related forecast with reality, evolution of energy supply and consumption in time, and the government guidelines for the future up to year 2020. At present, renewable energies still represent a small fraction of the total energy balance, in spite of an enormous surcharge to taxpayers and consumers. It is shown that even modest increases of energy conversion efficiency can have an effect more significant than the gradual growth of the renewable energies contribution, and with no or far less indirect support. Furthermore, the energy R&D budget is presented, together with the distribution of responsibilities between participating ministries and main directions (fields) of energy R&D currently supported by these ministries.**

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I. INTRODUCTION

On February 20, 2008, the ZIEHL Symposium in Bonn, Germany (see Highlight H22), was opened by Dr. Knut Kübler, Head of the Department “Energy Research” in the German Ministry of Economy (Bundesministerium für Wirtschaft, BMWi). He presented an overview of the German research policy for increased energy efficiency. We were not able to secure an official English translation of that presentation, but believe that its highlights should be of vivid interest to the readers of “News Forum”. Germany is aspiring and succeeding to be European and worldwide forerunner in renewable energies and CO_2 emissions reduction, which requires harnessing all means leading to reduction of primary energy consumption. Energy efficiency improvement by wide implementation of superconducting components in the power grid could make an important contribution here. This issue should be of interest for all developed national economies. Therefore, we endeavor to present a concise version of our notes illustrated by copies of graphics selected by the speaker; translations were added by us. These Notes are authorized by the speaker and include also some of his opening remarks.

The purpose of the ZIEHL Symposium, organized with encouragement of BMWi, was to disseminate information on the German status of high-temperature superconducting (HTS) technology and its applications in energy industry, and to point out their potential for increased energy efficiency. The targeted audience were engineers active in energy technology, potential future investors, and hopefully decision makers in politics, economy, industry and environmental protection. The underlying belief of organizers has been that after nearly twenty years of R&D, at least some HTS applications are becoming ready for implementation in energy industry, and should be tested as real-scale demonstrators.

German Ministry of Research and Education (BMBF) and its predecessor ministry supported R&D in superconductivity to the tune of about 300 millions EUR between 1970 and 2004. Bulk of that support concentrated on HTS between 1987 and 1995, in the framework of the “special focus” program “Superconductors” [1]. Although BMBF is supposed to support fundamental research, bulk of the money supporting HTS was channelled to applied projects. Consequently, excessive and unrealistic expectations of immediate industrial breakthroughs lead soon to disenchantment and the resulting termination of the program, prompted also by rapidly declining interest of industry. After a few more years, the BMBF support for HTS technology "as such" became practically nonexistent [2].

The BMWi has been involved in supporting HTS technology thus far only marginally. Its Energy R&D Department currently supports non-nuclear energy technologies on the modest annual level of approximately 100 millions EUR for the whole spectrum from energy conversion, through energy transport, to storage and utilization. At present, one of areas of special focus is that of modern power plant technologies promising enhanced efficiency and environmental safety.

Generally, the energy policy of the German Federal Government and that of BMWi resides in the strategic concept of balance between the two principles of "focussing" and "flexibility". Focus on most promising strategic solutions is sought in interactive decision making involving the domains of economy, science and politics. Flexibility is sought by realizing that progress in R&D cannot be planned rigidly and reserves for temporary concentration of support for areas promising breakthroughs in energy economy must be provided. Superconducting technology might become one of future candidates for such temporary concentration, if it is really advanced enough to promise short-term breakthroughs. In any event, however, the bulk of support must be provided by the energy industry, as it should have objective means of assessing how ripe any such candidate really is and what savings it promises?

For its assessment purposes, the BMWi is seeking answers to the following three questions:

1. What is the true status of energy technology involving HTS, especially in Germany?
2. Where are the main deficiencies hampering quick market penetration by that technology?
3. Where and how could BMWi best provide the critically needed help?

II. POLICY CONCERNS, ENERGY CONSUMPTION AND FORECAST

Current concerns of the German energy policy are:

- High and increasing prices of oil and natural gas,
- Undetermined security of energy supply from Russia,
- What will be the new order in energy economy?
- How to protect the global atmosphere?
- What should be the future energy mix?

Table I presents the current trends in German primary energy supply by comparing the data for 2000 and 2007.

Table I. Primary Energy Supply of Germany, in Peta-joules

Energy Source	*Year 2000*		*Year 2007*		*Change, 2000 – 2007*
	PJ	%	PJ	%	%
Mineral Oil	5.499	38.2	4.678	33.8	- 15
Natural gas	2.985	20.7	3.136	22.7	+ 5
Hard (black) coal	2.021	14.0	1.952	14.1	- 3
Brown coal	1.550	10.8	1.618	11.7	+ 4
Nuclear energy	1.851	12.9	1.533	11.1	- 17
Renewable energies and other sources	495	3.4	925	6.6	+ 87
Total	14.401	100.0	13.842	100.0	- 4

One should note that only coal is the natural energy resource available in Germany, but its relatively massive use is criticized because of the greenhouse effect. Subsidies for hard coal are being gradually reduced. Gradual exit from nuclear energy, programmed since the Social Democratic Party (SPD) shared power with the "Greens", is motivated mainly by political or rather ideological considerations. Massive support and subsidies for renewable energies, effectively shouldered by taxpayers and the electricity consumers, resulted in almost doubling of their share, which is nevertheless still small (6.6 %) and without major effect on the overall balance.

One should also note that apparent reduction in mineral oil consumption is skewed by the increase of German value-added tax at the beginning of 2007. Homeowners purchased maximum possible amounts of heating oil in 2006, before the tax increase, and could thus abstain from good part of purchases during 2007. The oil consumption decrease by -15 % and the overall consumption decrease by – 4% are thus not entirely real. Overall, the total primary energy supply (TPES) stayed close to the official forecast, although several energy-related indices did not. Figure 1 compares the official forecast with reality. We can see that oil prices increased much more than forecasted, while the gross domestic product (GDP) and the energy productivity grew less than expected.

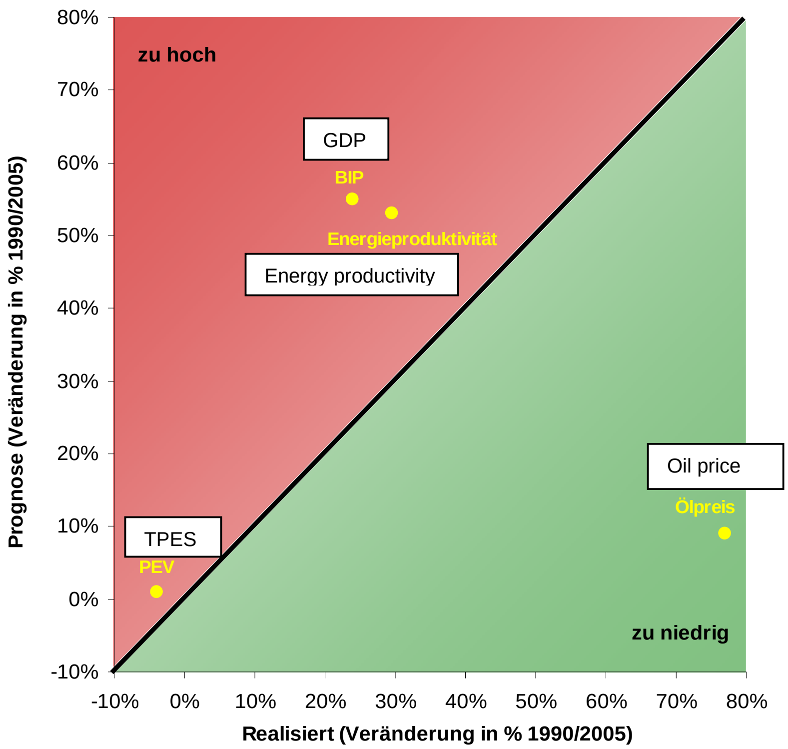

Fig. 1. Energy forecast and reality. Abscissa: reality (change 1990/2005, %); ordinate: forecast (change 1990/2005, %); diagonal line: perfect forecast. Green field – too low forecast,, red field – too high. TPES is the total primary energy supply.

III. ENERGY EFFICIENCY

Improved energy efficiency is a major policy goal as it can reduce the energy consumption and thus the necessary supply. It is well-known that only a fraction of the total primary energy supply is usable due to major conversion losses, *i.e.*, to low conversion efficiency. Securing this primary supply also costs energy. Table II visualizes the actual German example for year 2004: the energy expenditure to secure the primary energy needed (14, 440 PJ (peta-joule) was 1.830 PJ or about 12 %. The primary energy conversion losses into (mostly) electricity amounted to nearly 3.4 peta-joule or 36 %, and even more, 4.318 PJ, was lost in conversion into the final energy form used (such as light or heat, for example). Overall, only about 34% of the primary energy was effectively used in the final form. Implementation of technological improvements capable of reducing the conversion losses is thus an essential task.

Table II. From Primary to Final (Used) Energy: Example of Germany in 2004.

Energy	*Supply, PJ*	*Energy Loss*	*PJ*
Primary	14.440	Extraction loss	1.830
Final	9,.236	Conversion loss	3.374
Used (heat, light,..)	4.918	Conversion loss	4.318

The German Federal Government guidelines assume a reduction in primary energy supply (consumption) by about – 17% in the 15 years from 2006 to 2020, while in the past 15 years (1990 to 2006) it was hardly reduced at all, as is illustrated by Figure 2. This ambitious goal is to be attained simultaneously with the planned GDP increase by + 26%, similar as in the past 15 years. Increase in energy efficiency should make this possible and a good part of it should occur through implementation of results of energy R&D.

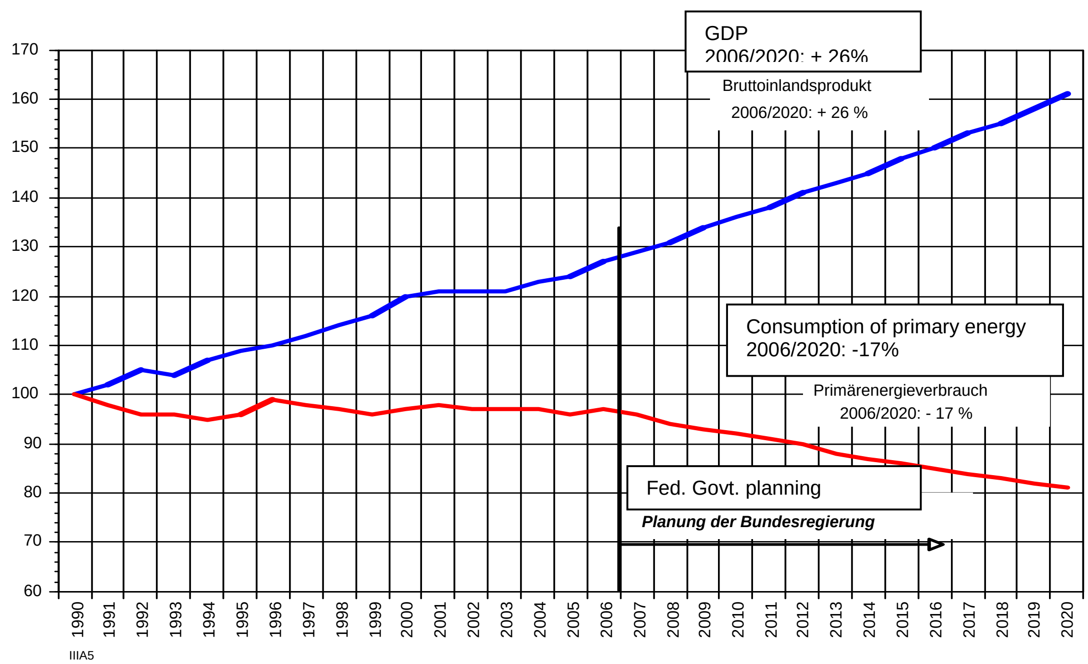

Fig. 2. German gross domestic product (GDP) and primary energy consumption. Actual Record 1990-2006 and Guidelines of Federal Government for 2006-2020

IV. FEDERAL ENERGY RESEARCH & DEVELOPMENT POLICY, RESPONSIBILITIES AND SUPPORT

According to the Federal Government policy, the primary responsibility for energy technology R&D resides with the economy and industry. The role of the Administration is to provide the favorable regulatory conditions, and to provide direct financial support in few selected areas when:

- the necessary time scale for development is very long,
- the selected technology R&D involves high financial risk,
- the selected technology has strategic importance.

The responsibility for energy R&D is spread across four ministries, with the BMWi having the *overall coordination* responsibility. The support is provided via two channels (1) direct support for projects, and (2) support of governmental institutions (such as research centers) performing energy-related R&D. Below we list the topical area responsibilities of each ministry.

The BMBF supports fundamental research via both channels listed above. The covered topical areas are:

- Nuclear fusion
- Nuclear safety
- Rational use of energy
- Renewable energies.

The three other ministries support only applied research, development and demonstrations. Specifically, the BMWi supports projects and provides institutional support for:

- Nuclear safety and waste storage
- Rational energy conversion.

The Ministry of Environment supports directly projects in renewable energies. Finally, the Ministry of Agriculture supports projects in bioenergy (biomass).

Returning to the BMWi, let's have a look on its technology R&D program "Protection of climate and energy efficiency". For this program, the BMWi is budgeting in year 2009 EUR 110 millions. In the area of energy generation & distribution, the main directions of supported R&D will be:

- Modern power plant technologies
- Heat generation & transport (efficiency of)
- Fuel cells and hydrogen technology.

In the area of energy use, the main directions will be:

- Efficient use & storage of electric energy
- Energy optimization of (house) construction
- Rational use of energy in industry and commerce.

The overall federal energy R&D expenditures in 2007 and those budgeted for 2008 to 2011 are shown in the diagram of Figure 3. There is a noticeable increase planned for 2008 (from about 440 to over 510 million EUR, but only little from 2008 to 2011. Overall, the budget for 2008 to 2011 should amount to 2.1 billion EUR or 2.3 billion when including other activities relevant to R&D. The four major topical categories shown are: nuclear fusion, nuclear safety, renewable energies and rational energy conversion. The energy R&D budget is rather modest, compared to the historical past, when nuclear energy R&D was actively supported. When the energy R&D budget sharply peaked in 1982 it amounted to over 2 billions EUR (recalculated for the EUR value in year 2000). This is illustrated by the graph of Figure 4 (see the last page). The blue curve presents the historical perspective of the energy R&D budget. From about 1995 it is nearly constant at the level between 400 and 500 millions. The red section of the curve refers to the planned R&D budget of Figure 3.

The *de facto* German support for renewable energies is currently an order of magnitude higher that the R&D budget. The steeply ascending green curve represents the extra cost (largely of direct subventions and other incentives) that the German taxpayers and electricity consumers have to cover indirectly and via the effective consumer cost of electricity. Between 1995 and 2005 that extra cost was increasing annually by about EUR 250 millions, with hardly any saturation symptoms in sight. It is this massive indirect support mandated by government policy that permits Germany to keep the forerunner role in renewable energies. Comparison with the data of Table I shows that the fifteen-fold increase of the effective support resulted in barely + 87 % increase of the renewable energy contribution to the primary energy supply; this contribution is still less than 7 % of the total. The enormous expenditures thus far affected the balance between different energy sources only moderately. To get a feeling of how expensive is the implementation of renewable energy sources one should remember that part of their total share (6.6 %) comes from traditional established technologies, especially hydro.

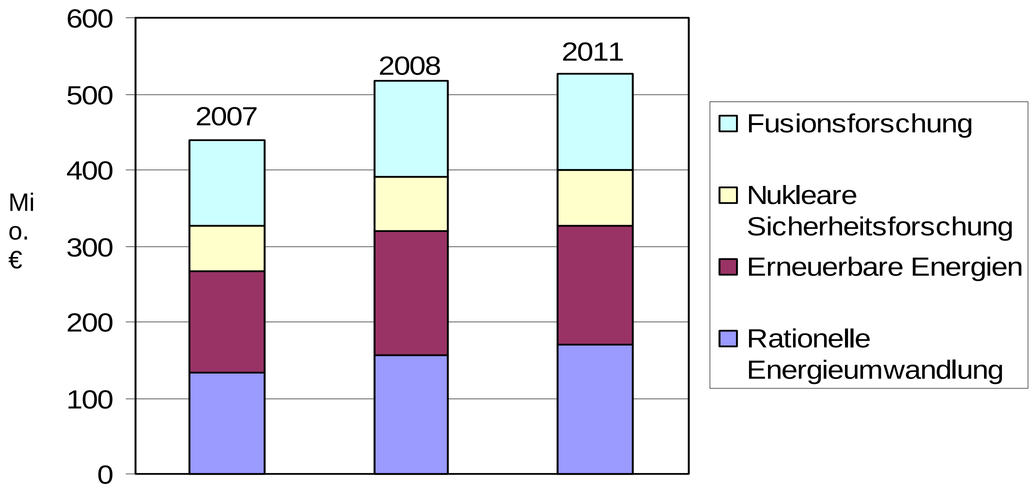

Fig. 3. Energy R&D: the 2007 expenditures in millions of EUR and the German Federal Budget for 2008 and 2011. Color code: light blue – nuclear fusion research, cream – nuclear safety, crimson – renewable energies, violet – rational energy conversion.

V. CONCLUSION AND OUTLOOK

Using the example of Germany, the presented data illustrate the importance of increasing the energy efficiency across the whole spectrum of primary energy sources. The conclusion is valid for Europe and, in fact, the whole developed and developing world. Even modest increases of conversion efficiency can have an effect more significant than the gradual growth of the renewable energies contribution, and with no or far less indirect support. Therein resides the importance of R&D resulting in higher energy efficiency. The document of the World Energy Council "Energy Efficiency Policies around the World: Review and Evaluation, 2008" states explicitly: "energy efficiency policies should address all areas with energy savings potential". One of such areas with a considerable potential could become the massive implementation of high-temperature superconducting components and subsystems in the whole energy chain: from electric energy generation through transmission and distribution to storage and industrial end use. However, this can occur only when this HTS technology will demonstrate reliability at least equivalent to that of conventional apparatus on the grid and at comparable capital expenditure.

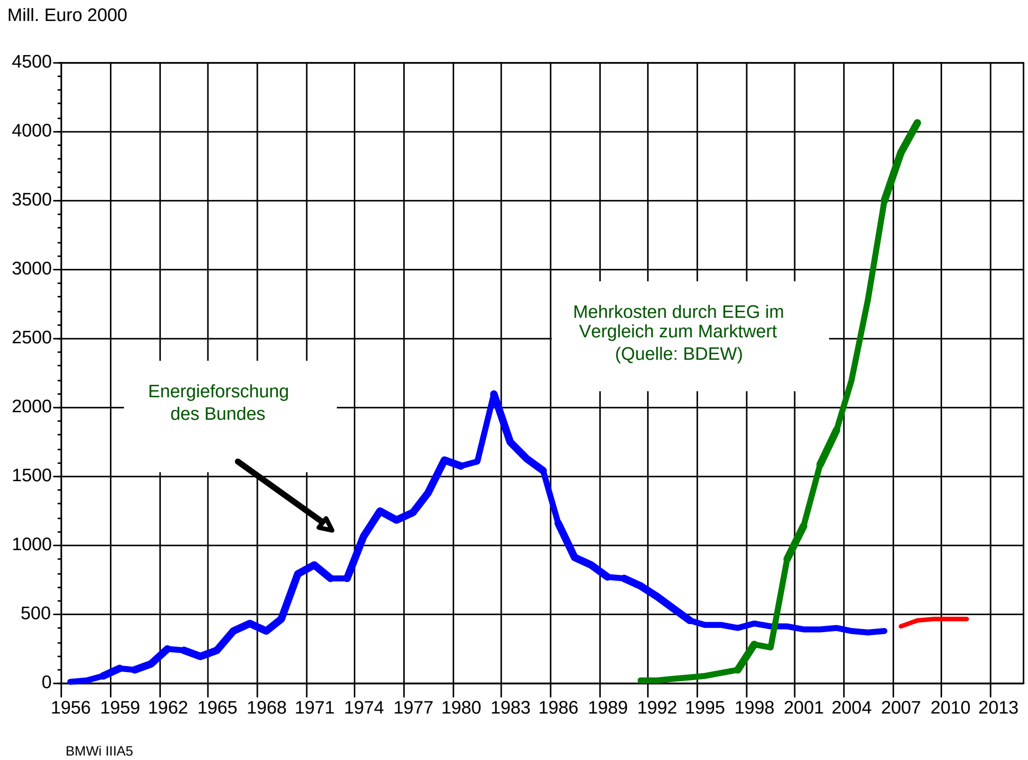

Fig. 4. Historical evolution of Federal Budget for energy R&D 1960-2011 (blue curve), planned evolution of budget in 2008-2011 (red) and extra cost (surcharge) of renewable energies to taxpayers and consumers (green). The surcharge data are from BDEW – Association of German Energy and Water Economy Management.

NOTES

[1] This amount is modest in comparison with the US and Japan support in the same period, but probably one of the highest in Europe.

[2] This is in contrast to the US and Japanese situation, where significant governmental support of R&D into HTS technology, especially for energy industry and especially for demonstration projects, extends over much longer periods and is still active.