STIMULATING INDUSTRIAL INNOVATION FOR SUSTAINABILITY:
AN INTERNATIONAL SURVEY FOCUSED ON TECHNOLOGY

GERMANY

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1. INSTITUTIONAL CONTEXT/BACKGROUND

1.1. GERMANY’S INDUSTRIAL PROFILE

Within the last decade there has been an ongoing substantial structural change in Germany. Manufacturing has been losing its importance and services, together with transport and communications, has been growing. In 1988, manufacturing produced 30.7% of the national GDP; in 1998 its share was only 27%. In contrast, services increased from 32.9% to 38.1% in the same amount of time, while transport and communications experienced a ten percent increase in its share from 5.4% to 6.0%. In the future, Prognos expects that these structural changes will continue; by the year 2010, services plus communications will grow to 50% of the German GDP, with manufacturing falling to 25%. The public sector will also lose its importance, falling from 11% in 1988 to 7.7% in 2010.

Within the German manufacturing sector, there has been a strong export orientation; this is especially true for the sectors of machinery manufacturing, chemicals and transport equipment. These sectors were responsible for 57% of the total industrial export turnover in 1997.

The final major factor of the German industrial profile is unemployment. This is a major consideration, because at the moment about 10.8% are unemployed. Unemployment is not evenly distributed throughout the country, being higher in the former German Democratic Republic Länder.

Looking at the size of companies, Germany's industry is dominated by small and medium-sized enterprises. In 1987, 1.8 million companies employed only 1 to 9 workers, 156,000 companies gave work to 10-19 persons, 108,000 companies employed 20-499 workers and 3,000 companies employed 500 and more persons.

1.2. GERMANY’S INNOVATION PROFILE IN INTERNATIONAL PERSPECTIVE

Germany's total R&D investment is a bit higher than the OECD average. In 1998, Germany spent 2.3% of its GDP on R&D. Six OECD countries spent more money on R&D: (Sweden [3.9%], Finland [2.9%], Japan [2.9%], South-Korea [2.9%], USA [2.6%] and Switzerland [2.6%]). But this relatively high level of investment has to be seen in the context of a historical decrease. German R&D investments were much higher in the 1970s and 1980, but shrank significantly in the first half of the 1990s. Recently, there has been a slight rise in this investment.

<table>
<thead>
<tr>
<th>Table 1: German R&amp;D Investment by Source, in million EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Companies</td>
</tr>
<tr>
<td>Universities</td>
</tr>
<tr>
<td>Public Authorities</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

In total almost 43 Billion EURO were spent for R&D in 1997. Looking at the sources for this expenditure most of the money was spent by the private sector, namely 67.4 per cent. Consequently public authorities and universities only spent 32.6 per cent of the total R&D expenditure. Between 1995 and 1997 the companies’ share even increased.
As can be seen in the table, the four German sectors **Chemicals**, **Machinery Manufacturing**, **Electrotechnical Products** and **Transport Equipment** dominate the industrial R&D activities. These sectors can be characterized as the “technology-generating” sectors within the German economy. There, technological developments and solutions are searched for and found which will be used and implemented by other industrial sectors. It is interesting that the sector **services** are only responsible for 3 per cent of the total industrial R&D expenditure, even though software research and development activities are taking place here.

The four R&D intense German industrial sectors mainly consist of **big companies**; most of them are global players. **Small and medium-sized** enterprises act as suppliers within this system. The SMEs concentrate their R&D on applied research activities. These companies act as innovators themselves in niche markets which in respect to their financial volume are not interesting enough for the global players.

### 1.3. THE STRUCTURE OF THE GERMAN R&D SYSTEM

![Diagram of the German R&D system]

On the left hand side of the picture, the different stages of knowledge within innovation processes are shown, on the right hand side the main players stimulating innovation in...

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**Table 2: Private R&D Investment 1997 by Industry of Origin**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals</td>
<td>17.5</td>
</tr>
<tr>
<td>Basic metals</td>
<td>2.5</td>
</tr>
<tr>
<td>Machinery Manufacturing</td>
<td>10.2</td>
</tr>
<tr>
<td>Electrotechnical Products</td>
<td>23.0</td>
</tr>
<tr>
<td>Transport Equipment</td>
<td>36.8</td>
</tr>
<tr>
<td>Services</td>
<td>2.8</td>
</tr>
<tr>
<td>Others</td>
<td>7.2</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>
Germany. Here, a distinction is made between the public and the private sector. The square dimension of the rectangles gives an idea of the expenditures sizes.

As mentioned before, the **biggest players** within the German innovation system are from the private sector. But the public sector is also a quite important too. **Cooperation** between these two sectors is not really organized in terms of an officially arranged R&D transfer. But cooperation and especially knowledge transfer does work more or less well between the universities and research institutes and the private sector.

In addition to the players shown in the picture, there are **two ministries** mainly involved in this innovation system: the Federal Ministry for Science and Education and the Federal Ministry for Economic Affairs and Technology. The Federal Ministry for Science and Education concentrates its activities on technological developments/improvements while the Ministry for Economic Affairs and Technology mainly deals with increasing competitiveness.

Both ministries changed their names, as well as their functions, after the elections of October 1998. The former Ministry for Science and Technology took on Education and gave up Technology. This latter function was passed to the Ministry of Economic Affairs. The passing on is not complete; both ministries still deal with technology-oriented issues, although the majority of work has passed from Science to Economic Affairs. For instance, both ministries support R&D activities on integrated environmental friendly technologies. The same is true for the Federal Ministry for the Environment, but this Ministry is not as important as the other ones (speaking of the amount of money spent on R&D activities).

There are also R&D supporting activities on the **state level** (There are 16 states in the German Federal Republic, each with its own government and ministries.)

As can be seen in the picture, the **public sector** concentrates its research activities on fundamental research as well as on short- and long-term applied developments. But some research institutes are also responsible for technological developments and the conduction of pilot project such as the Federal and State Research Institutes and the Fraunhofer Institutes. **German industry** dominantly conducts applied research activities, namely technological development, pilot projects and implementation.

### 1.4. GERMAN POLICY FRAMEWORK

Until the **mid 1980s** public R&D policy in the field of developing and introducing technologies that reduce the environmental burden concentrated on R&D for **end-of-pipe technologies**. The reasons for this were the relatively high emissions and environmental burdens in many industrialized regions in Germany (e.g. the German Ruhrgebiet). Environmental Policy set the environmental standards and explicitly demanded for specific technologies. Therefore R&D activities concentrated on technologies which could **meet the environmental standards** and on technologies which were able to **measure emissions**. In the 1970s air pollution control as well as water protection measures were the objects of focus; in the 1980s soil protection activities started to develop.

In the **mid 1980s** up to the **beginning of the 1990s**, two new approaches were added to environmental protective R&D policy:

- Environmental system analysis, specially climate system and ecological system analysis,
- Regional ecological research heading for practicable ecological concepts for cities or regions.

The reasons for these developments were on the one hand side the knowledge that a specific emission does not only effect one environmental media (e.g. air or water) but the entire
environmental system. On the other hand side the need for first practicable concepts on a regional level arose.

Because of the German Reunification and as a side effect of the developments described above a number of new research institutes were founded such as the “Potsdam Institute for Climate Change and its Global Impact”. Also quite a lot of new research projects were started dealing with special environmental problems in the New German States.

Right now, cleaner products and further integrated environmental production technologies are the center of attention. These R&D activities are heading for a much higher energy and material efficiency within the entire production and consumption process.

The German definition of a sustainable development is pretty much the same as the Dutch one (Development that fulfills the needs of the current generation without endangering possibilities for future generations). Maybe the emphasis is a bit more on the last part of the definition (“without endangering possibilities for future generations”).

The German government also strives for a de-coupling of economic growth and burden on the environment. Here main action is undertaken on energy issues, rather than on material issues.

Some important innovation policy programs in the field of sustainable development are:
• “Research for the environment” initiated by the Federal Ministry for Science and Technology, Berlin, in 1997,
• “General set-up supporting sustainable innovation” initiated by the Federal Ministry for Science and Education, Berlin. The project has not started yet, at the moment the ministry is calling for proposals,
• “Support for innovation on plastic production and waste treatment,” borne by the Federal Ministry for the Environment, is not a program but a policy mix. Single measures started in 1990, most of them are still in force; some new measures are in preparation.

The explicit goal of the first program was to support sustainable innovation in business and society. The program headed for energy and material efficiency innovations as well as so-called basic or fundamental innovation. Basic innovation are defined as innovations being able to offer completely new technological or product-related solutions (for instance redesign of products and processes, function and system innovation). There were a lot of disciplines addressed to meet this goal: from oceanography, energy and energy technology research, biotechnology, health science up to information as raw material for innovation and services for the 21. Century. The results are basically fundamental research oriented. A lot of studies were conducted within this program, most of them analyzing the impact of certain instruments on innovation in selected areas.

The second program can be characterized as a follow-up program on “Research for the environment”. Here, the goal is to give financial support to cooperation projects between research institutes and companies. These projects should aim at (technological or non-technological) innovation for a more sustainable development in selected companies. By this a general organizational, political and economic set-up which is able to support innovation shall be found.

As mentioned above, the third program is not a program but a policy-mix. Here the goal is to support a more sustainable plastics production, manufacturing and waste treatment. Measures included instruments setting environmental standards such as the German “Circulation-Economy-Law” or the German Waste Law. In addition certain laws for waste
treatment and environmental labels (such as the so-called “blue angel”) were implemented. Altogether this policy-mix can be characterized as quite successful.

1.5. INTERACTION OF GOVERNMENT WITH INDUSTRY

In general, environmental policy seeks for consensus among public and private actors. But quite often German industry only seems to be willing to cooperate under the pressure of sanctions. A good example of this are the negotiations about the shut-down of nuclear power plants which the government demanding and the electricity producers are resisting. The negotiations on this issue started about 18 months ago and consensus is still not in sight.

The trade associations and the German industry itself are quite powerful actors within the German policy framework. Important environmental/economic issues are generally discussed between industry and politicians before a new law is designed and set into force. There are institutionalized discussion platforms such as the German “Energy Dialogue 2000”. Within this institutionalized dialogue the main trade associations, some companies, the unions, the environmental associations, research institutes and the ministries involved (Federal Ministry for Economic Affairs and Federal Ministry for the Environment) are discussing the design of a new German energy law (basically dealing with the legal framework for further, more specified energy related laws). This dialogue started in March last year and will take about 15 months.
2. CLASSIFICATION OF POLICY INSTRUMENTS

2.1. ROLE OF GOVERNMENT

At the moment the German government dominantly acts as a stimulator of theoretical knowledge of instruments and the general set-up supporting sustainable innovation. Also the German government acts as an initiator supporting R&D on specific energy technologies (e.g. large solarthermic power plants or wind energy power plants). Here, mostly pilot projects are supported. The German government acts as an interventionist as well, influencing the price for energy and labor. In April 1999, the first step of an ecological tax reform came into force. The goal is to raise the price for energy and at the same time (and with the money gained from the higher taxation on energy) to lower the price for labor. The second step came into force in January this year, three more steps with a gradually rising tax on energy are planned.

2.2. TYPE OF SUPPORT/INSTRUMENTS

In general there is a large variety of instruments. A distinction can be made between instruments directly supporting sustainable innovation and instruments which do not specifically aim sustainable innovation but can also (indirectly) support such innovation. Until recently, innovation was basically understood as technological innovation, but gradually a different approach can be recognized where organizational, services related and social innovations are sought. It is also worth noting that the innovation process is no longer understood as a determinable “linear” process with a clear cause-impact relation (meaning one instrument leading to a specific innovation) but as a dynamic process which is often not predictable and has a number of different causes.

Looking at instruments directly supporting sustainable innovation, there are quite a lot of technology oriented measures which provide financial support. For instance, some technologies for the use of renewable energies are supported that way in Germany. There are also programs supporting research on energy or material efficient technologies. This financial support is not technology specific, any technology fulfilling this goal can be sponsored by these measures. In addition, the knowledge transfer between the public and the private sector is financially and organizationally supported.

There is a variety of instruments not directly supporting sustainable innovation in Germany but being able to support such innovation indirectly. First of all, the ecological tax reform must be mentioned (see above). In addition, there is a very thorough command-and-control system setting environmental standards for almost every environmental field. Of course also “soft” instruments such as information and motivation, labeling (e.g. the so-called “blue angel” identifying environmental friendly products) as well as subsidies for the use of specific products and technologies exist. For instance, there are subsidies for the use of very efficient heating equipment in private households.

2.3. MODALITIES OF CONTRACTING IN CASE OF FINANCIAL SUPPORT

Control over outcome differs among programs/projects. Programs/projects initiated by the Federal Ministry for Science and Education usually have their own steering group or steering committee. Other programs/projects mainly do without. Most projects require two or three reports (at the middle and end of the project). Generally, there are some, but not too many reporting requirements.

Most of the time performers of research have to adhere to specific conditions given by the ministry/public institution involved. But cooperation between researchers (in companies and research institutes) and the ministries/public institutions involved works in general quite well.
The ministries/public institutions concentrate on being informed and discussing certain topics before the researchers begin their work.

**Allocation of financial support** differs among programs/projects. There are programs with competitive elements offering financial support for R&D on specific environmental/technological issues. In such cases, the money is given only once to the company/research institute offering the best price/idea/project. Other programs spend money for a number of interesting ideas, research projects or demonstration installations dealing with the same (technological or innovation related) questions. And there are programs offering a certain amount of money to every company which meets specific conditions (e.g. size, technology involved, goal that is to be met).

### 2.4. INTERNAL ORGANIZATION, MANAGEMENT STRUCTURE OF THE PROGRAMS

The Federal R&D programs/projects are dominated by the Ministry for Science and Education and the Ministry for Economic Affairs and Technology. While the Ministry for Science and Education very often involves project-managing public institutions (see part III), the Ministry for Economic Affairs and Technology most of the time organizes and manages the programs itself. The Ministry for the Environment mainly deals with strategic and political issues while the Federal Environmental Agency has to fulfill environmental research management duties (on behalf of the Federal Ministry for the Environment).

In general R&D programs/projects on the **German state level** are only able to offer a very limited amount of financial support compared to the support offered by the Federal ministries. The state activities can be characterized as programs which prioritize certain federal programs/goals on the state level. The state R&D activities do not differ conceptually from the federal R&D politics. Mainly the state programs/projects are managed by the state ministries themselves or communal institutions.

### 2.5. METHODS TO ASSESS EFFECTIVENESS

The definition of effectiveness or impact differs among the programs/projects. The programs offering financial support to every company which meets certain conditions (size etc., see above) define and measure effectiveness by the number of technological solutions/innovations found or patents applied for/patents pending, the pollution avoided, the number of companies involved, the amount of money spent on R&D in the companies, the technological investment created by the program, the number of new jobs created or the number of jobs saved by the program etc. Not all of these criteria are universally applied, but the major outcome measures are almost always to be found.

The programs selecting financial support by competitive bids and supporting R&D on specific technologies also define and measure effectiveness by the number of technological solutions/innovations found or their importance. In addition some of these programs measure effectiveness by analyzing the number of new systems implemented or products used.

The programs (with competitive or non-competitive allocation of funding) supporting fundamental research or (more theoretical) studies define effectiveness by the new knowledge gained from these initiatives. In that case only “soft” data exist to measure effectiveness.

Most of the government programs (on a federal as well as on a state level) are being evaluated in order to look at their effectiveness. In general there are two approaches: an evaluation at the end of the program/initiative and an evaluation while the program is in progress (from the beginning to the end of the program). Evaluations are conducted by external research institutes or consultants. Some initiatives are analyzed on a more
theoretical level; at present, the ecological tax reform is being analyzed by two research institutes with respect to the additional employment created by this instrument. The general experience is that evaluations while the programs are in progress are more useful but mean a greater effort. Model-based, more theoretical investigations depend a lot on the assumptions set and the model chosen. Therefore the results are politically quite vulnerable.
3. SPECIFIC EXAMPLE PROGRAM DESIGN CHARACTERISTICS

3.1. PROGRAMS/INITIATIVES SELECTED

A) Solarthermic Technologies 2000. In 1993, the Federal Ministry for Science and Technology started this program in order to support R&D activities on this technology. Financial support was given to selected pilot projects and demonstration installations especially in the New German States. A specific focus was set on large solarthermic installations. This program achieved significant and continuing decreases in the specific investment cost of this technology. The program focuses on the specific target area of improving existing products and processes and partly on the target area of redesign of technologies.

B) ZÖW (in English it would be something like “Future Initiative for Companies’ Ecological Reconstruction”). This is a program initiated by the State of Berlin for the financial support for the implementation by small and medium-sized enterprises in Berlin of integrated cleaner technologies. Other goals include supporting knowledge transfer, decreasing unemployment, and the improvement of existing products and processes. The program lasted from 1994 to 1999; it focused on the specific target areas of market introduction and improving existing products and processes.

C) Renewable Electricity Laws supporting wind energy systems. The goal of these federal laws (one passed in 1991 and one passed in 2000) is to support R&D on and the implementation of wind energy systems in Germany. Private households or companies get financial support if they generate wind (or other renewable) electricity themselves. They get this financial support from the energy suppliers, who are required by the Renewable Electricity Laws to buy this electricity for a certain (fixed) amount per kWh. These laws are part of a policy-mix combining direct financial support, cheap loans, and tax reductions as well as fixed prices for renewable electricity. Altogether, these measures took several years (the laws for renewable electricity are still in force) and were quite successful. The instruments focus on the specific target area market of introduction and the improvement of existing products and processes.

3.2. SOLARTHERMIC TECHNOLOGIES 2000

3.2.1. Background

Two developments which took place in the beginning of the 1990s were “responsible” for the design of the program. First, the Federal Ministry for Science and Technology realized that the specific cost for large solarthermic installations (100 m² and bigger) are relatively lower than the specific cost for smaller installations. This they learned from a study which was finished around that time. Second, German Reunification began. A lot of old buildings in the New German States (former German Democratic Republic) got much better thermal insulation. And there was a special interest in solarthermic systems from East German building owners, public institutions, engineering companies as well as from the industry. This special interest arose because the East Germans had the strong desire to catch up with the west. They addressed this interest to the Federal Ministry for Science and Technology. Because of both developments the program “Solarthermic Technologies 2000” was invented.

With respect to the rather bad experiences gained from an earlier program with broad financial support to almost every company which met certain (rather weak) conditions, the Federal Ministry for Science and Technology decided to support only selected pilot projects and demonstration installations. Only solarthermic installations for buildings which have had a very thorough thermal insulation first were considered. This selection criterion helped to get closer to economic efficient solarthermic solutions because otherwise too much energy
is lost by the building itself. Another selection criterion was to sponsor only public buildings. Here the underlying idea was that the public sector should have a first mover role within this field. Other selection criteria had a strong technical background: only buildings which were offering technical ideal conditions for large solarthermic installations were accepted. The underlying idea for this rather strong selection was to make a positive demonstration effect possible.

Therefore the number of accepted projects was much lower than the number of proposals; altogether almost 500 proposals were written since 1993 but only about 50 projects were accepted.

The Federal Ministry for Science and Technology designed “Solarthermic Technologies 2000” as a long-term program (8-10 years) because experience with shorter programs (2-3 years) revealed that programs usually need a relatively long time to even become known to potential participants.

Projects/programs initiated by the Federal Ministry for Science and Technology are most of the time managed by external implementation agencies or institutions. This situation arose because the growth of sponsoring activities by the Federal Ministry for Science and Technology increased beyond their capacity to manage. These intermediary agencies are typically sponsored by federal money and are able to provide more R&D specific consultancy than the ministry itself. This is also true for “Solarthermic Technologies 2000” which is managed by the publicly financed institution BEO.

Experience shows that “Solarthermic Technologies 2000” was quite successful. Significant drops of the specific investment cost for large solarthermic installations were gained. Additionally, a remarkable number of solarthermic installations for public swimming pools were installed without any financial support.

3.2.2. Objectives
The immediate objective of the program is to reach economic efficiency of large solarthermic systems. Therefore remarkable drops of the specific investment cost for this technology were to be gained. Further immediate objectives are:
• to support the knowledge transfer between science and industry,
• to improve the solarthermic knowledge of public institutions, regional crafts centers, producers of solarthermic installations, architects and engineers as well as universities and research institutes,
• to inform the broader public about the advantages of solarthermic systems.

Scientific monitoring is taking place during the entire program, measuring and analyzing technical and economic data (e. g. energy produced, cost).

The wider objective of the program is to increase the renewable energies’ share in Germany. The program is one element of the federal strategy towards a (much) greater use of renewable energies. While most of the other federal programs concentrate on electricity produced by renewables, this specific approach heads for environmental friendly generated heat. Therefore a limited number of pilot projects and demonstration installations is financially supported.

3.2.3. Elaboration of the types of policy instruments
The program started in 1993 and will last till 2002. It has 3 elements:
• Financial support of selected large solarthermic pilot projects and demonstration installations with a special emphasis on public buildings in the New German States.
• Analysis of the technical long-term experiences on already existing ("traditional")
solarthermic installations.
• Support of decentralized solarthermic heat supply systems, especially on a communal
level.

In this paper only the first element is analyzed in detail.

Financial support is given for the investment of solarthermic installations with a size of at
least 100 m² per building. The investor does not have to pay back the financial support in any
way. In 1993 financial support was given to the maximum of 90 percent of the total
investment cost, nowadays only 60 percent of the total cost is sponsored. No financial support
is given for the operating cost. Under this program, about 25 million EURO have been spent
since 1993.

In order to get the financial support, certain conditions have to be met. These criteria are
checked within a 3-step selection procedure conducted by BEO:
• Only solarthermic systems with specific cost of 15.38 Cent/kWh (in the beginning of the
program) or 12.82 Cent/kWh at the most (now) can get this financial support. These
figures are lower than the respective average costs of “traditional” large solarthermic
systems. In this way, only innovative systems receive financial support.
• Only solarthermic systems with a high potential for demonstration effects and for
getting further knowledge are given financial support.

Every institution accepted will get a guarantee by the producer of the solarthermic system to
be able to generate a certain amount of heat (by the system chosen). This way the
institutions involved have a solid basis for their calculations. If the solarthermic system is not
producing the heat amount guaranteed, the systems’ producer has the responsibility for
solving the problem. This design element is apparently unique in Europe.

Altogether a large variety of solarthermic installations are sponsored (different sizes of
installations, of producing companies, of technical solutions, of locations, of users).

All participants have to agree to and to cooperate with the technical and economical
monitoring process which takes about 3 years per solarthermic installation.

3.2.4. Role of government in the program/project
The federal ministry involved here acts as a stimulator of sustainable innovation by financial
support. For a limited time (until large solarthermic installations have reached economic
efficiency) the ministry acts as a financier of innovative investment (investment which
meets very high efficiency standards). Therefore the government can be characterized as a co-
investor of R&D.

3.2.5. Internal organization and management structure
Apart from the Federal Ministry for Economic Affairs and Technology,1 two organizations
are mainly involved in this program: BEO, which is a publicly sponsored institution and
functions as the project managing organization, and ZfS Ltd., which is a private company and
mainly deals with the practical implementation and consults the sponsored institutions. BEO
works on behalf of the ministry; it decides which proposals to fund and manages the financial
support. ZfS works on behalf of the federal ministry and of BEO; it coordinates the scientific

1 Since 1998. Before that, the Federal Ministry for Science and Technology was responsible
for „Solarthermic Technologies 2000“ (see I.3).
monitoring and cooperates closely with local universities. In addition a number of universities act as consulting organizations; they were chosen by being situated close to the sponsored institutions. The ministry itself is responsible for the strategic design of the program and for its financial and organizational supervision.

3.2.6. Stages of knowledge addresses
Within this program the knowledge stage “pilot projects” is addressed. Only solarthermic systems with specific cost much lower than average are accepted for this program. The design of the supporting criteria (specific cost of 15.38 Cent/kWh in the beginning; 12.82 Cent/kWh now) gives an additional innovation incentive. By this means, technological development is also supported. Only selected, technically ideal pilot projects are accepted for sponsoring in order to allow a positive demonstration effect.

3.2.7. Modalities used
Since October 1998, the program has been financed by the Federal Ministry for Economic Affairs and Technology. Before it was financed by the Federal Ministry for Science and Technology (see I.3). The money is issued by BEO, the implementation agency chosen (see above). As mentioned above, the money is only given to very selected public institutions. One selection criteria is the specific cost for heat produced by the planned solarthermic installation. Other selection criteria are ideal technical conditions for such an installation and a high potential for demonstration effects and for getting further knowledge from the installation planned. So competitive bids (referring to the lowest specific cost) are only one part of the selection process.

3.2.8. Hurdles encountered
It is interesting to notice that no main hurdles were encountered within the program. The only hurdles so far were relatively insignificant. This appears to be in part because “Solarthermic Technologies 2000” was designed with the experiences from former programs in mind.

Some of the small hurdles encountered referred to technical problems (e.g. the problem to find technically ideal solutions for flat roofs or the problem to measure the average heat demand at the right point in time).

Another rather small hurdle was pointed out by the solarthermic systems’ producers. They were arguing that they did not make enough profit by the systems sponsored. Even though nothing was done to solve that problem, the systems’ producers are still willing to participate. Institutions applying for sponsoring complained that the application procedure is rather complicated and needs a lot of time. They also complained about the low percentage of proposals funded. BEO, in response, has attempted to pre-select the applicants by systematic interviews first. Also, BEO provides more information about the selection criteria.

3.2.9. Focus on specific industrial sectors
On the one hand the program focuses on public institutions--principally public buildings. On the other hand side the money can only be spent for the investment of large solarthermic installations. Therefore the industrial sector machinery manufacturing (where solarthermic systems are produced) clearly profits from the program economically and technologically.
3.3. ZÖW

3.3.1. Background
Since the end of World War II, the Berlin economy had been quite weak due to its isolated geographic location. This was not changed much by German Reunification; in some sense it was worsened by the structural changes that are still ongoing. A lot of privatized former East German companies - even though they were sponsored by federal money – were not able to survive. Also, many West Berlin enterprises turned out to be too weak under real competitive conditions (quite a lot of West Berlin companies had received federal subsidies since the end of World War II). As a consequence, dramatic and widespread job losses occurred in the Berlin region at the beginning of the 1990s.

At the same time new technological and global developments took place. The Berlin State Government became aware of a much faster technological change (with a higher demand for information technology and integrated environmentally friendly technologies) and of a greater economic globalization. Additionally, the environmental situation in East Berlin was quite bad and created a demand for change.

In order to strengthen the (East and West) Berlin industry and its entire economy, the Berlin State government decided to enhance the innovation ability of Berlin industry. A number of programs partly co-financed by the European Fund for Regional Development (EFRD) were designed and implemented. One of them is ZÖW, which is oriented towards small and medium-sized enterprises in East and West Berlin and aims at greater use of and R&D on environmental friendly technologies.

SMEs were chosen due to the fact that these companies offer a relatively large potential for further environmental protective measures. Experience showed that SMEs usually do not have enough knowledge, man-power and money to invest in further environmental friendly technologies, even if the investment itself can be characterized as a no-regret measure. ZÖW was designed to activate the no-regret-potential within SMEs.

3.3.2. Objectives
The immediate objective of the program is to support the implementation of and R&D on environmental friendly technologies, processes and products, conducted by small and medium-sized enterprises in Berlin. ZÖW should enable these companies to conduct such R&D and to gradually change production processes towards are more sustainable production in general. In a broader perspective, ZÖW intends to strengthen the economic and technological competitiveness of small and medium-sized enterprises in the State of Berlin. As a result unemployment should be reduced significantly and regional development should be supported. At the same time, the environmental burden would be reduced.

The wider objective of the program is to support the de-coupling of economic growth and environmental pollution in Berlin. Energy, material and raw material efficiency shall be increased significantly. This will not only support an ecological sustainable development but also an economic and social sustainable development (because of a higher energy or material efficiency cost reductions, a higher competitiveness and a higher employment can be realized).

3.3.3. Elaboration of the types of policy instruments
Financial support is given to any expenditure within the eligible companies which have a direct relation to the implementation of or R&D on environmental friendly measures and meet certain criteria (see below). Sponsored environmental friendly measures are the investment for a specific technology or for a (technology oriented) pilot project, but also cost for organizational solutions or for new services with environmental friendly effects. Cost for
consultants as well as cost for information can be financially supported as well. The applicant
accepted does not have to pay back the financial support in any way.
The Berlin State sponsors only part of the total cost. On average, 60% of the total costs are
financed by the program. The other part has to be financed by the participating companies
themselves.
The amount of public financial support given depends on various factors of the individual
project applied for: its ability to reduce pollution, its potential for innovation, its possible
demonstration impact and its ability to support (not specified) State Interests. On average the
Berlin State spent about 150000 to 250000 EURO per sponsored project.
In order to get financial support, certain conditions have to be met:
– Only small and medium-sized enterprises with total sales of 40 million EURO at most
or a balance sheet total of 27 million EURO at most can get this financial support. In
addition, these companies should not employ more than 250 workers and should implement
the environmental friendly measures in Berlin.
– Only measures which can reduce pollution beyond federal environmental standards
and in more than one environmental medium are accepted (so-called integrated approach).
– At the same time, measures can only be financed if they create additional jobs or
provide some further training to already employed workers. Also measures will only be
accepted if they have a relatively high demonstration potential.

3.3.4. Role of government in the program/project
The Berlin State government here acts as a stimulator of sustainable innovation and its
implementation within small and medium-sized enterprises by giving financial support. The
government partly finances any measures which have a direct relation to the implementation
of or R&D on environmental friendly measures and meet certain criteria. Therefore the Berlin
State government can be characterized as a co-investor of environmental friendly
technologies and of such R&D.

3.3.5. Internal organization and management structure
Apart from the Berlin State Government for Communal Development, two organizations are
mainly involved in this program: IBB (Berlin Investment Bank, the single financial
intermediary for Berlin State Governmental efforts), which functions as the project managing
institution, and the private consultant B.& S.U. IBB is responsible for the economic and
general consultation, B.&S.U. mainly gives technology-oriented advice to the participating
companies. Both organizations work on behalf of the Berlin State government, IBB and the
Berlin State government jointly decide about the proposals. IBB handles the financial support
(spent by the Berlin State government and the EU). The Berlin State Government for
Communal Development itself is responsible for the strategic design of the program and for
its financial and organizational supervision.

ZÖW was terminated, as planned, in December 1999. The follow-up program UEP which
integrates ZÖW and another, more pollution-reduction oriented program started in January
2000. This new program is no longer managed by IBB but the Berlin State Government for
Communal Development itself (see III.3.8 for reasons).

3.3.6. Stages of knowledge addressed
ZÖW mainly addressed the knowledge stage “implementation”. If certain criteria are met,
any environmental friendly effort which produces higher emission reductions than the
reductions called for by federal environmental law is supported. It is remarkable that ZÖW
does not only support investment but costs for any measures being able to meet that goal. By
this, organizational and services-related environmental friendly measures as well as such
R&D can get financial support. Therefore technological development is also supported by
ZÖW.
3.3.7. Modalities used
The program is financed by the Berlin State Government and the European Fund for Regional Development (EFRD). East Berlin companies get a little higher financial support because East Berlin is classified as an objective 1 region, while West Berlin is classified as an objective 2 region. As mentioned earlier the money is only given if certain criteria are met. One important selection criteria is the size of the company, only small and medium-sized enterprises in Berlin are financially sponsored. So basically block grants are given, but other criteria (e. g. pollution avoided, employment created; see above) also have to be met.

3.3.8. Hurdles encountered
The main hurdle encountered was the lack of cooperation between the implementation agency IBB and the Berlin State government. It turned out relatively quickly that IBB itself did not have enough experienced employees in order to provide the technology related advise needed by the companies. To provide this consultancy the private consultant B.&S.U. was employed. But the result were relatively long application times, sometimes it took 6-12 months from the company’s proposal to the final decision. As a consequence a number of companies lost interest and the public money available for ZÖW could not be issued completely.

This problem was solved within UEP, the follow-up program on ZÖW. UEP is managed by the Berlin State government itself. IBB is no longer involved. B.&S.U. is still in charge, but for very limited technology-related consultancy activities only.

3.3.9. Focus on specific industrial sectors
ZÖW does not focus on any industrial sector. On the contrary, any company which meets the conditions explained above can get financial support. Therefore industry as well as services and local crafts can profit from this program. Public institutions can not participate within this program.

3.4. RENEWABLE ELECTRICITY LAWS SUPPORTING WIND ENERGY SYSTEMS

3.4.1. Background
The impetus for governmental support for wind energy systems may be traced to 1986. The Chernobyl accident, which occurred in April 1986, was the key factor driving a different German energy policy. Until then, the Federal Ministry for Science and Technology clearly favored nuclear power; the only other significant technology sponsored by the ministry was photovoltaics as one energy option for the far future. But after Chernobyl, any and all renewable energy sources became of interest.

Parallel to this development, two studies discovered that wind energy was the renewable energy closest to economic efficiency. As a result, the German government recognized wind energy as the most favorable short-to-medium term available alternative energy option.

Because of both studies, and because of the Danish R&D successes in this field, the German government as well as the Federal Ministry for Science and Technology decided to support R&D on the diffusion of wind energy systems in Germany. Therefore a number of different instruments were implemented. This policy mix was mainly designed by the Federal Ministry
for Science and Technology. In detail, direct financial support, tax reductions, cheap loans and fixed prices for wind electricity (per kWh) were implemented. Altogether, these measures took several years and resulted in successful R&D on and implementation of wind energy systems in Germany.

The most interesting of the instruments from a policy innovative perspective is the passage of the so-called Renewable Electricity Laws. These laws significantly stimulated an efficient and cost-oriented demand for wind energy systems in Germany. In addition, R&D activities on such systems were supported on a relatively broad basis. The measures gave (and still give) a strong incentive for a further technological development of wind energy systems in Germany.

The first Renewable Electricity Law came into force on a federal level in 1991. It was designed to solve the problem that German energy suppliers had no incentive to use the extent functioning and reliable technological solutions for the use of wind energy. The main reason for this reluctance was the presence of a centralized German energy supply system with its need for big power plants. As a result, wind energy systems were not implemented on a broad basis.

Therefore the Federal Ministry for Science and Technology had the idea to financially support private households or companies if they generated wind (or other renewable) electricity themselves. The energy suppliers were forced by law to buy this electricity for a certain (fixed) amount of money per kWh. The reason for this special design of the law was a former voluntary agreement of the German energy suppliers: Until 1990/1991, they agreed to pay 3.3 Cent per kWh generated by renewable energies and sold by private households and companies. In August 1990 the German government asked the energy suppliers to modify this agreement in order to raise the price for renewable electricity. But the German energy suppliers resisted. As a consequence, the German government and the Federal Ministry for Science and Technology designed and implemented the Renewable Electricity Law on a non-consensual basis. It came into force in January 1991.

The Renewable Electricity Law was designed to support the diffusion of wind energy systems and to open up the electricity market for private electricity producers. It is interesting to note that this law was accepted by all political parties, which is quite unusual in Germany. (Those days, the government consisted of representatives of the conservative and the liberal party). The acceptance was explained by the environmental burden avoided by renewable energy systems. The law was implemented at a point in time when the Danish producers of wind energy systems had already solved the main technical problems; therefore the issue was one of price and not of unavailability of the technology.

The law has been a center of discussion ever since it came into force. The energy suppliers were and have been opposed to it, and the political debate has resulted in considerable modification of the original law, leading to the passage of a modified law in February 2000. This new law is called the “Renewable Energies Law” and calls for a doubling of today’s renewables’ share by 2010. In the remainder of this section, we will discuss both the experiences under the old law and the expectations from the new law.

2 As mentioned earlier these prices are not only given for wind electricity but for any renewable electricity such as photovoltaics, water and biomass energy.
3.4.2. Objectives
The immediate objective of both Renewable Energy Laws is to support a greater use of renewable energy systems in Germany, by promoting private demand for such systems. The electricity market dominated by the energy suppliers should be opened up by these instruments. The wider objective of both laws is to gradually raise the renewables’ share in Germany. The previous political coalition in Germany was heading for this goal, but the new coalition, which includes the Greens, tends to be a bit tougher on this issue (at least in part because they want to shut down nuclear power plants and therefore need alternative energies). Another wider objective is to promote the national wind (and other renewable) energy systems manufacturing industry. The governmental measures were relatively successful; today this German sector can be characterized as quite competitive on the global market.

3.4.3. Elaboration of the types of policy instruments
As mentioned above, the first law supporting renewable electricity came into force in 1991. It was basically a financial instrument which forces the regional energy suppliers to buy such electricity generated by private households or companies. The energy suppliers had to pay at least 90% of the average last year’s price per kWh offered to private households. In 1995 for instance, the energy suppliers had to pay 8.86 Cent/kWh on average, in 1997 it was 8.79 Cent/kWh. Since most of the “good” wind energy locations are located in North Germany, the North German energy suppliers had to buy most of the renewable electricity generated. As a result, large regional disparities appeared. In order to solve this problem, the Renewable Electricity Law was modified in 1997: then the so-called 5%-lid was invented. Since then the regional energy suppliers are only forced to buy wind electricity up to 5% of their total electricity generation. If more than 5% is produced by wind energy, the (economically speaking) up-stream energy supplier has to pay for the additional amount.

In February this year, the “Renewable Energies Law” came into force. As explained earlier, this new law is intended solve the hurdles encountered with the old law and the problems arising for renewables from the liberalization of the European Energy Markets. The new law is, like its predecessor, a financial instrument, but differs from the old measure in that the refund is not calculated on the 90% basis but instead, a fixed amount per kWh has to be paid. For wind electricity 8.84 - 6.79 Cent (depending on the location) have to be paid per kWh. Another difference is that the 5%-lid does not exist any more. This way, the renewables’ share will be able to exceed 5%. The financial burden will be shared among all German energy suppliers, thereby avoiding regional disparities.

3.4.4. Role of government in the program/project
The German government here mainly acts as an interventionist, forcing the energy suppliers to buy renewable electricity for a fixed amount of money. Indirectly, the German government also acts as a stimulator supporting demand for wind (and other renewable) energy systems and thereby promoting not only the diffusion but also further R&D on renewable energy systems in Germany.

3.4.5. Internal organization and management structure
The first Renewable Electricity Law was primarily designed by the Federal Ministry for Science and Technology. It is notable that the second law was designed by the government itself. Basically some social-democrats and some greens were responsible for its design and its implementation. The Federal Ministry for the Environment was involved in this process too. The Federal Ministry for Economic Affairs and Technology (which is responsible for all

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3 Private households in general pay the highest energy prices in Germany.
energy related issues) was not an actor on this issue. As a consequence, the government decided to design the new law without the Federal Ministry for Economic Affairs.

3.4.6. Stages of knowledge addressed
The Renewable Electricity Laws address the knowledge stage of “implementation” by supporting the diffusion of technologies for the use of renewable energies on a broad level. Additionally, further technological development in this field is promoted because the laws provide strong incentives for further technological development of wind (and other renewable) energy systems in Germany.

3.4.7. Modalities used
The German energy suppliers have to pay a certain, nowadays fixed, amount per kWh generated by wind or other renewable energies. The money is directly given to private households or companies generating this electricity. No intermediate organization is involved. The energy suppliers are allowed to raise the electricity price on a national or regional level in order to finance this additional expenditure. In this way, energy consumers are financing the governmental support of renewable energy systems in Germany.

3.4.8. Hurdles encountered
The main barrier was the German energy suppliers, who argued against this instrument from the very beginning. Sometimes they prevailed, especially when they emphasized the strong regional disparities in the employment of this instrument. Another important hurdle was the liberalization of the European Energy Markets, which in general runs counter to a greater use of renewable energies if these systems have just reached economic efficiency. Because of the liberalization, energy prices are decreasing significantly and most renewable energies’ systems – at least at the moment – are a bit more expensive than systems that use fossil fuels. Therefore renewable energies are not competitive within liberalized energy markets. In order to get rid of the regional disparities, to liberalize the German energy market and at the same time to support renewable energies required a new law, which was passed in February 2000.

3.4.9. Focus on specific industrial sector?
The Renewable Electricity Laws focus on private households or companies in general, instead of a specific industrial sector. Nonetheless, the Machinery Manufacturing sector, responsible for producing wind (and other renewable) energy systems, clearly profits more than any other sector from this financial instrument.
4. LIST OF CONTACT PERSONS AND INTERVIEWEES

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