
Saarbrücken, Germany

Comprehensive Municipal Energy Efficiency

Profile #78

Executive Summary	2
Country Overview	3
<i>Map of Europe; Map of Germany; Environmental Policy; Electric Utility Structure; Utility Regulatory Environment</i>	
Overview of the City of Saarbrücken	7
<i>1992 Saarbrücken Energy Consumption By Sector (chart); Overview: Stadtwerke Saarbrücken AG; Stadtwerke Saarbrücken 1992 Statistics Table; Stadtwerke Saarbrücken 1992 Fuel Mix (chart); Saarbrücken Energy Concept; District Heating</i>	
DSM Initiatives	10
<i>Saarbrücken Participation Program; Cost of Saved Energy Table; Saarbrücken Energy Services Table</i>	
Renewable Energy in Saarbrücken	14
<i>Transportation Overview</i>	
Award-Winning Advertising	16
Lessons Learned / Transferability	17
<i>End-Use Energy Table; End-Use Energy (chart)</i>	
References	19

Executive Summary

Saarbrücken is located in the Saar River Valley along the French border in the heart of Germany's coal country, adding a healthy touch of color and irony to Saarbrücken's extraordinarily progressive energy platform. Despite the fact that the City sits on hundreds of years worth of coal, the City and its utility, Stadtwerke Saarbrücken, view coal as a "transitional fuel" which must be replaced with highly-efficient and non-polluting power supplies (through advanced power plants and district heating), energy efficiency, and renewable energy resources. In each of these areas, Saarbrücken has become a European and international leader.

The basis for Saarbrücken's success with promoting efficiency has been its financing program called The Participation Program. This program provides positive monthly cash flow for participating customers while shifting the burden of the cost of energy efficiency from the utility's balance sheet to consumers. Stadtwerke Saarbrücken works with local banks to aggregate customer loans, then guarantees the loans against default, and by doing so has been able to buy-down loan interest rates for its customers. To date the banks have lent close to \$22 million while the utility's cost of administering the program has been on the order of \$2.2 million.

Bolstered by its successful financing program Stadtwerke Saarbrücken has realigned its rate structures and now offers 14 discrete energy efficiency programs that range from consumer education programs to energy conservation diagnostic services and incentive programs. For instance, more than 15,000 information requests are handled annually by the downtown Info-Center E. The Heat Passport Program provides lower electricity rates for customers that can prove low energy intensities. The utility provides rebates for purchasing energy-efficient appliances and incentives for converting from electric to gas water heating. A pilot program is focused on school lighting and school gymnasium lighting retrofits in particular.

Saarbrücken's efforts with solar energy are also exemplary. In addition to retrofitting each of its community pools Stadtwerke Saarbrücken's Solar Rooftop Program is intended to install photovoltaic arrays on approximately 1,000 homes throughout the City. To date over 130 systems have been installed. The utility has also invested in a future concept home in Ensheim where the entire roof of the home is covered with photovoltaic panels owned by the utility!

City of Saarbrücken, Germany Comprehensive Municipal Energy Efficiency

Utility: Stadtwerke Saarbrücken

Sector: Residential

Measures: District heating conversions, insulation, windows, appliances, and solar installations

Mechanism: Utility aggregates and guarantees energy efficiency loans and by doing so buys down interest rates on loans provided by local banks to fund efficiency measures. Utility also offers 13 other programs including information and lighting programs, many with utility incentives

History: District heating first installed in 1964, the Saarbrücken Energy Concept was established in 1980, and the Participation Program began in 1988

The Participation Program Cumulative Data

Energy savings: ~ 75 GWh

Total costs: \$24.2 million

Utility costs: \$2.2 million

Conventions

For the entire 1993 profile series all dollar values have been adjusted to 1990 U.S. dollar levels unless otherwise specified. Inflation and exchange rates were derived from the U.S. Department of Labor's Consumer Price Index and the U.S. Federal Reserve's foreign exchange rates.

The Results Center uses three conventions for presenting program savings. **Annual savings** refer to the annualized value of increments of energy and capacity installed in a given year, or what might be best described as the first full-year effect of the measures installed in a given year. **Cumulative savings** represent the savings in a given year for all measures installed to date. **Lifecycle savings** are calculated by multiplying the annual savings by the assumed average measure lifetime. **Caution:** cumulative and lifecycle savings are theoretical values that usually represent only the technical measure lifetimes and are not adjusted for attrition unless specifically stated.

TITLE: EUROPE.FH3
CREATOR: FreeHand
CR DATE: 12/30/93 14:34:33

On October 3, 1990 the Federal Republic of Germany (West Germany) and the German Democratic Republic (East Germany) were reunified with the resulting country named the Federal Republic of Germany (Germany). Given the huge differences in the former countries' economies and environmental policies there have been and continue to be some very unusual and complex problems in the transition. For instance, in the late 1980's East Germany had an annual gross national product (GNP) of approximately \$14,000 per person while the comparable level in West Germany was nearly \$22,000.

Geographically Germany is situated in the heart of Europe, bordered by Denmark, the Netherlands, Belgium, France, Switzerland, Austria, the Czech Republic, and Poland. About the size of the State of Nevada, Germany covers 356,910 square kilometers (221,773 square miles) and has a population of 79,548,000. The official language of the country is German and the currency is the Deutsche Mark (DM) which had an average exchange rate in 1992 of 1.56 DM per U.S. dollar. (Note that per The Results Center convention, all dollar values have been converted and will be expressed as 1990 U.S. dollars.) ➡

Country Overview (continued)

TITLE: GERMANY.FH3
CREATOR: FreeHand
CR DATE: 12/30/93 14:47:19

In 1991 Germany was responsible for 1.9% of world commercial energy production and 4.3% of world energy consumption. Germany's total energy production is approximately 10% of the United States' energy production and

Germany's energy consumption is roughly 19% of America's consumption. The unified country ranks as the world's third largest coal producer. The average price of electricity in Germany in 1991 was 19.68 pfennig/kWh or 11.34 ¢/kWh.

ENVIRONMENTAL POLICY

In 1986, the Federal Republic of Germany published its energy policy objectives which are still valid today. These goals include reducing the share of oil in the energy supply; increasing the role of other energy sources and diversifying import sources, especially oil; continued reduction of energy production and use; improving emergency response measures; and supplying and using energy with the lowest possible environmental impact. Along these lines the federal government is formally committed to reducing carbon dioxide emissions in the former West Germany by 25% between 1987 and the year 2000. Reductions for the former GDR are expected to be even greater. The creation of these policy objectives was motivated in large part by the Chernobyl nuclear accident which made the need for global environmental protection apparent to many Germans for the first time.

Clearly Germany's progressive energy policies have been the result of its environmental policy and Germany is considered a world leader in this area. Germany's Federal Environmental Ministry is responsible at the national level for legal acts and ordinances relating to all areas of environmental protection but at a higher level come European Community (EC) laws known as "EC directives." The EC is responsible for keeping a close eye to ensure that no member states pass national laws that might constitute barriers to trade. Goals of the Ministry include setting more stringent environmental standards among all EC countries and generating effective citizens action regarding environmental protection. The Ministry has a staff of 850 and a 1992 budget of \$1.07 million. This amount might not seem large but the Environmental Ministry prefers "the polluter pays principle" over using taxpayers' money for environmental protection. It has been a challenge to maintain this policy when dealing with former East Germany because of the country's weak economy and extensive environmental damage.

ELECTRIC UTILITY STRUCTURE

Since the unification of the two Germanies in October 1990, integration of their power supply systems has been a major challenge. The Federal Republic of Germany historically burned large quantities of domestic coal and lignite resources, supported by natural gas, hydro, and nuclear power and to date has had an impressive nuclear power safety record. The former German Democratic Republic historically burned large amounts of high-

residue coals and lignites in old, inefficient powerplants with little or no emissions controls. Existing powerplants in the former GDR must meet FRG's air emissions standards by the year 2000 or close down. At this time all of the former GDR's nuclear plants are out of service for safety reasons.[R#1]

In 1989, FRG utilities had a total capacity of 110,075 MW and produced 452 billion kWh with a fuel mix of solid fuels (coal/lignite) 48%, oil 4%, gas 9%, nuclear 31%, and hydro 8%. In 1989, the former GDR had a total capacity of 24,585 MW and generated 122.5 billion kWh. The former GDR's fuel mix for the same year was 85% coal, 9.8% nuclear, with oil, gas, and hydro accounting for the rest.[R#1]

A striking feature of the electricity supply in the former West Germany is its decentralized, pluralistic structure. Electricity is generated by public utilities, private industry, and the Federal Railway. Approximately 900 individual electric utilities supply power. The eight largest utilities supply more than 80% of the country's power. These eight utilities have interconnected networks as there is no national transmission grid. In addition there are 41 large regional utilities most of which are subsidiaries of the eight large utilities. Finally, there are many local utilities (approximately 440) which may or may not generate their own power. In many instances these local utilities also supply gas, district heating, and water, and may operate public transportation systems and public swimming pools. These suppliers are similar in size and scope to municipal utilities in the United States.[R#1,7]

Energy suppliers are further divided into three groups on the basis of their legal structure and capital participation:

- Publicly-owned undertakings (95% or more of the capital participation is by the Federal Republic, the federal states, communal associations, and municipalities). Note that there is a high degree of capital participation by government organizations in the utility industry;
- Mixed-capital undertakings (capital from both the public and private sectors);
- Private undertakings (at least 75% of capital is private)

Another interesting feature of the German electricity market is its support for coal. A national coal policy forces power generating utilities to mostly buy German coal ☞

Country Overview (continued)

to support the German coal industry and maintain maximum energy independence. (Many experts both in Germany and outside, believe that Germany was forced to surrender in World War 2 primarily because it ran out of energy. This lesson coupled with the Middle Eastern oil embargoes of the 1970s have been strong drivers for German energy independence.) Even with federal subsidies, German coal is more than twice as expensive as imported coal. In addition, oil- and gas-fired power plants larger than 10 MW are basically forbidden. These rules will change in 1995 under the open-market policies of the European Community when Germany will likely have to reduce its protection of German coal.

The Association of German Electricity Supply Companies (VDEW) is the trade association of the electricity supply industry in the Federal Republic of Germany. Its members include virtually all large and medium-sized and most smaller companies involved in the public supply of electricity, with 700 company members out of a possible 900. VDEW members account for approximately 90% of the electricity supplied in Germany. The role of VDEW is to help develop the electricity supply industry. Central to this role is ensuring a reliable supply of safe, environmentally-friendly, and economically-priced electricity to the public as well as assuring the efficiency and quality of power stations and electrical installations.

UTILITY REGULATORY ENVIRONMENT

The German electricity supply industry developed its present pluralistic and decentralized structure largely independently throughout the course of this century. The regulatory framework can be summarized as follows:

In accord with legally established objectives and principles, the electricity suppliers supply electricity to the citizens as an entrepreneurial activity. This activity is carried out within assigned service areas under the principal obligation to connect and supply electricity with as much competition as possible under state supervision. This of course is similar to the franchises awarded U.S. utilities who then have "the obligation to serve" all customers within that territory. [R#12]

The **Law Governing the Energy Industries (ENWG)**, enacted December 13, 1935, still applies today and with few exceptions places electricity suppliers under state control. This state control is yet another measure to offset the privileged market position of energy suppliers. It acts as a substitute for the missing competition and controls electricity suppliers in the interest of the consumer. State control is exercised by the federal states. This control covers everything from investments to licensing the supply to imposing fines for infringements by energy suppliers upon legal or official directives. The law makes any undertaking to supply electricity subject to official approval, including the construction, replacement, extension or closure of electricity installations. The states' monitoring of these undertakings is concerned with consumers' electricity needs. Furthermore, the prices charged to normal rate consumers are subject to price control by the federal states' Ministers for Economic Affairs.

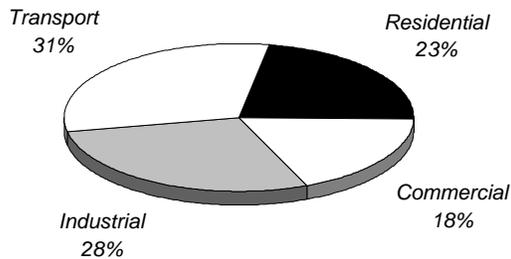
The economy in Germany is organized according to free-market principles but exists as a social market economy. The **Anti-Cartel Law (GWB)** is intended to guarantee free competition and overcome economic power whenever it hampers effective competition or jeopardizes the optimal supply to consumers. Provisions of the law allow electricity suppliers to restrict direct competition from other suppliers by permitting territory contracts valid for a maximum of 20 years, what are called service territory franchises in the United States. These territory protection (demarcation) contracts between a supplier and its customers are agreed upon by competing electricity suppliers and grant the contracted supplier exclusive rights for use of public roads and land within a community. This means that electricity suppliers in their supply areas are insulated from direct competition.

Under the Anti-Cartel Law, however, electric suppliers are required to purchase electricity from other undertakings whenever this is technically possible and economically viable (i.e. if the price they must pay for outside power does not exceed their avoided costs.) This, of course, is similar to the Qualifying Facilities provisions under the United States' Public Utilities Regulatory Policy Act. Similarly, a law enacted on January 1, 1991 requires electric suppliers to buy electricity from renewable energy suppliers and pay for this electricity at legally fixed prices. These prices are much higher than the supplier's avoided costs. ■

Overview of the City of Saarbrücken

The City of Saarbrücken has a population of approximately 190,000 and is located in southwestern Germany in the Saar Valley along the French border. Approximately 20% of the City border also forms the border between Germany and France. Saarbrücken is the capital of Saarland which is one of the smallest German states. The City is both the administrative and industrial center of Saarland. For many years the economy of the region has been tied to the fact that it is the largest coal producing area in Germany. Most, if not all, of the economy of the region is related to the extraction of coal with tens of thou-

1992 SAARBRÜCKEN ENERGY CONSUMPTION BY SECTOR



sands of jobs dependent on this industry. It's interesting to note that if you want to build a home in Saarbrücken, you need not only a building permit from the City, but also to register with the coal company since parts of the City are built above mines 1,000 meters (0.62 miles) below!

OVERVIEW: STADTWERKE SAARBRÜCKEN AG

The Stadtwerke Saarbrücken is a public utility which is held entirely by the municipal authorities of Saarbrücken. The utility and its 300 employees supply electricity, gas, district heating, and water. In 1992 the utility generated and purchased 1,163 GWh of electricity and sold 1,098 GWh of electricity, 593 GWh equivalent of district heating, 1,073 GWh equivalent of gas, and 12.1 million cubic meters (3.1 billion gallons) of water. For many years the Stadtwerke has been promoting district heating to increase the use of its power plants' thermal output, while concurrently promoting electric efficiency. As such the utility is able to "balance" the demands on its plant's thermal and electric outputs, thus maximizing its overall efficiency. [R#5]

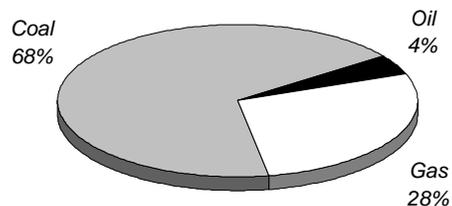
Electric sales in 1992 were 27% to the residential sector (296 GWh), 32% to the commercial sector (352 GWh),

STADTWERKE SAARBRÜCKEN 1992 STATISTICS	
Number of Employees	300
Electric Sales	1,098 GWh
District Heating Sales (equivalent)	593 GWh
Gas Sales (equivalent)	1,073 GWh
Peak Demand	225 MW
Generating Capacity	278 MW
Reserve Margin	24 %

and 41% to the industrial sector (450 GWh), underscoring industry's still prominent role in Saarbrücken's economy. Stadtwerke Saarbrücken AG had a 1992 peak demand of 225 MW and a peak generating capacity of 278 MW creating a reserve margin of 28%. The utility's 1992 fuel mix was coal 68%, oil 4%, and gas 28%. The utility uses approximately 300,000 tons of coal annually. [R#2,6,7]

Stadtwerke Saarbrücken has been involved with least-cost planning for the past two years and is currently part of a German Least-Cost Planning Group consisting of Stadtwerke Hannover (see Profile #77), Kassel, and

STADTWERKE SAARBRÜCKEN 1992 FUEL MIX



Munich. This group is sharing their experiences with studying and implementing least-cost planning and exploring how this North American concept can be used to support the efficient use and delivery of energy in Germany. While these utilities view least-cost planning as an effective way of institutionalizing energy efficiency initiatives, they have also identified two key barriers to such an approach: First there is a clear lack of knowledge about the concept, and second, there is a major concern that least-cost planning could force increased utility regulation which they very much want to avoid. [R#7] ■

Saarbrücken Energy Concept

The City and utility work hand in hand on many efficiency initiatives. In fact the City has its own Energy Department headed up by the very insightful and knowledgeable Dr. Jurgen Lottermoser, and many of the energy efficiency projects underway in the City have been initiated by the Energy Department which has an annual efficiency budget for projects of approximately \$320,000 (500,000 DM). In many cases the City's Energy Department has financed pilot programs that if proven successful have been adopted by the Stadtwerke and brought to fruition on a broader scale.[R#1,3,8]

Stadtwerke Saarbrücken's conservation and renewable programs have blossomed out of the Saarbrücken Energy Concept which seeks to reduce Saarbrücken's dependence on imported fossil fuels. In addition, the City's recent commitment to reducing its carbon dioxide emissions is providing another important driver in the process of increasing efficiency throughout the City. In fact on June 1, 1993 Saarbrücken's carbon dioxide reduction plan, discussed below, was approved by the City government led by the progressive Social Democrats.

To fulfill the intent of the Energy Concept and the City's CO₂ reduction commitment, the utility implements a wide range of conservation programs which include information programs, audits, financial incentives, and efficiency standards. Currently, six employees, or 2% of its 300-person workforce, implement the utility's energy conservation programs.[R#1]

SAARBRÜCKEN ENERGY CONCEPT

In 1980 the Saarbrücken Energy Concept was developed in response to the oil shocks of the 1970's coupled with the desire to replace nuclear power with other energy sources. The plan is geared to reduce Saarbrücken's dependence on fossil fuels by simultaneously addressing improvements in energy efficiency and the introduction and use of renewable energy resources. The initial goal of Saarbrücken's strategy was to save 200 million liters (52.8 million gallons) of petroleum annually through the use of

waste energy from the power generation process (district heating), conservation, and developing renewable sources of energy.[R#1]

Another motivation for implementing the Saarbrücken Energy Concept was the recognition that although the economy of the Saar Valley is closely linked to the production of coal, this resource is not endless. A long range industrial strategy for the region requires development of other sources of energy to replace this soon depleted resource. In 1991, in response to the goal of cutting CO₂ emissions in Germany by 25% by the year 2005, the efforts of the Concept were again renewed.[R#1]

Public education programs have increased public awareness of the need for energy conservation and created consumer demand for residential energy-efficient technologies. These programs have helped the City to cut CO₂ emissions by 60% for the heating of buildings over the past ten years, mostly the result of the City's focus on district heating.[R#1]

From 1980 through 1991 all of Saarbrücken's energy conservation programs resulted in a 15% reduction in total CO₂ emissions. (The programs also resulted in the City's reduction of SO₂ and NO_x emissions by 76% and 34% respectively.) The City projects it will reduce primary energy consumption by 13% from 1990 through 2000, resulting in CO₂ emissions reductions of 15%. Combined with reductions from 1985 through 1990, the City should achieve the goal of the Federal Government of a 25% reduction in CO₂ emissions from 1987 through 2000.[R#2]

DISTRICT HEATING

Saarbrücken's fundamental energy efficiency measure to date has been the development of its district heating system which the City continues to expand. The system now extends more than 130 kilometers (80 miles) and furnishes more than 25% of all space heating in the City. This penetration is approximately four times the German

national average. Where district heating is not suitable, there has been a push to replace oil and coal furnaces with natural-gas fired units. In the years to come the utility hopes to greatly expand its district heating network but believes that additional financial support from the federal government is necessary to make major improvements. [R#1,10]

“In Saarbrücken, no energy efficiency measures have been more important than the district heating system.” Stadtwerke Saarbrücken Chairman, Willy Leonhardt

Saarbrücken first examined the potential of district heating in 1958. Then in 1964 the first lines for the district heating system were put in place at the time of the construction of an oil- and gas-fired district heating power station. The move to district heating was motivated by two factors. First, the municipal government decided to use district heat exclusively for a new residential area of about 3,000 people. Second, a German national grant program for the construction of district heat networks was begun. Under this program, 42% of Saarbrücken’s investments related to the construction of district heat networks were subsidized. By 1967, approximately 10% of the homes in Saarbrücken had a district heat service connection. Unfortunately, at this time there is no longer federal funding for district heat networks. [R#3]

One of the remarkable aspects of Saarbrücken’s success with its district heating system is that connections to the system have never been compulsory. Hooking up to the system, with its obvious cost and environmental advantages, is and has been completely voluntary, and the utility’s success with garnering the participation of its citizen-owners has been based on a dialog with citizens. It is to the City’s and utility’s credit that through effective communication and financing (discussed at length later) that Saarbrücken has had such success with its district heating system. [R#3,10]

In 1980, in response to a federal energy conservation law Saarbrücken established a comprehensive program to conserve energy used for space heating. The initiative was called The Local Heat Supply Plan and was designed as a 15-year comprehensive effort to reduce heating demand (expressed in electric capacity terms) by 20% from 1,800 MW to 1,450 MW by 1995. This program also sought to increase the share of homes connected to the district heating system from 12% in 1980 to 35% in 1995. This plan became one component of the Saarbrücken Energy Concept. The Stadtwerke began by compiling the Saarbrücken “heat atlas” (essentially a database) which identifies the heat demand (including existing system type and total energy demand) of virtually every individual building in Saarbrücken. The heat atlas is a major component of the utility’s future planning and is continually updated. [R#3]

Since 1989, Stadtwerke Saarbrücken AG has offered a “direct heat service” for customers living in multi-tenant dwellings. Typically, the heating bills are divided evenly among all tenants. Thus, there has been no motivation for individuals to conserve energy if they must pay an equal share for the energy use of neighbors who may not be conserving. To the extent that it is technically possible the utility offers gas or district heat to single units so that customers pay only for the heat they use. Between 1989 and mid-1992 more than 3,200 customers took advantage of this service. [R#3]

From 1980 through 1992 the length of Saarbrücken’s district heating network grew from 45 kilometers (28 miles) to 130 kilometers (80 miles) at a cost of over 1 billion DM (approximately \$600 million), the supply capacity increased from 225 MW to 435 MW, and the heat supplied increased from 350 million kWh to 520 million kWh equivalent. Another indicator of the utility’s success with energy efficiency is that in 1980 the City required 1,870 MW equivalent of heat. Now, despite population growth in Saarbrücken that level has actually decreased to 1,580 MW in 1990 due to increased energy efficiency. During this same period, the number of district heat households has reached 60,000. [R#3,10] ■

DSM Initiatives

Saarbrücken's initiatives surrounding energy efficiency have primarily focused on district heating and capturing the huge potentials for efficiency by using not only the electric but also thermal output of power plants. But in close parallel the City has creatively invested in energy efficiency and in its long-term strategy to develop renewable energy forms today so that they will be viable and available at reasonable cost in the future.

One indicator of Saarbrücken's European reputation with energy efficiency is that the Organization for Economic Cooperation and Development (OECD) chose Saarbrücken as the site of its first European conference on demand-side management. The site of the well-attended conference was Saarbrücken's Hotel Renaissance, a facility that has recently been completely relit with compact fluorescent lamps. The fact that Saarbrücken was hosting Europe's first OECD DSM conference, attended by representatives from 17 countries, speaks highly of its efforts. The conference was attended by delegates from 44 cities in Poland, Estonia, Lithuania, Czech Republic, Slovak Republic, East and West Germany, Turkey, England, Sweden, the Netherlands, Norway, etc. The conference was also financially supported by the German Ministry of the Environment whose director provided a keynote address.

While Saarbrücken has received national and international attention for its efforts with energy efficiency it, like many other communities, is experiencing growth. Much of the growth is occurring outside the traditional urban core and onto the surrounding hillsides, creating problems for transportation planning and district heating hookups. With energy efficiency in mind, Saarbrücken hopes to increase the density of new buildings, build new structures facing south in order to increase solar potentials (both active and passive), and concentrate schools, work places, and shopping in districts to help reduce transportation needs. One of the most pleasant amenities in Saarbrücken is its downtown redevelopment, a delightful and historic pedestrian arcade complete with cobblestones, boutiques, and sidewalk cafes.[R#2]

A discussion of Saarbrücken's energy efficiency initiatives must begin with The Participation Program. While

many utilities in North America are investigating means of getting customers to pay for energy efficiency to avoid rate impacts and cross subsidization of retrofits, Saarbrücken provides a powerful model in The Participation Program, a financing program that effectively moves customers' energy efficiency investments off the utility's balance sheet. By aggregating energy efficiency investments and thus buying down local banks' interest rates, and guaranteeing the loans, the utility has been able to facilitate nearly all of its DSM activities by working with private sources of capital. In fact, all the district heating conversions have been financed through local banks, and approximately \$22 million (37 million DM) have been invested while the utility's total exposure has been on the order of \$2.2 million (3.7 million DM). (For similar strategies in the United States, see PacifiCorp's Energy FinAnswer #46, the Iowa Energy Bank program #73, and various equipment leasing programs, Profile #'s 3,42)

SAARBRÜCKEN PARTICIPATION PROGRAM

The Saarbrücken Participation Program is one of the most impressive components of the Saarbrücken Energy Concept and offers residential energy users a method to finance their energy conservation activities. The program began in 1988 and fosters energy and water conservation and provides loans up to \$11,900 (20,000 DM) per home, paid back over 20 years. [R#1,8,10]

The Participation Program offers loans to customers at a substantially lower rate of interest than would otherwise be available. Stadtwerke Saarbrücken subsidizes these loans, which are provided by a local partner bank for any household improvements which are related to energy efficiency, energy conservation, or water conservation. [R#1]

To begin the project, Stadtwerke Saarbrücken formed a partnership with a local savings bank, the Sparkasse Saarbrücken. With a fund totaling \$22 million (1988 through November 1993), the utility provided loans to homeowners at interest rates 3 to 5 points below the current German prime rate. This difference in interest rates allows program participants to more than offset monthly

loan payments by the amount of energy savings achieved as a result of measures installed through the program. The cost of buying down interest rates by the utility amounts to about 10% of a project's capital costs. The financing agreement is made directly between the customer and the bank. All periods of financing, defaults, and other financing issues are handled by the bank. The utility is only responsible for technical control and determining which energy saving measures will save energy and should therefore be eligible for financing. The program has been so popular that there is usually a long waiting period for customers to apply and qualify for loans.[R#1,8]

This loan arrangement has now been expanded to include 11 other banks operating in the Saarbrücken area. A credit volume of \$35.6 million (60 million DM) has been made available by the banks.[R#4]

Citizens are allowed to finance anything which saves energy or water, including natural gas heating, connection to the public district heating system, insulation, growing plants on building facades, solar systems on the rooftops of residential buildings, retrofitting of windows with more energy-efficient units, or the installation of energy-efficient appliances. Customers interested in converting their heating system to district heat or gas are eligible for a \$237, \$475, or \$11,900 loan (400, 800, or 20,000 DM) depending on the size of the heating system and the condition of the dwelling. These grants are also available to replace old, inefficient heating systems with new natural gas systems. Photovoltaic systems are financed differently with the utility providing up to 50% of the investment.[R#1]

In some cases, the utility may provide customers with minor technical assistance, but in most cases the contractor who installs the energy improvements is responsible for determining the energy conservation potential. Customers are encouraged to determine the energy use of their existing equipment through the use of consumption meters borrowed from the utility. The installation of energy saving improvements is carried out by private companies. The customer has a choice of contractors but is encouraged by the utility to get several estimates before

proceeding.[R#4]

Marketing for the Participation program is accomplished through advertisements in the local press, booklets distributed to customers, and at the store-front information center.

The only type of monitoring performed by Stadtwerke Saarbrücken is a database containing the details of each individual project at the time of financing. This data is used to calculate the results of the program as a whole. To date the program has had approximately 2,000 participants, with total annual energy savings estimated at between 50,000 and 100,000 MWh. Approximately 3/4 of the loans are used for new heating equipment such as boilers and district heating. The rest of the loans are used for insulation and new windows.[R#8]

Stadtwerke Saarbrücken staffing requirements for The Participation Program are approximately 0.5 full-time equivalents. This minimal staff requirement can be attributed to the bank handling all the financial details.[R#4]

The Participation Program has been a key to the City reducing its space heating demand by more than 15% during the 1980s. This program is one of the very first long-term loan/lease programs implemented by an electric utility. Flexibility has been a major factor in the program's success, with customers allowed to choose from a wide range of retrofit options recommended by home energy auditors. A major bonus from the utility's standpoint is that most of the capital comes from the private sector, with the utility subsidizing the interest rate and paying for administrative costs.

The Results Center has calculated an average cost of saved energy for the Participation Program (1988 through November 1993) based on costs of \$24.2 million, savings of 75,000 MWh and assuming a 20-year lifetime. The 20-year lifetime was used because 3/4 of the savings are attributed to heating measures. The savings figure of 75,000 MWh was selected as "middle ground" between the range of savings estimates from 50,000 MWh to 100,000 MWh. At a 5% discount rate, the program had a 

DSM Initiatives (continued)

Cost of Saved Energy (¢/kWh)	Discount Rates						
	3%	4%	5%	6%	7%	8%	9%
Total Cost	2.17	2.37	2.59	2.81	3.05	3.29	3.53
Utility Cost	0.20	0.22	0.24	0.26	0.28	0.30	0.32

total cost of saved energy (bank loans plus utility administrative costs) of 2.59 ¢/kWh. The cost of saved energy varies from 2.17 ¢/kWh at a 3% discount rate to 3.53 ¢/kWh at a 9% discount rate. When considering only the utility's cost, the Participation Program has had a cost of saved energy of 0.24¢/kWh at a 5% discount rate. [R#8]

RATE STRUCTURES

Like many utilities not only in Europe but certainly in North America, Stadtwerke Saarbrücken and the City recognize that reforming rate structures must be a precursor to effective energy efficiency programs. While Saarbrücken's rates for electricity are high compared with those of their North American counterparts, Saarbrücken has been grappling with declining block rates (the more you use the less you pay) and has identified these antiquated rate structures as major impediments to conservation.

Stadtwerke has now implemented a linear rate structure and a voluntary off-peak electric tariff is now available as well. Beginning in July of 1993 the utility began experimenting with three-zoned time of use rates, which range in price from 0.89 ¢/kWh - 11.9 ¢/kWh (1.5 pf/kWh - 20 pf/kWh). Nine in the morning to 1 pm is the most expensive period and 6-8 pm at night is the cheapest.

THE FOURTEEN CORE PROGRAMS

Bolstered by its comprehensive financing program and its realigned rate structures, currently Stadtwerke

Saarbrücken offers 14 discrete energy efficiency programs. The utility offers many different forms of consumer education on energy and the environment as well as energy conservation diagnostic services and incentive programs. [R#1,5,9]

Consultation programs include the Saarbrücken Energy Advice program, the Saarbrücken Energy Savings program (a computer analysis of energy consumption), Customer Seminars, and Info-Center E. More than 15,000

SAARBRÜCKEN ENERGY SERVICES
Saarbrücken Participation Program
Energy Advice
Energy Savings
Customer Seminars
Info-Center E
Direct Heating Service
System for Energy Saving Management
Info-Bus
Heating Passport
Electricity Detective
Linear Tariffs
Solar Rooftop Program
Electricity Savings Handbooks
Allround Contract

information requests are handled annually by the Info-Center E which was opened in 1983. This center is located downtown and includes energy conservation displays as well as expert staff who can answer energy conservation questions either in person or over the telephone. One of the features at the Center is an exhibit of an actual rooftop solar photovoltaic installation. Meters in the Center allow visitors to see the levels of generation at the panels and to simultaneously view and compare that level with the amount being used at the Center, to get a feel for the net benefit of the solar system.[R#5,9]

Other programs include Direct Heating Service, the System for Energy Saving Management (SESAM), an Info-Bus (mobile advisory service similar to an Info-Center E on wheels), and Heat Passport, a program that Stadtwerke Saarbrücken has jointly developed with The Wuppertal Institute, the leading German DSM research center. The Heat Passport program is based on a simple principle: If you save energy you are rewarded. "Heat passport" gives an indication of a home's energy intensity and works like a rating system. If you have a good rating, i.e. low energy intensity, you get lower electricity rates. (See Profile #67 for a similar mechanism.)

The utility also provides rebates of \$30 (50 DM) for purchasing certain energy-efficient appliances and \$60 (100 DM) for converting from electric to gas water heating. Stadtwerke Saarbrücken also publishes an electricity saving handbook. The Electricity Detective program provides interested customers with an energy consumption monitor to measure appliance energy use.[R#5,9]

Pilot school lighting program: This program has been funded to date by the City's Energy Department and was initially intended as a mechanism to profit from efficiency while taking advantage of daylighting. Traditionally fluorescent lighting troffers (recessed ceiling fixtures) have been controlled in blocks, for instance one switch controls the first three rows of troffers nearest the window or even the entire room. By rewiring the lamps the program has made it possible to control troffers 1,3, and 5 and to thus

be able to reduce lighting intensities by 50% near the windows when there is adequate daylighting. The system can be manually controlled or can be automatically controlled through the use of photosensors and occupancy sensors.

One of the ironies of the program is that German schools, unlike their American school counterparts, are currently underlit. Thus some of the program's savings have been negated since the retrofits are resulting in additional lighting capabilities. The retrofits are being used as an opportunity to bring up the illumination levels to current standards but to date are making this pilot not cost effective. Thus it's been hard to sell as an energy efficiency program, but is socially desirable nevertheless.

Gymnasium Pilot Lighting Program: This program focuses on school gymnasiums where lighting retrofits are clearly cost effective. Electricity is being used unnecessarily in gyms because the lights are not being turned off when they are empty, the lights are left on even when there is sufficient daylight, and lights are used at their highest intensity all day long regardless of the type of activity in the gym.[R#8]

To date one gym has replaced its former lighting system with a new automatically-controlled system. This system includes motion detectors which turn the lights off if no motion is detected for 5 minutes. A photocell-controlled sensor turns the lights off if daylighting is providing sufficient light levels. The highest level of lighting intensity can only be turned on manually by the janitor. Prior to installation of the new lighting system the gym was using 52,800 kWh annually for lighting. With the new system consumption is estimated to be 39,800 kWh for annual savings of 13,000 kWh.[R#8] ■

Renewable Energy in Saarbrücken

Willy Leonhardt, the utility's chairman, put it most aptly in a speech at the recent OECD conference in Saarbrücken. He was addressing delegates from all over Europe and his message was progressive and profound. His remarks are paraphrased herein: "Solar energy will provide a bridge to a new age. In the next 100-200 years, solar must provide the majority of new supply. In the next 50-100 years, fully one-half of the present power supply system will not exist. There will be no more oil, certainly no gas used for power plants, and if there are no breeder reactors, there'll be no nuclear power either. So we will need and have something entirely new." [R#10]

With this outlook firmly in place at the top of the utility, and supported and encouraged by Saarbrücken's ruling Social Democrat party, Stadtwerke Saarbrücken has become the leading solar utility in Europe, akin to the position gained by Sacramento Municipal Utility District in California (see Profile #66). Saarbrücken has developed a demonstration solar house with an integrated photovoltaic rooftop, it has retrofitted its community pools to be solar-heated (and note the latitude!), and it has begun one of the most exciting solar rooftop programs in the world working with its customers to install photovoltaic systems throughout Saarbrücken.

The Solar Demonstration House at Ensheim:

Stadtwerke Saarbrücken's demonstration house at Ensheim is located in a rather common subdivision but is a focal point of the solar program. Its south-facing roof is made of photovoltaic cells. Other than that, the house looks completely normal. What makes the house so interesting is that the roof is owned by the utility, while the home is privately-owned, an interesting conceptual model of a possible future utility paradigm. Another feature of the home is that when its PV system provides more power than the home requires, it sells back the power to the utility,... causing the meter to run backwards. Through this sort of interface with its customers the utility plans on developing a 1 MW rooftop capacity in Saarbrücken through its Solar Rooftop Program.

Solar Rooftop Program: The solar house in Ensheim has paved the way for the Solar Rooftop Program. Through this program 100 MWh of photovoltaic electricity is produced annually by utility customers and sold to the utility. At a cost of 11.89 ¢/kWh, the program is not cost effective when compared to utility production costs of 7.13 ¢/kWh, but cost effectiveness is not the primary measure of success for this program because it is a pilot program focusing on a new technology. Fully 50 customers now provide solar to the grid. [R#2,5,7]

The Solar Rooftop Program has begun to move the City towards its goal of producing 1,000 kW of solar power from the roofs of Saarbrücken. This program allows customers to become energy producers as well as consumers by asking for bids for supply of solar generated electricity which is purchased by the utility at the same rate its customers pay. The initial request for bids met with a response of more than 500 proposals from residential and small commercial customers. Currently more than 50 projects are either underway or fully implemented, including a 27 kW solar system which is the largest privately-owned PV system in Germany. So far an overall connection load of 130 kW is operational. Only 1/3 of this power is produced by small commercial customers with the rest coming from residential customers. [R#1]

The City provides up to 50% of the equipment costs and the customer is responsible for the remainder. Currently the typical payback period for customers is 20 to 25 years so most participants are environmentally-conscious individuals who understand that their project is part of a bigger picture of social responsibility, such as incrementally helping to slow global climate change. The 1 MW goal for the Solar Rooftop Program nicely complements the 1 MW hydroelectric power plant planned for construction on the Saar River. [R#1,2,8]

Solar electric vehicles: Already the City and utility have several electric vehicles and the utility wants to have 100 solar electric vehicles which can be "tanked up" at solar

recharging stations throughout the City. City officials caution however, the use of electric vehicles and point out that they are not looking for ways to use more electricity through electric vehicles – a suspicion that they have about many promoters of EVs. Instead, they claim that the vehicles must be lighter weight, must be built with environmentally-friendly materials, and must get their electricity from the sun.[R#8]

Outdoor swimming pools: Presently there are three outdoor swimming pools being heated by solar energy with a fourth pool expected to come “on line” soon. The City’s Energy Department, led by Dr. Jurgen Lottermoser, pioneered this highly successful program and began at an ideally suited pool for a retrofit, as its south facing roof was angled just perfectly for a simple solar system! Thin plastic pipes were arranged in a concentric pattern on the roof of the indoor pool and directly heated hot water was collected in storage tanks in the pool’s boiler room.

Because of the facility manager’s suspicion that solar energy would not provide enough heat for the indoor pool in the winter, Dr. Lottermoser kept the oil-fired system in parallel with the solar system. It took a year to convince the facility manager at the pool that the system could be 100% solar heated year-round, and the oil-fired boilers were scrapped! Now the system will be expanded to provide hot water for the showers and janitorial purposes as well.

The Tech Center Hybrid System: Another interesting solar system has been tested at the Saarbrücken Innovation and Technology Center, a vocational education center. There a 50 kW photovoltaic system and 180 MW co-generation power station operate in tandem and pick up a clever synergy. When the sun’s out, there is little or no need for heating, so electrical demand can be fulfilled from the sun alone! ■

TRANSPORTATION

Saarbrücken is along the major rail lines that run from Frankfurt to Paris, a strategic position that coupled with its coal and industrial base caused the City to be heavily bombed twice in World War 2. The City also borders the Saar River, a major barge route. Although no oil has been used in Saarbrücken’s power plant since 1984, before then oil was barged in from Rotterdam.

Like each of the other European cities we researched (see Profiles 76,77,79,80), Saarbrücken is also focused on increasing the efficiency of its transportation. In 1989, the modal split for transportation in Saarbrücken was 53% individual cars, 28% pedestrians, 17% buses and trains, and 2% bicycles. Fully 81% of commuters rely on automobiles. In order to reduce traffic, the City has implemented paid parking for all spaces in the City; special bus lanes and priority for buses at traffic lights; and reduction of speed limits on many streets to 30 kilometers/hour (20 mph) down from 50 kilometers/hour (30 mph).

Saarbrücken is spending approximately \$416,422 each year building new bike lanes and pedestrian paths. In an effort to encourage bus ridership, fares have been reduced and a monthly bus pass costing \$33.26 has been introduced. One study by the City’s Energy Department estimates that traffic in the City has been reduced by 8% from 1978 through 1990. If the necessary funds can be obtained from the Federal Government, Saarbrücken hopes to build a new light rail system as well.[R#2]

Award-Winning Advertising

Europeans, compared to North Americans, on a per capita basis are already quite efficient. Thus encouraging Europeans to further refine their use of energy is very challenging. While Stadtwerke Saarbrücken has been promoting the rational use of energy through economic arguments, it recognized the need to move people emotionally. Therefore the utility set out to elicit an emotional response to the destruction of our environment, forging a mental link between individual energy consumption patterns and the resulting increase in pollution as well as the need for additional power plants.

To raise awareness of detrimental energy use, Stadtwerke Saarbrücken contracted with a highly-acclaimed local university professor to design and establish an unusual campaign. Professor Maksimovic did just that and in the process shocked many residents of Saarbrücken with his bold graphics and uncanny statements. Despite some concerns that the utility was spending too much on full-page ads and full-sized posters, the strategy has worked. When ads have run in the Sunday newspapers, the energy information center and utility efficiency staff have been besieged with calls the very next day! Along the way, Maksimovic won a "German Oscar" for the utility's advertising series.

The advertising campaign is made up of two series. The first is a series of full-page newspaper ads containing unusual photographs with text below encouraging energy conservation. The second component is a group of graphically-awesome posters reflecting Maksimovic's unusual view of reality and his powerful ability to elicit an emotional response from the viewer. This series consists of stark black and white drawings (rather Munchesque) and text bemoaning the horrors of wasting energy and urging people to contact and/or visit Info-Center E. Each series depicts a wide range of images guaranteed to catch the eye of newspaper and magazine readers.

Perhaps the greatest attention getter to date has been the utility's full-page newspaper advertisement of a photo of an attractive, semi-nude woman lounging in a bathtub. A caption reads, "The Daily Bath," and accompanying text reminds people that while a warm daily bath is luxurious it also wastes a great deal of energy!

Another photo depicts a stand of dead trees. The caption reads, "My son, someday this will all be yours." In this ad the Stadtwerke was suggesting that our environmental future will be very grim indeed if we continue to consume natural resources at current levels.

Another powerful image shows a couple hugging with the caption "Make love, not warm." This theme takes off on the American anti-war slogan, "make love, not war." The advertisement explains that typically people have no idea of how much energy they consume (especially for household heating) and don't really think about it. To overcome this lack of awareness, Stadtwerke's "Warmepass" computer program measures energy use and allows customers to see their energy consumption and potential savings.

A simple black and white photo of a pristine landscape also lures the reader's eye. A cut-out image presents an outline of a power plant to show the potential despoliation of the setting if society continues to demand ever-increasing amounts of power. The caption tells it all: "Whether a power plant is built here is determined by you and the use of your light switch." In finer print below are direct action steps consumers can take including calling the utility for more information on how to get started in energy conservation.

Each poster in the second series is made up of rather unsettling black and white images with red lettering. The red lettering is reserved for advice on how to get loans and information by contacting the Info-Center E, and assures the reader that, "We can fight this environmental horror." A poster presents black clouds billowing from a chimney and recommends loans for new heating systems. "Monster eats innocent energy reserves!"

"You still haven't gone to Gerberstrasse?" (the address of Info-Center E). "How much more terror can you take?" A woman screams in horror endlessly! Another poster shows a screaming mouth coming out of a faucet. "Don't waste hot water" is the theme and information on the poster shows how to get low interest loans for water saving measures. Another poster shows a picture of a devil's head in a light bulb: "Devilish light sucks away a bright, beautiful future."

Finally, our staff had the opportunity to meet Professor Maksimovic in Saarbrücken this past summer and to hear him address a utility conference on energy efficiency. His style was provocative but thoughtful. Inferring that utilities have been sheltering their customers from reality he urged us to, "Tell people the truth... that is what people are least prepared for." And he quoted Mark Twain, "When you tell the truth, there's nothing to remember." He ended his talk by making fun of himself, a parody on society, and in particular society's penchant for the car and our endless excuses to continue to drive unnecessarily. He quipped, "I wanted to walk to the conference but my slides weighed a ton!" ■

Lessons Learned / Transferability

LESSONS LEARNED

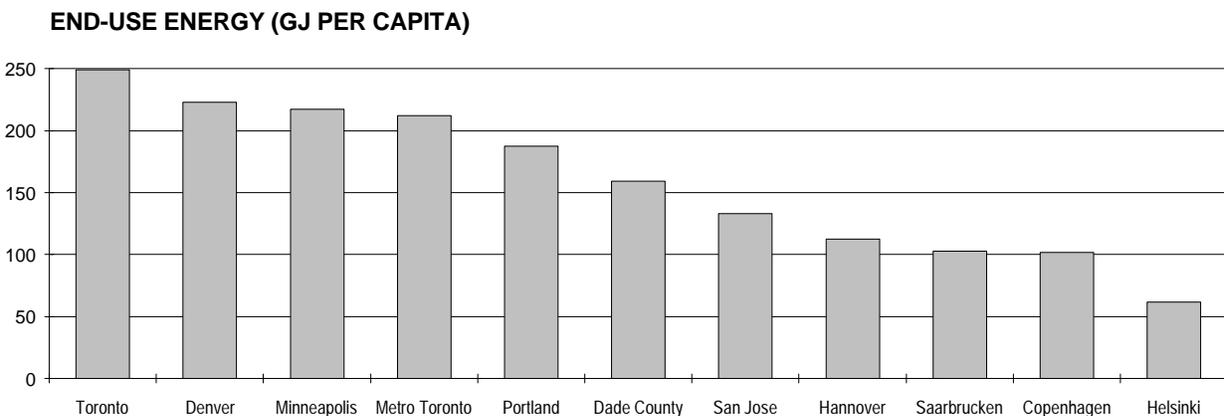
There are several key lessons that have been learned in Saarbrücken, the first being that it is possible to enact major efficiencies in a city that is already quite efficient in terms of energy consumption when compared to North American standards. (The accompanying table and chart are expressed in gigajoules per capita to show the relative energy intensities of North America and Europe.)[R#13] Despite historically high prices which have at least theoretically already instigated relatively high levels of efficiency, Saarbrücken has proven to its European and North American counterparts that more efficiency can be gained through effective communication and program design.

Lesson number two is that Saarbrücken has effectively integrated its efficiency and energy initiatives. As such the City has focused on increasing the efficiency of its power plant through extensive district heating and through efficient power plant repowering. At the same time it has promoted significant investments in energy efficiency, nicely complementing its district heating efforts and surpassing its goals for its power plant operations. The City has also recognized the importance of careful transportation planning that has resulted in increased bicycle and pedestrian and bus traffic, weaning the community away from automobiles.

Third and perhaps most important to utility DSM program planners is the success of Saarbrücken's Participation Program. This financing model proves that utilities don't have to bear the full costs, or even a major share of

the costs, of efficiency programs that benefit their customers. Working with the local banks, The Participation Program has enabled over \$22 million in private investment in energy efficiency in Saarbrücken, established through utility oversight, aggregation, and risk guarantees 

END-USE ENERGY (GJ/CAPITA)	
City of Toronto	248.99
Denver	223.24
Minneapolis/St. Paul	217.38
Metro Toronto	212.44
Portland	187.75
Dade County/Miami	159.51
San Jose	133.03
Hannover	112.43
Saarbrücken	102.81
Copenhagen	101.97
Helsinki	61.96
Total/Avg.	160.14
N. America Avg.	197.48
Europe Avg.	94.79



Lessons Learned / Transferability (continued)

that each allowed for favorable and simple bank financing for district heating hookups, energy efficiency upgrades, and even investments in the Solar Rooftop Program.

The fourth key lesson learned from Saarbrücken is that through effective communication a utility can promote long-term, sustainable energy initiatives even in a region where the economy is heavily dependent on a fossil fuel, in this case coal. Supported by a progressive government and heightened environmental awareness, Saarbrücken's planning horizon is in the hundreds of years and its investments in solar energy resources underscore this commitment to the future. Saarbrücken provides a remarkable example of a community thinking globally and acting locally.

Finally, Saarbrücken has been able to communicate the trade-offs between energy and the environment and thus to promote its long-term, environmentally-sustainable energy path to the community. Part of its success in this arena has been based on its unique and powerful public advertising campaign discussed in this profile. What Saarbrücken has embodied by investing in such a startling approach is that energy efficiency can be promoted on emotional grounds. Customers in Saarbrücken have demonstrated that they are moved by concerns about the environment and that when they have the opportunity to do something for the planet and their children's generation, they will, especially when they have access to a favorable financing package that allows them to easily and affordably convert a desire to be environmentally conscious and responsible, into a concrete action.

TRANSFERABILITY

Let's examine Saarbrücken's programs in three areas for the purposes of discussing transferability. The first is district heating which of course can be transferred wher-

ever power plants are located near enough cities and communities to be able to pipe their thermal energy for district heating. Utilities might want to consider Hannover's success (Profile #77) with matching industries thermal demands with power plants' thermal outputs. Another example is Copenhagen, Denmark, where an aggressive district heating system was built into an already dense, and historic infrastructure (see Profile #80).

Saarbrücken's energy efficiency initiatives and financing model appear to be extremely transferable. The Participation Program model may become a precursor in a major North American trend towards "energy service charge" programs, whereby a line item on a customer's monthly bill represents a new form of utility service, the energy efficiency service charge. This concept is being experimented with already in the United States (see Profile #46) and may be Saarbrücken's most important contribution to the field of DSM. What Saarbrücken has demonstrated over time is that customers are willing to pay their share of the costs of energy efficiency if they have positive cash flow while participating in the program. North American utilities and advocates to date have expressed concern that energy service charges may discourage participation, but that has clearly not been the case in Saarbrücken.

Finally, how transferable are Saarbrücken's solar initiatives? First off, Saarbrücken, unlike Sacramento (see Profile #66), is not particularly sunny and that is telling in itself. You don't need a perfect solar situation to take advantage of the power of the sun. Second, what drives Saarbrücken's solar efforts is an awareness and that could be raised anywhere. The people of Saarbrücken understand the importance of a long-term perspective. They realize that coal, oil, and all fossil fuels are inherently finite. Thus their efforts with efficiency (on both the supply side and demand side) must be coupled with a long-term strategy that fosters energy sustainability. Saarbrücken has demonstrated that this important message can be transferred from decision-makers to the public through effective communication. ■

References

1. International Council for Local Environmental Initiatives, Case Study 4, "Energy Conservation/Finance, Saarbrücken, Germany," January 1992.
2. "The Program of the City of Saarbrücken for Protecting the Climate," February 11, 1993.
3. Dr. Wolfgang Bruck, Stadtwerke Saarbrücken AG, "District Heat Supply of the City of Saarbrücken," May 25, 1992.
4. "Financing Program Profile, Saarbrücken Participation Program," ICLEI paper.
5. Willy Leonhardt, Chairman, Stadtwerke Saarbrücken, "Municipal Environmental Management Using Innovative Service Ideas."
6. Stadtwerke Saarbrücken, "1992 Annual Report," 1993.
7. Dr. Wolfgang Bruck, Manager of Environmental Affairs, Stadtwerke Saarbrücken AG, personal communication, June - December 1993.
8. Dr. Jürgen Lottermoser, Energy Department Manager, City of Saarbrücken, personal communication, June - December 1993.
9. Stadtwerke Saarbrücken, "Das Saarbrücker Zukunftskonzept Energie," December 1992.
10. Willy Leonhardt, Chairman Stadtwerke Saarbrücken, Keynote address to the first European OECD DSM conference in Saarbrücken, June 1993.
11. "International Directory of Electric Utilities," Thomas C. Elliott, Editor, 1991.
12. Energy Information Administration (EIA), "International Energy Annual 1991," December 1992.
13. Ralph Torrie, Torrie Smith Associates, "Baseline Energy and Emissions Data from Municipalities Participating in the Urban CO₂ Reduction Project," February 1992.

Special thanks to Dr. Jürgen Lottermoser for his guidance and support throughout the development of this profile, and especially for his hospitality in Saarbrücken in June of 1993.