

## **APPENDIX 2**

### **FREIBURG SOLAR CITY**

SolarRegion Freiburg is a long term development vision that the city of Freiburg in southwest Germany has embraced since 1986, which has resulted in multiple benefits for both the environment and the local economy.

#### **Origins**

Freiburg is a city of 205,000 people that was founded 900 years ago in the wine-growing area of southwest Germany, close to the French border, the upper Rhine and the Black Forest. During World War 2, bombs destroyed 80% of the old city, but most has been rebuilt in a replica of the old historical style. In the 1970s, the region of Baden-Württemberg planned to build a nuclear power plant at Wyhl, just 30 km from Freiburg. There was a major protest, with widespread civil disobedience, and in 1975 the plans were defeated. This raised the environmental awareness of many of Freiburg's citizens, and left a hole in the region's future energy plans. During this time, Freiburg developed a reputation as Germany's "ecological capital", and a wide network of environmental organizations, businesses and research institutes were founded. In 1986, with the nuclear catastrophe at Chernobyl fresh in their minds, Freiburg's municipal council voted to adopt the guidelines for a future-oriented energy policy which would set the pattern for Freiburg to become Europe's most prominent solar city.

#### **Aims and Objectives**

Freiburg's energy policy has three pillars: energy conservation, the use of new technologies such as combined heat and power, and the use of renewable energy sources such as solar to meet new demand, instead of fossil fuels, with the goal of realizing an ecologically-oriented energy supply. Behind this, there lies a deeper goal to create sustainable regional development for the area as a whole. In 1996, this was strengthened by a city resolution to reduce Freiburg's CO<sub>2</sub> emissions to 25% below the 1992 level by 2010, which calls for initiatives in the areas of transport, waste and industrial production, as well as energy. The average Freiburg citizen produces 11 tonnes of CO<sub>2</sub> a year, three quarters of which comes from the city's use of energy.

#### **Activities**

Freiburg's solar activities attract a lot of attention, but their efforts to reduce energy consumption are also significant. There is a support program for home insulation and energy efficiency retrofits, and all new houses build on city land must meet a new low-energy efficiency design standard that uses two thirds of the legally permitted limit. The houses cost about 3% more to build, but their energy costs and CO<sub>2</sub> emissions fall by 30%.

On the solar front, Freiburg has developed numerous significant projects that use every kind of solar application - solar PV (photovoltaics - over 400 installations), solar thermal (for hot water), solar sunrooms or "wintergardens", passive solar design, solar cooling, and transparent solar insulation, which converts the solar heat which hits a wall into useable thermal energy. Freiburg is one of Germany's sunniest areas, with 1800 hours of sunshine a year, but it only receives 1,117 kWh per square meter of solar radiance, which is lower than southwest England, and about the same as most of England and western Scotland.

At a time when solar manufacturers were withdrawing from Germany, Solar-Fabrik, a solar module production plant, chose to locate in Freiburg in 1997, employing 130 people. The

entire factory is 'zero emissions', being powered by 570 square metres of PV, and a rape seed oil-fired combined heat and power plant.

Through the Forum SolarRegion Freiburg, the City council provides a solar information desk in central Freiburg. Freiburg's Central Station has installed a solar PV facade that is 19 floors tall, with 240 solar modules, and the city is full of houses whose owners have installed solar systems for electricity or hot water on their roofs. The University Hospital Cafeteria has installed a rooftop PV system that meets 10% of its energy needs; the Ganter Brewery has done likewise, as has the Lutheran Diakonie Hospital. The city's national league soccer stadium has installed a large solar PV array on its roof, many schools have created solar installations, and there is a big solar roof of 440 kW on the New Fair Grounds which host Europe's largest solar trade fair Intersolar. All of the solar energy is fed into the grid, rather than used on the spot or stored in batteries.

Within Vauban, a new ecologically designed settlement of 2000 houses that is being built on the site of an abandoned French military base, a Solar Village - Europe's most modern solar housing project - is being built at Schlierberg, with 50 solar houses that will produce more energy than they consume, designed by Rolf Disch, one of the most renowned solar architects in Europe. The brightly coloured terraced homes use only 15% of the energy that is needed by Freiburg's low-energy homes, and need additional heat for only a few weeks a year, from a wood chips biomass combined heat and power (CHP) plant.

Freiburg is also attracting solar research and development organizations. The Fraunhofer Institute for Solar Energy Systems conducts research for practical solar applications all around the world, and has developed a new system for solar refrigeration. A trades school runs a Solar Training Centre, producing the technicians and installers who are needed to service the growing activity. The International Solar Energy Society (ISES) and numerous other solar institutions have located their headquarters in Freiburg, and the city has often hosted major European solar energy conferences, attracting many delegates.

In addition to Freiburg's solar activities, mention should be made of some of the city's other environmental initiatives, since they all contribute to the quality of life which is an important sustainer of Freiburg's economic health. A cycling plan was drawn up in 1970, and the city now has over 500 km of bicycle paths, and a third of all journeys are by bicycle. There are more than 5000 bicycle parking spaces in the city, with more at tram stops for "bike and ride" commuters. The main railway station has parking and other cyclist facilities for 1,000 bicycles.

The old town centre became car-free in 1973, and in 1990, a 30 kph zones was introduced for almost all residential streets, except main roads. Freiburg introduced a low-cost flat-rate monthly "Environment ticket" for the region-wide bus service in 1991, and there has been a 100% increase in people using public transport since 1980. In the new district of Vauban, if residents sign a contract stating that they will live without a car, the requirement to buy a parking space in the district garage is waived, reducing the cost of their housing. Around 30 - 35% of the residents have chosen to live without a car. In 2004 and 2005 the city will open two major new tram lines, one from the city centre to Vauban. As a result of these initiatives, motor vehicle use fell from 38% to 32% between 1982 and 1999, in complete contrast to the trend in almost all other central European cities.

The city has an ambitious recycling programme with four separate household containers, including a bin for all kitchen and garden wastes, which are composted. As a result, Freiburg reduced its waste disposal from 140,000 tonnes a year in 1988 to 50,000 tonnes in 2000. Freiburg has also put 42% of its surrounding area under nature or countryside protection, where building is no longer permitted.

## Structure and Finance

As an economic development driver, Freiburg's solar strategy does not require any specific structure, or core funding. It is powered by the synergy created by the city's vision among many solar players working together, who gain a mutual benefit from each other's presence.

In the open market, solar PV is still too costly for most builders and developers. Under the German federal government's 2001 Renewable Energy, Law, however, energy supply companies are obliged to reimburse stored solar energy producers at a highly subsidised price. The current rate of 0.457 Euros a kilowatt hour (compared to a standard electricity rate of 0.15 - 0.20 Euros, depending on the tariff) is guaranteed for a period of 20 years. The purpose of the law is to promote a doubling of renewable energy's share in the electricity market from 5 to 10% by 2010. This makes it possible to finance a PV installation which may cost 5,000 - 8,000 Euros per kW (1 Euro = £0.70). The electricity output that can be expected in Freiburg should cover the investment costs within 15 years. Under its "100,000 Rooftops Solar Power Programme", the German government provided subsidized loans until June 2003, when the programme expired.

In addition to national support, the regional power supply company Badenova (which is jointly owned by a number of regional municipalities) offers a solar investment subsidy for customers who want to install photovoltaic panels, which helps to increase solar's economic competitiveness. The program is financed from electricity sold under the brand label regiostrom. Badenova invests all of the income from the difference between the standard rate and the slightly higher regiostrom rate into further regiostrom plants (photovoltaics, biomass and small hydropower), which has resulted in a steady increase in the generation of environmental friendly electricity. 10% of Badenova's customers have voluntarily opted for electricity from regional and renewable energy sources.

## Performance

By December 2003, the total PV capacity in Freiburg had reached 3,200 kW (3.2 MW), producing 3 million kWh per year for use in the grid. An additional 8560 square meters of solar thermal heating had been installed, and 700 square metres of solar swimming pool heating.

During the 1990s, Freiburg undertook a study to investigate the economic significance of its commitment to environmental policies. For the region as a whole, the study showed that solar energy and environmental policies have proven to be important economic development assets for Freiburg, which has never had any major industry. It also fits with Freiburg's position in a major tourist area.

By spending its energy dollars on solar and other renewable energy technologies, these dollars are also remaining within local circulation, instead of leaving the region to purchase gas, oil or uranium elsewhere. In addition to the economic and environmental benefits, Freiburg's citizens enjoy a pride in their city for showing this kind of leadership.

## Future

Solar PV and other renewables still only provide 2% of the power that Freiburg needs. The city generates 50% of its electricity from natural gas CHP plants, and the rest is imported, including 30% from nuclear. Freiburg's goal is to decrease nuclear's influence, and increase the energy from renewables to 10% by 2010. This can not be achieved by PV, so the city is

looking at obtaining more energy from biomass from Black Forest woodchips, and from wind power, which is generating a very heated debate, due to concerns that the turbines will spoil the Black Forest scenery. Six 1.8 MW turbines were erected in 2003, increasing the energy from renewables to 3.9%, but there is a court injunction against two of them. There are also plans to explore geothermal deep heat, which is very good in the Upper Rhine area around Freiburg.