Hannover, Germany

Comprehensive Municipal Energy Efficiency

Profile #77

Executive Summary

Hannover is a capital for energy efficiency in Europe and has worked on a comprehensive approach to energy management that includes supply-side efficiency, district heating, transportation efficiency, water efficiency, promotion of renewable energy, and more conventional energy efficiency. Its efficiency initiatives are a subset of the City's far broader drive toward sustainability and environmental stewardship and have been spurred on by concerns about foreign oil dependence and the Chernobyl nuclear accident, concerns that translated into the City's progressive Energy Plan and Climate Protection Program.

Hannover has one of the most vibrant multi-modal transportation systems in Europe. A proliferation of bicycles nicely complement light and high speed rail systems, all in place to reduce dependence on automobiles and imported petroleum. Hannover's biggest employer is Volkswagen, yet the downtown core has been closed off to cars and two-lane roads coming into the City narrow down to single lanes, purposefully creating traffic jams and incentives for commuters to leave their cars at home.

Stadtwerke Hannover's new combined heat and power plant provides an insight into the City's commitment to wise and responsible energy use. While the typical U.S. power plant is 30-35% efficient and produces only electricity, Hannover's new plant has five basic outputs and one saleable by-product, making its overall efficiency approach 90%. The plant generates electricity and provides district heating for downtown Hannover. The plant also sells hot water to the Volkswagen van factory across the street, and high and low pressure steam to a tire factory adjacent to the plant. Particulates collected, including sulfur from flue gas desulfurization units, have been used for cement for the chunnel.

Stadtwerke Hannover AG has also implemented numerous DSM programs with a focus on advisory services and space heating. Programs include free furnace efficiency analysis; development of heating system databases; energy efficiency contests for architects; customer efficiency contests with cash awards; demonstration programs; loans of end-use measuring equipment; a downtown energy-efficiency information center; all in conjunction with pilot renewable energy programs.

Hannover's least-cost planning study is a pioneering effort to use the North American planning concept to institutionalize energy efficiency investments in the utility's broader business and investment strategies. The study includes six pilot DSM programs and is especially important in Hannover where an increasingly competitive power market threatens to undermine investments in energy efficiency and long term strategies for sustainability.

City of Hannover, Germany

Comprehensive Municipal Energy Efficiency

Utility:	Stadtwerke Hannover AG
Sector:	Residential, commercial
Measures:	Transportation efficiency, supply-side efficiency, district heating, renewables, water efficiency, and comprehensive energy efficiency inititatives
Mechanism:	Energy efficiency is primarily driven by energy advising and information services, coupled with design competitions, and some incentives
History:	The City and utility have worked together developing an integrated approach based on the City's Energy Plan and the utility's Concept 2000. Both are committed to Hannover's Climate Protection Program which will reduce 1987 CO2 emissions levels by 25% by the year 2005. Least cost planning study underway with Oko Institut

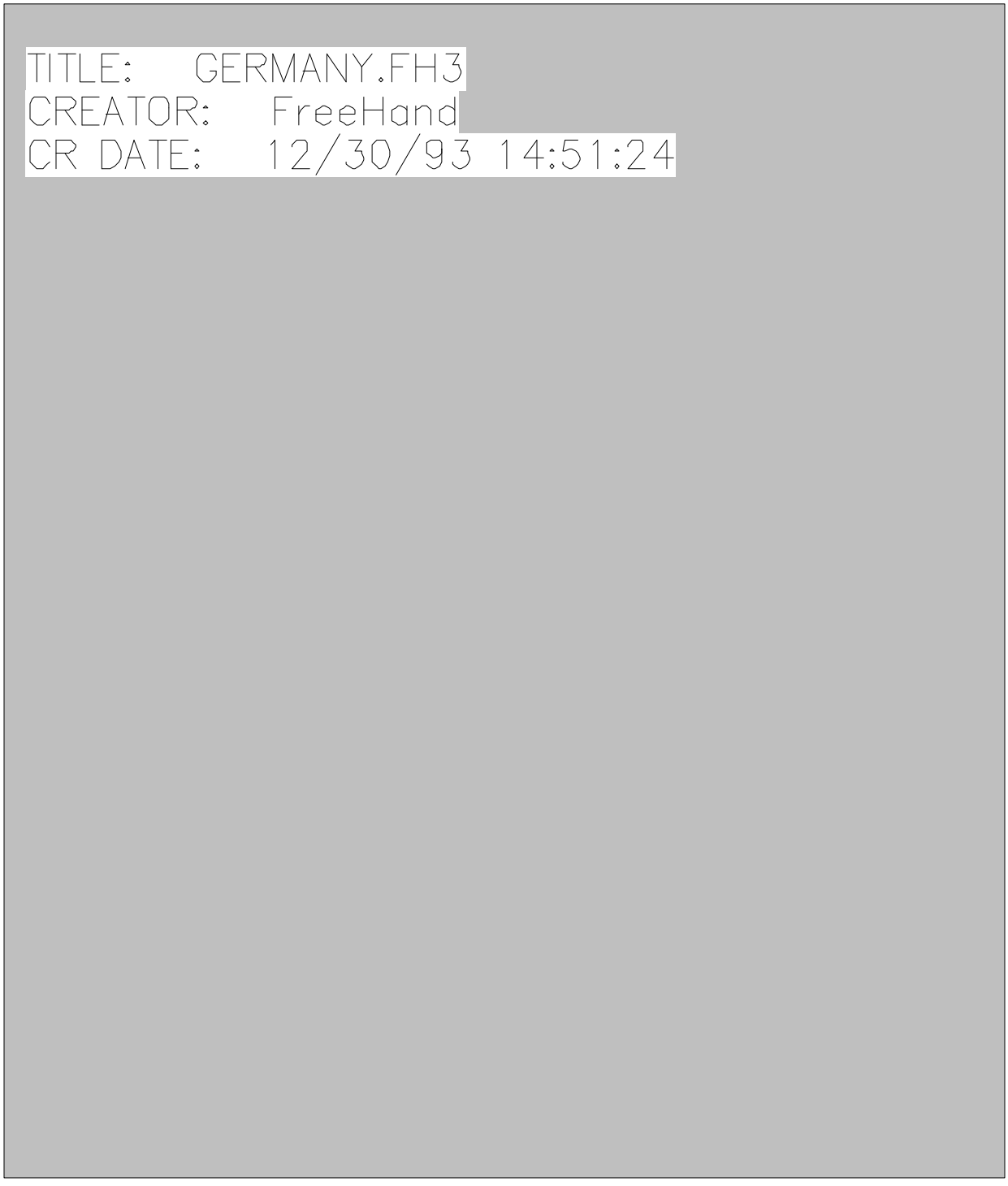
Conventions

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.

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.)



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 ☞

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. ■

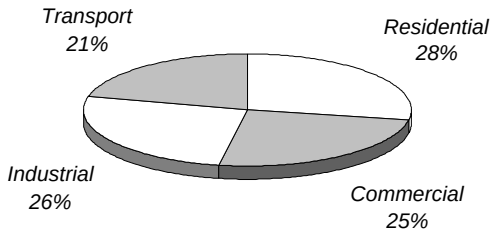
The City of Hannover is located in north central Germany and is a center for technology and medical research. Because of its historical role as a manufacturing center in Germany, Hannover was especially hard hit in World War 2 when fully 90% of all buildings in Hannover were destroyed by repeated Ally bombings. Rebuilt quickly, Hannover's economy is based on trade and the service industry, and a Volkswagen auto plant which produces small vans is located there.

Hannover has a population of just more than half a million and is the capital of Lower Saxony. The municipality covers approximately 200 square kilometers (124 square miles) and is located on the same latitude as Birmingham, England and Edmonton, Canada and has an average annual temperature of 8.6°C (47.5°F). Nearly 50% of the City area is made up of forest, parkland, or agricultural land, and the protection of open space is a key local concern. In this regard, the City has done the unthinkable and has been able to revegetate areas that had been characterized by brick and mortar, reversing a global trend of "development" with a new form of green redevelopment in line with the City's overall land-use plan.[R#7]

Hannover, like many German cities, is also recognized as a bastion of progressive politics. The Hannover City Council as well as the state government of Lower Saxony are run by the Social Democrats in conjunction with the Green Party. This influence is readily apparent in Hannover where environmental policies command equal importance with more traditional economic concerns. In terms of energy the City is also well known for its energy conservation and is proud of the fact that household electric consumption is 30% below the national average.

On June 26, 1986, the Hannover City Council passed a resolution which addressed both nuclear energy and future energy directions. This resolution specified the following priorities for energy policy: energy savings are given absolute priority over all other energy policy objectives; an increase in the use of energy-efficient measures; promotion and use of renewable energy sources; preference for the use of indigenous coal while promoting environmentally-friendly coal technology; and a gradual reduction of the City's use of nuclear power with nuclear power being eliminated as a power source by 1999.[R#2]

1990 END-USE ENERGY CONSUMPTION



In the Federal Republic of Germany, responsibility for the implementation of environmental laws (as passed by the Federal Government) lies with the Federal States (Lander). In Lower Saxony, the environmental activities of the State's own authorities are confined to the monitoring of compliance with environmental law by industry and to administering approval procedures for most matters affecting the environment. All other duties relating to the implementation of environmental laws (both Federal and State) are delegated to local authorities. Thus, the City of Hannover has to fulfill a great number of statutory environmental protection duties in its capacity as: nature conservation authority, water authority, refuse disposal authority, and emissions protection authority. These responsibilities are exercised by Hannover's Office for Environmental Protection.[R#2] ☞

The Department for Environmental Affairs and the Office for Environmental Protection were set up on August 1, 1988. Departments within the Hannover government are run by Commissioners who are elected by City Council for a term of six or twelve years.

EXPO 2000

In June 1990, the general assembly of the "Bureau International des Expositions" nominated the Federal Republic of Germany as the host country for the World Fair in the year 2000. Hannover will be the site of the World Fair which will be called EXPO 2000 and have the theme of "Man-Nature-Technology." This theme was ratified by the EXPO 2000 Advisory Board in March 1992. With this theme the City hopes to address the issue of encouraging a sustainable future with the goal of humanity redefining itself, its place in nature, and refine the role of technology as it effects the environment. The organizers of EXPO 2000 define sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.[R#2,3,4]

EXPO 2000 is expected to bring between 20 and 40 million people to Hannover! The City believes that being selected as the site of the World's Fair along with the theme of the Fair place Hannover under an obligation to restructure the City ecologically by the year 2000 in order to show the world the potential for environmental initiatives.[R#2]

UTILITY OVERVIEW: STADTWERKE HANNOVER

The City of Hannover along with the Greater Hannover Area and Hannover County own 100% of the shares of Stadtwerke Hannover AG, the municipal utility. Prior to 1971 the utility was a branch of the City administration.

STADTWERKE HANNOVER AG 1992 STATISTICS		
Number of Employees	3,700	
Electric Sales	3,239	GWh
Natural Gas Sales (equivalent)	9,587	GWh
District Heating Sales (equivalent)	907	GWh
Utility Revenues	$770	million
Average Electric Rates	13.19	¢/kWh

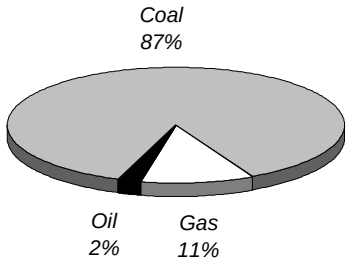
Currently the City exerts influence on the utility mainly through the supervisory board where it holds 10 seats including the chair. The other 10 seats are held by Stadtwerke employees as dictated by German law.

Stadtwerke Hannover AG supplies electricity, gas, district heating, and water. The utility has 3,700 employees and had revenues of $770 million in 1992. In 1992 the utility had electric sales of 3,239 GWh, natural gas sales equivalent to 9,587 GWh, district heating sales equivalent to 907 GWh, and 51 million cubic meters of water were sold. Electric sales were 20% residential, 77.6% commercial and industrial, and 2.4% other. The utility's fuel mix for utility generated power is 87% coal, 11% gas, and 2% oil. In 1992 Stadtwerke Hannover AG's purchased and generated power production totaled 3,325 GWh with 839 GWh (25%) being purchased. The commercial and industrial sector accounted for 46% of gas sales, while the residential sector accounted for 32%, and sales to other gas companies totaled 22%.[R#14]

Stadtwerke Hannover AG is one of the 10 largest municipal utilities in Germany and its annual revenues are approximately 8% of the largest German utility. The genera-

tion of electricity primarily in coal-fired plants accounts for more than 40% of Hannover's CO2 emissions, and Stadtwerke Hannover AG is the City's single largest source.

1992 STADTWERKE HANNOVER FUEL MIX



The utility operates three cogeneration plants which supply electricity and district heating to the City and process heat to two major industries.[R#5,9]

UTILITY DSM OVERVIEW

Germany has had a long history with load management programs. Currently DSM programs focusing on energy efficiency are motivated by local, regional, or national political goals or by the perceived social responsibility of the utilities. The least-cost planning (LCP) approach is very new in Germany and throughout Europe, and Stadtwerke Hannover's pilot LCP program makes the utility a leader in least cost planning.

Stadtwerke Hannover AG began its DSM efforts in 1989 with a long-range goal of energy conservation and use of renewable energy sources. The utility hopes to reduce energy consumption by 30% in the year 2005 and intends to have 100% of residential new construction hooked up to gas (for heat) or district heating. The DSM programs already implemented are an off-shoot of the utility's corporate goals, "Concept 2000," formulated in 1988. The initial design and implementation of DSM programs was motivated by environmental concerns and performed in cooperation with the municipal government. The utility has a wide range of energy and environmental conservation efforts either planned or underway.

Like all municipal utilities, Stadtwerke Hannover has a close relationship with the City of Hannover. In fact the utility contributes more than $32 million annually to the City's general fund. Currently the City government is controlled by the Social Democrats in conjunction with the Green Party. Despite the Reds' and Greens' reputation for environmental stewardship the government seems to favor only Stadtwerke activity that makes the City money. Thus DSM is under fire in Hannover as it is in many parts of the United States and North America. City control of the utility has translated to the utility into "increased profits," a scenario that challenges energy efficiency. In fact one option that the City has been considering to relieve its large municipal debt is to sell 24% of Stadtwerke's shares, and to do so would only put more short term competitive pressure on the utility. This in turn would heighten concerns about rate impacts associated with DSM. In order to make DSM profitable at the utility, one strategy being considered is performance contracting. The City government recognizes that the utility could profit by selling energy services to customers who would not only repay the utility, but share some portion of the savings with the utility over time. ■

Energy Efficiency Initiatives

Hannover has been a German leader in energy efficiency for a number of political and financial reasons. In this section we present two of the key drivers for the City's broad efficiency initiatives, the City's Energy Plan and its commitment to the Climate Protection Program, and then address two fundamental aspects of municipal energy efficiency in Europe: transportation and supply-side efficiency. In an unusual departure from The Results Center conventions, we'll delve briefly into Hannover's innovative transportation initiatives and then illustrate the City's recent power plant construction project as an illustration of their commitment to thermodynamic efficiency and environmental care. We also briefly present Hannover's work with renewable energy technologies and water efficiency initiatives.

THE CITY OF HANNOVER ENERGY PLAN

From 1988 through 1993, the City administration and Stadtwerke Hannover AG jointly designed the comprehensive Hannover Energy Plan, consisting of nine parts. Part 1 (Energy Policy Guidelines) was adopted by the Hannover City Council on November 26, 1992 and consists of the following:

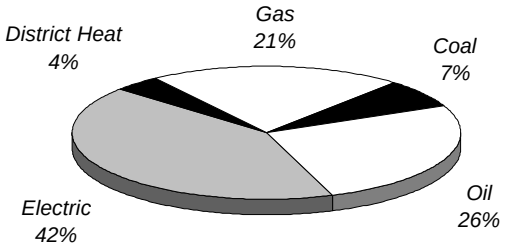
- Make energy conservation the number one priority over other policy objectives with a special focus on energy savings by the end-use consumer.
- Expand the use of cogeneration and renewable energy sources.
- Eliminate the use of power generated from nuclear sources.
- Reduce CO2 emissions by 25% by the year 2005.
- To maintain the delivery of cheap, reliable power in the long run.
- Maintain local autonomy with respect to the long-term energy supply.[R#7,9]

This plan came about as a result of many factors. The Chernobyl nuclear accident as well as the utility's Concept 2000 were major drivers. Other factors include the ongoing demands and pressures from the Green party and local environmental groups. The utility developed the plan internally despite requests from the Green party to have the plan designed by independent experts.

THE CITY OF HANNOVER CLIMATE PROTECTION PROGRAM

Given its interlocked goals of environmental protection and fostering a sustainable future The City of Hannover agreed to participate in the International Council for Environmental Initiatives (ICLEI) Urban CO2 Reduction Project. The result of this program is the Hannover Climate Protection Program. This program is one of the many projects being planned as part of the City's efforts to gear up for EXPO 2000 and its goals tie in directly with the Hannover Energy Plan. The program was designed through a collaborative effort involving both the municipality and Stadtwerke Hannover AG. This plan covers strategic policies, targets, and measures in all areas relevant for reduction of greenhouse gas emissions, such as energy supply, transportation systems, land use planning, housing development, waste management, and agriculture.[R#7]

1990 HANNOVER CO_2 EMISSIONS



In 1992, the Hannover City Council set a goal of reducing CO2 emissions by 25% in the year 2005 from the baseline year of 1987. This target is in accordance with the goal of the Federal Government to reduce CO2 emissions by 25% by the year 2005 and ties in directly with the Hannover Climate Protection Strategy.

In conjunction with this plan the City plans to cut back on its use of imported nuclear power. While the utility does not operate any nuclear plants, electricity from nuclear power sources contributes to Hannover's electric-

ity supplies through power purchases from Preussen Elektra which provides about 25% of Stadtwerke Hannover's supply.

TRANSPORTATION

Hannover has one of the most exciting transportation systems in Europe with a proliferation of bicycles coupled with rail systems, all in place to reduce dependence on automobiles and imported petroleum. What makes this multi-modal system so impressive is that Hannover's biggest employer is Volkswagen! Thus the fact that the downtown core has been closed off to cars is quite remarkable. In addition, two-lane roads coming into Hannover narrow down to single lanes as commuters enter the City, purposefully creating traffic jams and incentives for commuters to leave their cars at home and jump on their bikes or rail systems that pass by unimpeded.

Visitors to Hannover often arrive by high speed rail. Germany's system of ICE trains (the InterCity Express network) is extraordinary. Not only are the trains expedient but they are clean, frequent, and relatively low cost. The modern trainsets are fully equipped with conference rooms, phones, fax machines, and even computer terminals where passengers can book subsequent travel reservations. ICE trains pass frequently bound for Hamburg, Frankfurt, Munich, and in fact all of Europe's interconnected system. Germany has even considered banning domestic air travel to support its rail infrastructure, and crazy as it sounds, it may be politically feasible given that intercity trips have been made so short thanks to high speed rail!

In March 1994, the Federal Government will decide on a "Transrapid" link between Berlin and Hamburg. Transrapid is a floating train system (mag-lev) with no rail contact. This system will allow travel from Berlin to Hamburg (290 km/180 miles) in less than one hour, with the train reaching a maximum speed of 450 km per hour (280 miles/hour). The expected date of completion is 2004.[R#14]

Once on the street after leaving the central downtown train station, a visitor is immediately struck by Hannover's transportation. Bike lanes abound and are delineated from pedestrian sidewalks by a different color pavement. Countless bicyclists swoosh by on utilitarian three speed bikes, ringing their bells to warn pedestrians. Intersections are made complex because often light rail, vehicle, bicycle, and pedestrian traffic has to be coordinated. Incidentally, whenever a light rail train approaches an intersection, it is given priority through complex computer-controlled switching system.

Hannover has a great deal of available public transportation including a comprehensive light rail system. The system radiates out from the City Center running underground in the City (to serve the vibrant downtown shopping core) and at ground level in residential areas. Thus on weekdays 45% of trips are made by car, 22% by public transport, 15% by bicycle, and 18% on foot, a modal split that raises the envy of other European and American cities, but that Hannover considers moving in the right direction.[R#7]

Hannover is currently preparing a new transport development plan thanks to the efforts of its Transportation Commission made up of representatives from planning authorities and traffic policy groups. The primary goal of the Commission is to change the modal split and in particular to decrease the automobile share from 45% to 30%. The Commission plans to reduce the use of cars by reducing the number of downtown parking lots while increasing parking fees, permitting parking in residential areas only for residents, and by reducing speed limits. Other goals include expanding the light rail system along with improved schedules and service, giving public transportation additional priority at traffic lights, and installing more park-and-ride as well as bike-and-ride stations. The Commission also plans to increase the number of bike paths and pedestrian walkways. In order to achieve these goals it is believed that changes in federal legislation are necessary including an increase in fuel taxes, federal subsidies for public transportation, and tax benefits for using public transport while eliminating tax benefits for auto commuters.[R#7]

At present Hannover has a fairly extensive bike path network which is very popular and used by people of all ages. Visitors to the City are provided with transit maps that include details on the rail system and which highlight the maze of dedicated bike paths. Bikes have special traffic lights – which look like miniature automobile traffic signals – and even commuters who live outside the ☞

core find it possible to commute 5-10 kilometers (3-6 miles) on bikes while crossing no more than a handful of roads. Hannover is a "bicycle friendly" city and this is highlighted by a preponderance of bikes everywhere.

Incidentally, the Green Party has objected to the use of dedicated bike lanes which run parallel to pedestrian sidewalks. Instead, the Greens believe that bikes should be in the streets and that as such bicyclists would serve as additional and numerous traffic calming measures! Naturally, this view is not universally shared. (See Profile #80, Copenhagen, for an interesting compromise to this debate)

SUPPLY-SIDE EFFICIENCY

In addition to the demand-side energy efficiency initiatives that make up the bulk of this profile and which are discussed at length in the next section, Stadtwerke Hannover has been a leading European utility in terms of supply-side efficiency. Perhaps the following illustration of the utility's relatively new combined heat and power (CHP) power plant will provide an insight into Hannover's commitment to wise and responsible energy use. Note that complex negotiations with industries that would share the plant's thermal outputs were going on at the same time complex environmental studies and citizen involvement were occurring.

The typical U.S. power plant is 30-35% efficient and has one output: electricity. Hannover's new plant has five basic outputs and one saleable by-product, making its overall efficiency approach 90%. Of course the plant generates electricity (1) and provides district heating (2) for downtown Hannover. The plant also sells hot water to the Volkswagen van factory across the street (3), and high and low pressure steam (4&5) to a Continental Tire factory adjacent to the plant on the other side. The particulates collected from the plant's electrostatic precipitators which include the sulfur that comes out of the plant's flue gas desulfurization units have been used as cement (6) for the chunnel. By moistening the particulates and then drying them, the resulting product is much like cement and is currently being used to fill in a mine hole on a mountainside in an attempt to restore the mountain to its original appearance.[R#14]

One of the most difficult aspects of siting the plant was of course neighborhood concerns about the plant's impact on the community. The plant was to be built on a former automotive raceway that had been used by Continental Tire to test their tires. While directly adjacent to the plant site are industrial concerns, the tire company and the Volkswagen plant, there are neighborhoods within a few hundred yards of the area site that could have been impacted.

Note that Volkswagen had been generating its own power and thermal energy with a self-contained oil generator; Continental had a coal-fired facility. It was because of new federal government regulations that the two industries had to abandon their existing burners and find a new solution, paving the way for a complex arrangement with the utility. The resulting plant is now 75% owned by the utility, 15% owned by Volkswagen, and the remaining 10% is owned by Continental Tire.

Stadtwerke Hannover took several precautions to address local concerns. First and foremost, emissions from the plant were addressed. The utility researched a host of technologies for the plant, considering fuel efficiency and emissions, and ran extensive scenarios of local impacts by dividing up the vicinity of the plant into geographic blocks and modelling the emissions in each block based on regional weather patterns and plant emissions. The study showed that the plant was so clean that it could actually lower its stack from 100 meters (109 yards) to 79 meters (86 yards), but the utility elected to pay the additional cost of extending the stack above the required level and left the stack at the initially designed 100 meter level.

The issue of coal by rail was also addressed as citizens were concerned about additional rail traffic in their community. The utility agreed to barge in the coal, though more expensive and not possible in the winter when the barge canal freezes over. While it's hard to make a power plant pretty, the Stadtwerke invested more than $1 million to clad the plant's exterior in an aesthetically-pleasing way and to make it as attractive and unobtrusive as possible. Of course nothing could be done about the massive parabolic cooling tower, but at least its steam would only be given off during the summer when the plant's excess thermal energy wasn't required for district heating.

RENEWABLES

Stadtwerke Hannover's renewable programs focus on wind, solar, and hydroelectric power. Hannover has only one hydroelectric plant (700 kW) which is rather unique in that it was first operational in 1922 and was modernized in 1983 and 1984. The interior of the plant was totally renovated at that time and the exterior of the plant was left in with its original appearance and is pleasantly integrated into Hannover's green spaces.

Despite the fact that Hannover is 160 km (100 miles) from the nearest coast it has erected a wind turbine with a capacity of 280 kW. It is to the east of the City and was installed at a cost of $0.73 million. Local concerns were raised about visual degradation and noise pollution. Its final site was also moved to address concerns about noise levels close to a planned residential development. The forest service objected to the proposed siting of the turbine, on a gently rolling hill, because it had planned to reforest the site for recreation. In an unusual order, the utility was required by the City to invest $41,600 (70,000 DM) in apple trees as an environmental tradeoff for the wind turbine.

Stadtwerke Hannover AG is also promoting solar energy. The utility's major photovoltaic demonstration project is located at the Fair Grounds and generates electricity for use by the utility and also can provide power to electric cars. Because of space constraints the utility has experimented with building solar installations upward, stacking arrays vertically, and placing them on rooftops and south facing building facades. The utility's demonstration installation is 45 meters (49 yards) high and has a capacity of 15 kW. In addition to the large demonstration projects there are 14 other customer-owned PV installations in the utility's service area producing a total PV capacity of 43.73 kW.

WATER EFFICIENCY

In Hannover the average person uses 140 liters (37 gallons) of water per day. About half of this water is used for laundry, toilet flushing, and watering gardens and lawns. For these uses the water does not need to be of drinking quality and the utility informs interested customers about the use of self-drilled groundwater or rain water for these tasks in an attempt to conserve municipal water supplies. Although there is no shortage of quality groundwater in the Hannover region, consumers are interested in conserving water for both environmental and economic reasons. Self-drilled wells for watering lawns also save money as water prices are relatively high in most large German cities. In Hannover, 1 cubic meter of water costs $1.44 (2.42 DM plus 7% sales tax) plus $1.71/cubic meter (2.89 DM) for sewage fees. Metering charges are $2.97 (5 DM) monthly in a flat (apartment) and $11.89 (20 DM) in a typical home.[R#14]

A study of water consumption in 106 residential households was completed by the utility with the help of the Technical University of Hannover. This study found that water consumption could be reduced by at least 10% but there are major obstacles to residential water conservation. The main obstacle identified is that water consumption is typically not metered on an apartment by apartment basis, but rather is measured on a building wide basis, which decreases the incentive for tenants to conserve water. Therefore, at the request of the landlord, Stadtwerke Hannover will install meters in all individual apartments. There is an increasing demand for this service. Typically the water savings do not equal the additional metering costs but landlords are interested in the service out of fairness to tenants and the desire to reduce tenant complaints.[R#5]

The utility has been promoting water efficiency in a number of ways including awareness-building pamphlets that have Tina Turner on the cover! The utility also sponsored an extremely effective demonstration and display of water-conserving technologies at Hannover's old City Hall in the summer of 1993. Also in the utility's conservation storefront, both energy and water intensity are tracked for an array of appliances for consumers' information and advice on which appliance brands and models to purchase. ■

CONCEPT 2000

In January 1988, Stadtwerke Hannover AG adopted several goals for the remaining 12 years of the century under a plan called Concept 2000. The goals of Concept 2000 sought to address the rapidly-changing world of the utility industry. Its goals are: to protect the environment; to serve the utility's customers safely, reliably, and economically; to serve municipal goals; to achieve goals from national and international energy policies; and to keep secure the jobs of utility employees. While similar in some respects to the Hannover Energy Plan, Concept 2000 was designed first. Concept 2000 was motivated by the utility desire to contribute to a sustainable future as well as an attempt to appease local environmental groups.

Stadtwerke Hannover found itself facing challenges similar to those of many utilities throughout the world. Broadly put, utilities were forced to address the shift from assuming continued industrial growth and a corresponding continued increase in energy supply, to the present situation where government environmental and social policies have a profound impact on utility planning. This shift in attitude was due in large part to the oil crises of the 1970s. In addition, changing public attitudes as well as the new policies of the federal and local governments forced a rethinking of the utility's traditional policy. Thus the utility was forced to design a new type of long-term plan with the result being Concept 2000. The utility sees the challenge of Concept 2000 to lie in reconciling the environmental and social goals of the Concept with the economic realities of running a business.[R#5,6]

Thus Concept 2000 along with the Federal Government's goal of reducing CO2 emissions by 25% by the year 2005 can be seen as the primary drivers for energy and environmental initiatives in Hannover. As a result of Concept 2000 Stadtwerke Hannover AG has implemented numerous DSM projects (known collectively as the "5E Program") including: free furnace efficiency analysis for residential and commercial buildings; a survey of insulation and furnace system efficiency; a survey of customer attitudes; demonstration programs, including residential retrofits; free appliance energy use measuring equipment for customers; an energy-efficiency information center; architecture contests; heating maps; and renewable energy programs. Stadtwerke Hannover has provided about $640,000 annually for pilot programs and several million dollars annually for full-scale programs. The initial focus of the DSM programs has been on space heating because of the tremendous saving potential.[R#14]

RESIDENTIAL ANALYSIS

In 1990 the Stadtwerke Hannover completed a comprehensive study of the energy saving and CO2 reducing potential in the residential sector. There are approximately 75,000 residential buildings in the utility's service area and the residential sector consumes 28% of total end-use energy and is responsible for 25% of CO2 emissions. Space heating accounts for about 80% of the energy consumed in this sector. This study found that improvement of insulation is far more beneficial than the modernization of heating systems with regard to maximizing energy savings. The utility estimated that 95% of the projected number of residential dwellings that will be needed for housing by the year 2005 already exist today, providing a strong impetus for retrofits and its focus on retrofits for residential energy savings.

Over 90% of all buildings and residential dwellings in Hannover were constructed with insufficient heat insulation before the first German Building Code was implemented in 1978. Almost half of these dwellings were built during the 1950s and 1960s. (Note that only 10% of buildings in Hannover remained after World War 2 and thus much rebuilding was done shortly after the War. Because of its industrial prowess and importance to Germany, Hannover was especially hard hit during the War.) The average heat requirement of buildings constructed prior to 1970 is about three times as much for those constructed after 1978, the time of the first national building code. It is also estimated that the effective heat consumption for older buildings has been reduced by about 20% to 25% due to retrofit insulation measures. This study estimates that roughly 50% of current energy demands for space heating can be saved at a cost/kWh that is lower than the estimated average cost of energy over the next 25 years.[R#11]

DSM PROGRAMS

Energy Advisory Services: One of the core services offered by the utility is what Europeans call "energy advising." While akin to energy audits performed in North America, energy advising coupled with relatively high Eu-

ropean energy prices, has been the core of European DSM initiatives. Stadtwerke has 8 staff that go to homes when requested providing advise directly to customers on their opportunities for efficiency, what financial rewards they can receive through bill savings, and just how to begin and complete an energy efficiency retrofit.

Electric Meter Loans: In addition, Stadtwerke Hannover AG loans customers electric meters free of charge which measure the electricity consumption of individual appliances. By providing this service the utility hopes that customers will replace old, inefficient appliances.

The Downtown Energy Efficiency Storefront: The utility also runs an impressive downtown energy efficiency storefront where customers can receive objective product information on more than 18,000 household appliances. When a customer visits the showroom, an expert works with the customer by accessing the computer database to determine the monthly energy and bill savings possible through the customer's purchase of an efficient appliance. Note that this center has capabilities similar to those being promoted by the Washington State Energy Office's MotorMaster software (see Profile #45), but is tailored to the regional market and provides hands-on customer assistance.[R#5,11]

Customers' Efficiency Challenge: Customers of Stadtwerke Hannover that cut their annual energy consumption by 10% or more receive a year end bonus of $48 (75 DM). The top 20 winners in terms of energy use reductions are entitled to $320 (500 DM) worth of electricity at no charge. A similar award program for success with energy efficiency has been run in Kiel, Munich, and Saarbrucken.

Pilot Residential Retrofit Program: In the new residential sector the utility implemented a demonstration program called Low-Energy Houses. This program provided funds for 40 to 50 private residences in approximately 15 buildings to provide technical advice during the planning and construction phases. The goal of this program is to reduce heat energy consumption by 50% to 70% compared to the German Building Code.

New Residential Construction Brochure: The utility has also published a low-energy building information brochure which has been distributed throughout Germany for the benefit of prospective home builders/owners. So far nearly 100,000 booklets have been distributed. A similar guide is planned for retrofits of existing homes.

Pilot Compact Fluorescent Lamp Rebate Program: Langenhagen, a neighboring town of Hannover, distributed more than 4,000 compact fluorescents at no charge as part of a community-financed climate protection campaign. Customers purchasing one bulb received another for free. In anticipation of its own pilot programs, Stadtwerke Hannover paid for an evaluation of this program. The evaluation calculated a cost of saved energy for the program of approximately 4 ¢/kWh.[R#14]

Design Competition: Stadtwerke Hannover also conducted a design competition for an energy-efficient commercial building open to architecture students. The competition cost the utility $60,000 (100,000 DM) and had mixed results.

THERMIE Program: Stadtwerke Hannover has just begun this program following approval by the European Community. This project is being done in cooperation with the City of Utrecht which will be performing a parallel project. Stadtwerke Hannover will retrofit 30 multi-family homes (with 10 apartments each on average), and the total project cost for both cities is expected to reach $850,000. Retrofits will include insulation of the building envelope, improvements to room and water heating systems (including connection to local or district heat from combined heat and power plants), and use of renewable energy sources (especially solar water heating). All feasible energy conservation measures will be installed. Another goal of this program is to share the results with as many cities and utilities as possible.[R#20]

Stadtwerke Hannover currently does not offer DSM programs for industrial customers. In general, it is rare for any German utilities to run industrial DSM programs, with only the very largest utilities providing advice to industrial customers. The sentiment among most industrial customers is that they already possess the necessary engineering expertise and the utilities should simply focus on providing cheap and reliable power. For commercial customers, Stadtwerke Hannover offers energy conservation advice to customers on request or when utility/customer contract meetings take place, although this service is not often used. Recently the utility began offering audits for bakeries and restaurants as well as lighting audits for other select customers.[R#14] ☞

DISTRICT HEATING SYSTEM

For many years Hannover, like other European cities, has been promoting conversions from individual building heating systems to hook-ups to the City's district heating system. District heating systems in Hannover began in 1962. By 1987, 9% of all households in Hannover were hooked up to the district heating system. Gas predominated residential space heating with 67% of the households, followed by oil (15%), electricity (5%) and coal (4%). Since distric heating was promoted and continues to be promoted in the urban core, virtually all of new construction, which is now occuring outside of the core, is heated with gas. Nevertheless, by 1990, 17,000 households in Hannover, or just over 15% of the total residential stock, were hooked up to the district heating system. (For a similar but compulsory hookup program, see Profile #80 of Copenhagen, Denmark's new district heating system.)[R#23]

In the early 1980s the utility compiled a database or what it calls a "Heating Map" of 16,000 buildings. The database includes information on the type of heating system and the heat load for each building. The 16,000 buildings were targeted as being potentially suitable for addition to the extensive existing district heating system. This "heating map," which provides the utility with a strategy for promoting conversions, is still being expanded and utilized today.[R#5]

LEAST-COST PLANNING: HANNOVER CASE STUDY

The Hannover Least-Cost Planning Case Study (LCP-HAN) is a research project that will support the Hannover Energy Plan. This pilot project will run from October 1992 through December 1994 and be implemented by the Stadtwerke Hannover AG. It will research the demand of electric energy in all sectors in Hannover and the results will be used to help implement the Hannover Energy Plan in the best manner possible. By using least-cost planning methods the utility hopes to achieve an economic and ecological optimization for the provision of energy supplies. Because least-cost planning has primarily been used in the United States and Canada, Stadtwerke Hannover is anxious to see how this principle can be transferable to Germany.[R#7]

This study will cost an estimated $3.3 million and is receiving the financial support of the Federal Ministry of the Environment, the SAVE Program of the European Commission, and the Ministry for Economic Affairs of the State of Lower Saxony. The project is being designed by the Öko Institute (Freiburg, Germany) along with the Wuppertal Institute for Climate, Environment, and Energy located in Wuppertal, Germany.[R#8,9]

The ultimate objective of the research project is to put the Stadtwerke Hannover in a position to assess in detail the suitability of least-cost planning for long-term corporate planning, and should the assessment prove positive, to implement it with comprehensive DSM programs. Another goal is to develop proposals to the regulators at the EC, federal, and state levels.[R#9,13]

Specifically, the study will be used to help Stadtwerke Hannover AG with long-range planning, hopefully integrating the economic and ecological goals of the Hannover Energy Plan into annual company plans. Other goals include: discovering profitable energy conservation activities and thus shifting the utility's orientation towards energy services; examination of the viability of DSM; and assessing the transferability of American least-cost-planning to Germany.[R#7]

Actual DSM pilot projects will receive special emphasis. These projects are referred to as P1-P6. In addition to pilot programs, the project will: develop a systematical integration of all options to reduce energy demand and energy-related emissions of pollutants and greenhouse gases; develop a range of DSM programs for all sectors along with evaluation techniques; address legal and other institutional barriers to DSM; evaluate economic potential of DSM to Stadtwerke Hannover AG; and develop a comprehensive least cost plan.

Of the six pilot projects only one focuses on the residential sector (P6) due to the fact that the residential sector accounts for approximately 25% of Hannoverian electricity demand and the average electricity consumption for Hannover households is well below the national average. The other five pilot projects focus on the following sectors: public institutions (P1), office buildings (P2), small- and medium sized enterprises (P3A, P3B, P4), and industry (P5). The projects center on improvements in lighting, heating, drying, cooling, motors for heating, HVAC, and energy control systems.[R#9]

The residential pilot provides $30 (50 DM) to each customer purchasing an energy-efficient refrigerator or freezer. The rebate program is limited to 8,000 participants

LCP Costs Overview	*External Costs (x 1000)*	*Internal Personnel Costs (x 1000)*	*Total (x 1000)*	*External Funding (x 1000)*
LCP - HAN (core project)	$580	$1,280	$1,860	$580
P1 - P5 (pilots)	$380	$320	$700	$60
P6 (res pilot)	$320	$190	$510	$0
LCP-D (info sharing)	$190	$60	$250	$250
Total	$1,470	$1,850	$3,320	$900

and began in August 1993. This particular pilot is estimated to cost the utility $510,000.[R#9]

The interest in least-cost planning was motivated by several factors. In the year 2000, the contract under which the utility purchases 25% of its power runs out. In addition an inner-city cogeneration plant needs replacement. Even with an emphasis on energy conservation, several studies predict an increase in power demand in Hannover. This increase in recent years has been due in part to German reunification and an influx of immigrants to the greater Hannover area and will likely continue with EXPO 2000.[R#9]

This growing demand is met with a strong opposition to new power plants by the people of Hannover. In addition, for political and economic reasons, increasing purchased power imports is discouraged as there is a sense that by buying power from outside the community Hannover is exporting its pollution, a situation that is regarded as unworkable over time. Also, 60% to 70% of purchased power comes from nuclear sources. The outcome of least-cost planning, or what is now called integrated resource planning in North America, is seen as a possible working set of solutions to these impending challenges.[R#9]

INTERIM REPORT

In August 1993, an Interim Report on LCP-HAN was published by the Öko-Institut. This report discusses the progress of the project for the period from September 1992 through July 1993. The report estimates total project costs at $3.3 million with 55% of these costs going towards internal personnel costs for planning and implementation. Of these costs, $2.42 million is provided by the utility and the remaining $900,000 comes from external sources.[R#13]

The one pilot program for the residential sector (P6) was scheduled to run from August 1, 1993 to December 31, 1993, continuing beyond that date if funds remain. In order to receive the $30 (50 DM) incentive (rebate), a customer must purchase a refrigerator or freezer which improves upon certain energy consumption values and/or which are free of chlorofluorocarbons (CFCs). The energy consumption values are set such that no more than 10% of all models on the market are promoted, effectively shifting consumer purchasing patterns to higher efficiency levels. The interim report predicts that this pilot will save 8,000 MWh over the next 12.5 years. [R#13]

With the non-residential pilots (P1-P5), the utility contacted potential customers about participating in the program. Final selection of projects was based on high savings potential and customer willingness to invest in energy conservation. To date the utility has selected the following retrofit projects: a school (P1), an insurance building (P2), a metal working firm (P3A), a metal surface refinement company (P3B), a supermarket (P4), and a baking condiments manufacturer (P5). So far a general analysis of the energy consumption along with recommended conservation measures has been performed for all of these projects. The follow-up final analyses are nearing completion. The utility hopes to have the energy-saving performance contracts signed by the customers in the spring of 1994.[R#13,14] ■

LESSONS LEARNED

Perhaps the primary lesson learned in Hannover is that a broad integrated approach to energy efficiency has been a key to the City's success. Like other exemplary European municipal case studies of energy efficiency (see Profiles 76,78,79,80), Hannover's approach includes supply-side efficiency, district heating, transportation efficiency, water efficiency, renewables, as well as a focus on more conventional demand-side management. By taking a more comprehensive approach to total energy use, and total resulting emissions, Hannover has become a European and even international leader with energy efficiency.

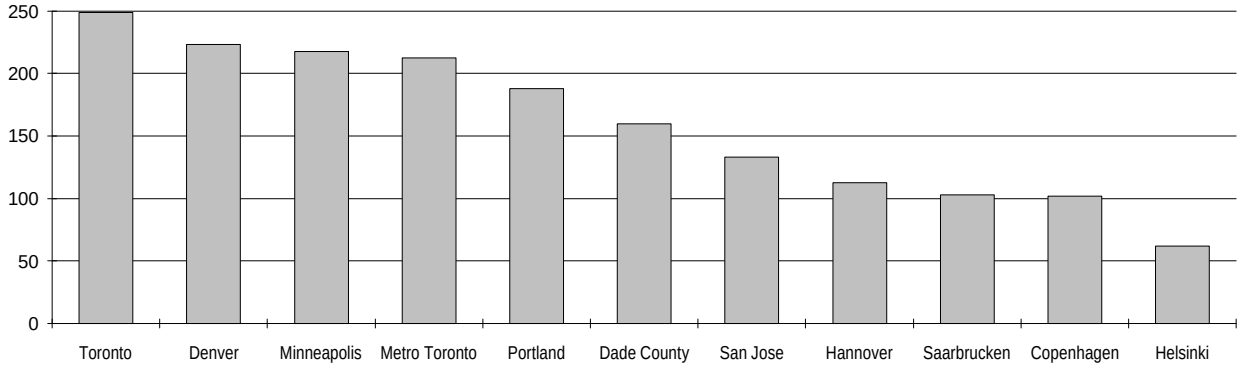
Two key forces make it difficult for Hannover to reach its commitments to reduced energy use. First, is an already quite efficient community. Compared to North American cities, Hannover's per capita energy consumption is about half. See accompanying table and chart expressed in gigajoules per capita for relative values.[R#22] The second related factor is energy prices. While Hannover's average prices are high by North American standards, energy efficiency advocates in Hannover see low prices as a fundamental barrier to moving customers to invest in efficiency.

Bernd Hagenberg reports that low energy prices mean that there is little financial motivation for customers to conserve energy. In fact, Hannover officials believe that their prices serve as disincentives to efficiency. This comment begs consideration of price elasticities related to energy prices and consumer consumption patterns. A key lesson learned herein is that even European prices are not necessarily sufficient to spur significant energy efficiency improvements.

Another lesson learned in Hannover is that politics can bog down a municipal utility's efforts with efficiency. Municipal utilities that are customer-owned theoretically ought to be able to save their customers money without concerns about lost revenues. But because Stadtwerke Hannover AG is a municipal utility that has provided funds to the City's general fund, there is a lack of funding for major energy conservation investments. Just as the North American experiences show, consumers and politicians are still focused and even entrenched on power rates, not bills. Thus while the municipal utility has a mandate to serve its customers in the least-cost, reliable, and responsible way, its short term expenditures, specifically related to energy efficiency, are scrutinized and challenged whenever they threaten to increase rates at all.

Another key lesson learned in Hannover is that even in a high-tech, industrial German city which is known for its environmental policies and actions, there is still a relatively low level of knowledge concerning energy conservation among architects and craftsmen. The utility's guide for residential new construction has become a product that has swept across Germany,... underscoring this lack of knowledge and the opportunity for utilities to work with the design community to prevent future lost opportunities. (The utility has also provided a great deal of con-

END-USE ENERGY (GJ PER CAPITA)



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**
Saarbrucken	102.81
Copenhagen	101.97
Helsinki	61.96
Total/Avg.	160.14
N. America Avg.	197.48
Europe Avg.	94.79

sumer education including a customer newsletter called the "Energy Information Letter.") It also has offered education to architects, craftsmen, and others on conservation measures.

A final lesson from Hannover is slightly more esoteric and is simply that the unthinkable seems to be possible! Hannover has torn up brick and mortar to rebuild green spaces, it has blocked off its downtown core to cars and created a vibrant shopping hub, it has effectively restricted automobile traffic into the City, and has been able to promote an integrated approach to wise energy management in light of municipal budget cuts. The City has proven that despite great barriers to efficiency, through clever customer awareness and program design, it is possible to aggressively promote a holistic concept of resource sustainability while paying careful attention to the sensitivities of shorter term economic criteria.

TRANSFERABILITY

Many of the projects underway in Hannover are certainly transferable within Germany and likely within the European Community, and can be transferred to North America as well. The Germans view energy efficiency as a key aspect of an environmental transition to sustainability. As such, Hannover, like a few other German utilities (see Profile #78 in particular) has begun to invest in the long term and as such is leading research and development of energy saving technologies. This long term view is commendable and can be effectively transferred, despite local barriers to long term investments in efficiency.

Many of the shorter term energy efficiency programs underway in Hannover are more easily and clearly transferable far and wide. Like other European cities, Hannover's DSM primarily is focused on information and to a lesser extent on financing. Stadtwerke Hannover has just begun to experiment with direct customer incentives such as rebates, and up till now has based its DSM work on advisory services that keep the utility's financial exposure low and effectively shift the burden of efficiency investments from the utility at large, to consumers who stand to gain. This approach to efficiency, coupled with key demonstrations, can be transferred across continents, and of course has been supported in Germany and Europe with high prices for energy services. ■

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