

Germany Launches Its Transition

How one of the most advanced industrial nations is moving to 100 percent energy from renewable sources.

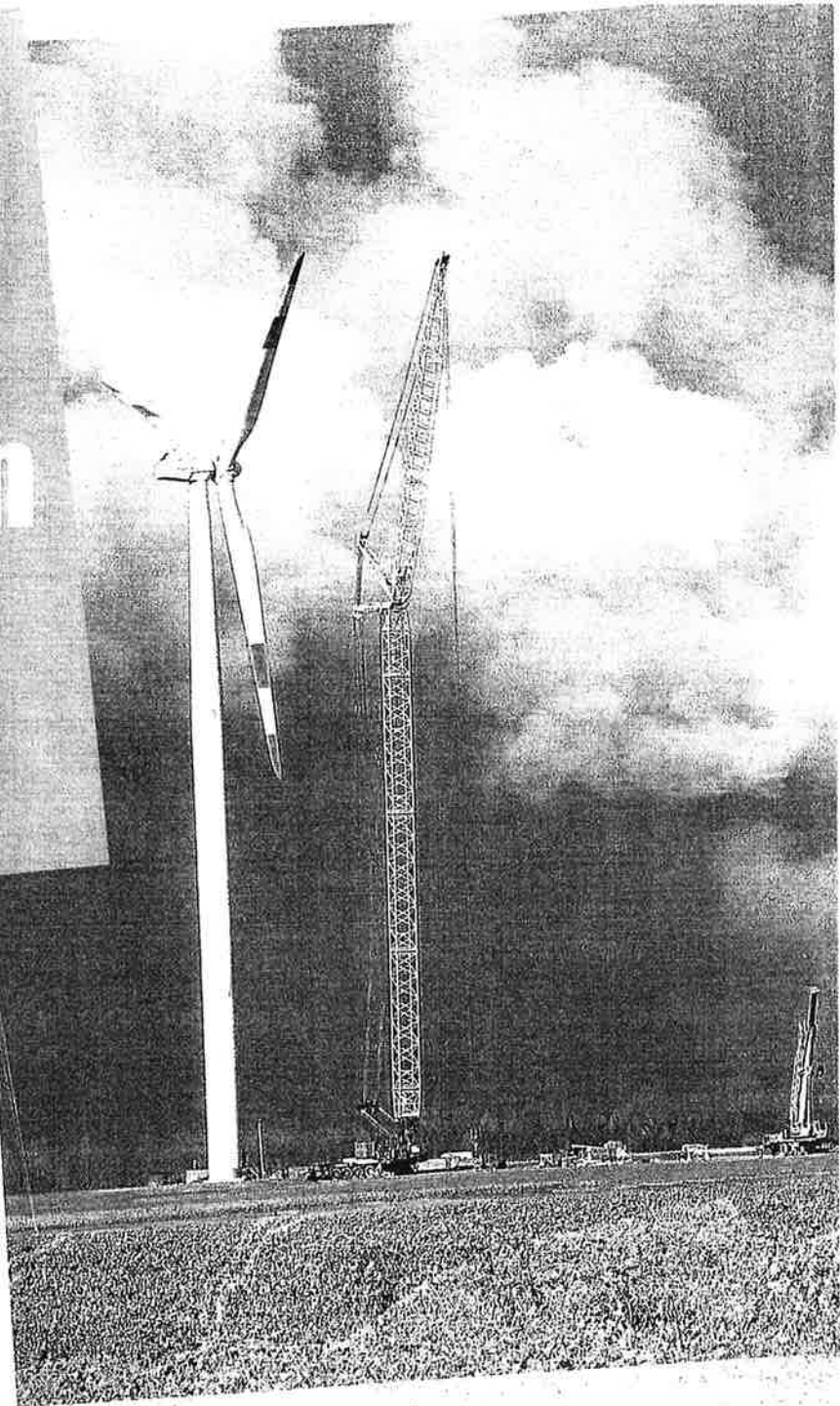
By Donald W. Arken, Ph.D.

Can renewable energy development keep pace with rising global energy demand? As world governments struggle with this question, Germany is advancing with resolve in a transition to 100 percent energy from renewable resources. The German government accepts that the goal is technically and economically possible, and has adopted a long-term national policy for the transition. After years of reliance on nuclear energy — which supplies 30 percent of the nation's electricity — Germany has concluded that nuclear is a dead-end and has established long-term plans to phase it out.

Germany's most urgent conclusion is that the period lasting until about 2020 comprises "make-or-break" years for the renewable energy transition. It is this conviction that has driven German policymakers to introduce the world's most aggressive support for renewable energy, to stick with it during the past decade and to guarantee that support for the next 20 to 30 years.

German renewable energy policy and applications to date have focused on the primary renewable energy resources, particularly wind, solar — both thermal and electric — and biomass. Brief summaries of two of the nation's most dramatic areas of accomplishment follow.

Wind Power. The first renewable energy resource to receive serious governmental attention in Germany was wind and, predictably, it started in the windiest region. Schleswig-Holstein (SH) is a strip of land located between the North Sea and the Baltic, across the border from Denmark, and is primarily populated by farmers. In 1983, one of the SH farmers connected a 55-kilowatt (kW) Vestas turbine into the Germany power



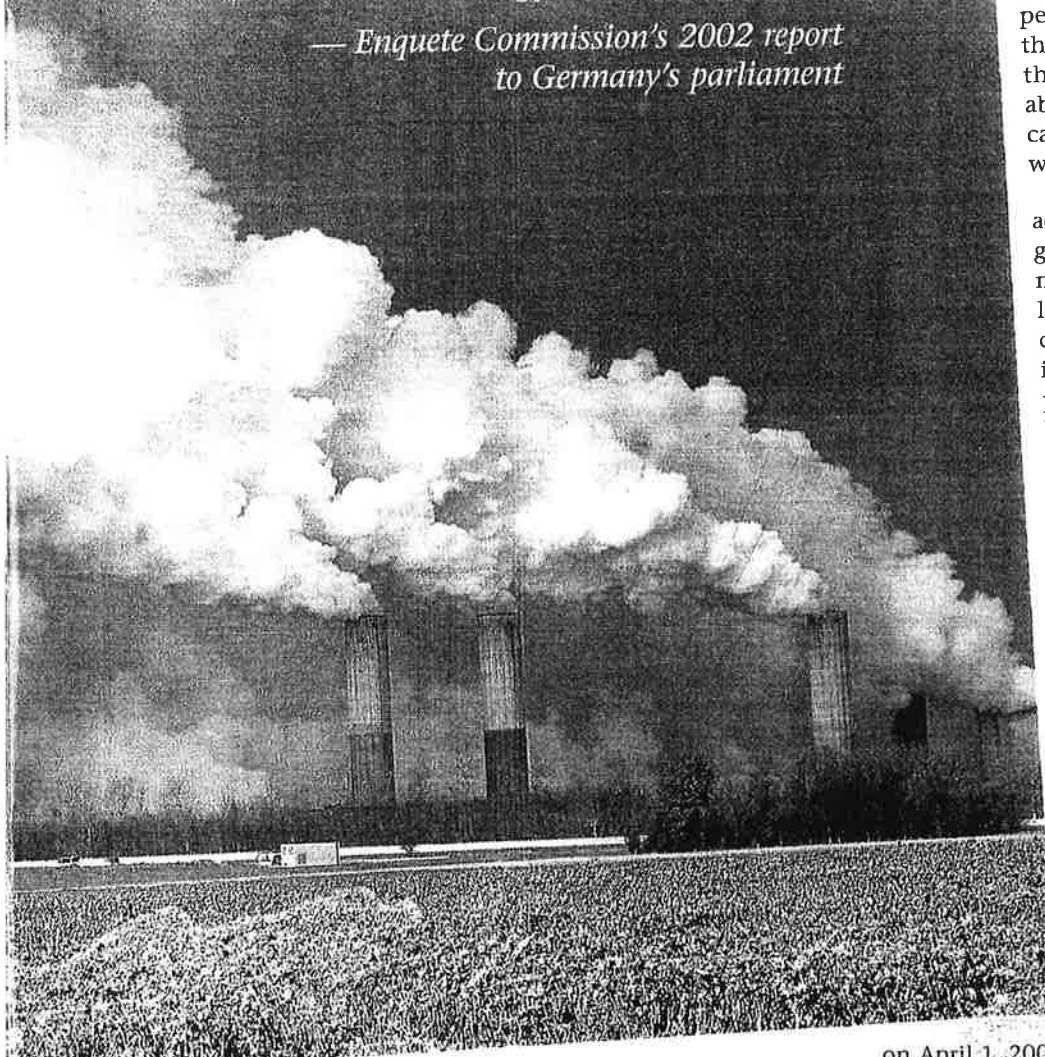
grid. By 1988, the SH regional government had established a wind turbine subsidy of up to 30 percent of the investment costs, and farmers in the region were reaping the financial rewards.

The federal government entered the wind-incentive picture in the late '80s with the "100 megawatts of wind" program, jump-starting the early German wind industry. Germany's serious national effort began with the first "feed-in law," which went into effect in 1991, requiring utilities to hook up to and purchase energy from all renewable energy providers in their areas, and to pay at least 90 percent of the retail price for the electricity purchased from wind and solar power producers. In 1996, the German government amended the Federal Building Construction Law to permit wind generators to be built in rural areas. By 1997, 2,100 megawatts (MW) of wind had been installed in Germany.

Germany made an important policy advance with the April 2000 introduction of the Renewable Energy Sources Act ("Act on

"It is possible to cover the total energy demand [for Germany] by means of solar/renewable energy sources."

— *Enquete Commission's 2002 report to Germany's parliament*



In just 10 years, Germany has transitioned to the forefront of global renewable energy applications. Here, a 1.5-megawatt NEG Micon/Vestas NM82C turbine is installed in Grevenbroich amid the billowing smoke of a lignite power plant.

COURTESY OF VESTAS WIND SYSTEMS

15,688 MW of wind installations, delivering 6.2 percent of the country's electrical energy. It was the world leader in total installations, as well as in the annual rate of installations. Germany has about 125 percent more installed wind energy capacity than either the United States or Spain, which are virtually tied for second.

Solar Power. *Photovoltaics (PV):* Germany's accomplishments in the development of solar energy for both electricity and water heating are as dramatic as those for wind, despite starting somewhat later. This achievement is especially remarkable considering that Germany's average solar potential is about 1,000 kilowatt-hours per square meter per year — about half that of the United States. Nevertheless, Germany was the fastest-growing PV market in the world in 2003, when over 20,000 new PV systems were installed, representing a capacity of 145 MW peak (MWp) and bringing the end-of-the-year total in Germany to over 400 MWp of PV installed. In 2004, Germany installed another 25,000 PV systems, totaling 300 MWp, *double the 2003 installation pace* and exceeding an annual investment of 1 billion euros (\$1.3 billion U.S.) for PV for the first time.

The PV industry in Germany was effectively spurred by the "100,000 roofs program," which from 1999 until 2003 produced 65,324 PV systems totaling 342 MW of capacity. The aim was to stimulate a new building-integrated PV (BIPV) market. The government initially stimulated this program by offering interest-free 10-year loans, waiving the last installment payment and guaranteeing a "feed in" incentive of 8.5 euro cents (11 cents U.S.) per kilowatt-hour. With the beginning of the EEG

on April 1, 2000, the PV incentive price jumped to 50.62 euro cents (66 cents U.S.) per kilowatt-hour. By the end of 2004, Germany had become the world's No. 2 PV producer and the world's No. 1 PV installer.

The amended Renewable Energy Act of 2004 assures continued activity in the German PV market. The base incentive remains 45.7 euro cents per kilowatt-hour (about 60 cents U.S. per kilowatt-hour). This incentive is *increased* to 54.0 to 57.4 euro cents (70 to 75 cents U.S.) per kilowatt-hour, depending on the size for PV systems mounted on building roofs (the upper size limit has been eliminated). The incentive is *further increased* to 59 to 62.4 euro cents (77 to 81 cents U.S.) per kilowatt-hour for PV systems integrated into building surfaces other than the roofs (e.g., walls).

Because the upper size limit for PV systems eligible to receive the incentive has been eliminated, even large ground-mounted systems are assured a revenue stream of 45.7 euro cents (59 cents U.S.) per kilowatt-hour *for 20 years plus the year of commissioning*. The law also requires grid operators to give preference to renewable energy generators, and to guarantee connection to the grid and

Granting Priority to Renewable Energy Sources," or EEG). The EEG detailed production incentive payments for each of the renewable energy technologies, spread the cost burden among all German utilities in proportion to total electricity sales by each utility, and allowed for payments to the developers to continue for 20 years plus the year of commissioning.

The EEG was most recently amended last July and extended for several more years. Under the new law, onshore wind turbines coming online in 2005 will receive not less than 8.53 euro cents (about 11 cents U.S. at mid-January exchange rates) per kilowatt-hour for the first five years (12 years for offshore development), and 5.39 euro cents (7 cents U.S.) per kilowatt-hour after that, *for 20 years plus the year of commissioning*. Special incentives are intended to redress reduced power production (hence, revenue) in the lower wind regimes.

Germany's accomplishments since 1990 have been astonishing. By the end of September (the most recent figures available at the time of the writing of this article), Germany had

transmission systems, even if that means upgrading their transmission facilities to serve a new renewable energy system. They can recover their costs in the fees they charge for use of their facilities.

Solar Thermal Water Heating: Germany also leads Europe in both total and annual installations of solar thermal collectors for water heating. Interest in solar water heating was boosted by the increase of the subsidy, effective Feb. 1, 2003, from 92 to 125 euros (\$120 to \$163) per square meter of collector area. By 2003, the solar heating market in Germany was 10 times greater than it had been in 1991. The 2003 sales alone totaled about 600 million euros. In 2004, 740,000 more square meters were added, about 80 percent of them for domestic water heating and 20 percent for space heating. The 518 thermal megawatts rated output of the 2004 additions alone shows that solar water heating is a major contributor to the reduction of carbon dioxide emissions.

In order to keep this important solar sector expanding and encourage applications on apartment buildings, the German government is developing a Renewable Heating Act. Whereas the EEG raised money for PV by spreading the costs proportionately over all utility districts, the Renewable Heating Act would raise money with a country-wide tax on oil and gas used in the heating sector, using this revenue to provide an incentive payment per kilowatt-hour of heat generated by solar thermal systems.

Long-Term Commitment Drives Results

Many factors contributed to the rapid rise of Germany's renewable energy industries and applications, but seven were vital:

Enlightened politicians, in particular the alliance of the Social Democrat Party and the Green Party, and the leadership



PHOTO BY STAHL & WEISS, FREIBURG

This building, one of an identical pair of apartment buildings in Freiburg, demonstrates the increasing integration of solar photovoltaic and solar domestic water-heating systems into "low-energy" building architecture. Each features a 27-kilowatt peak photovoltaic array on the south wall, providing 13 percent of electricity needs, and a 310-square-meter rooftop solar water-heating system that provides 28 percent of the demand for 600 occupants.

of Parliamentarian Hermann Scheer.

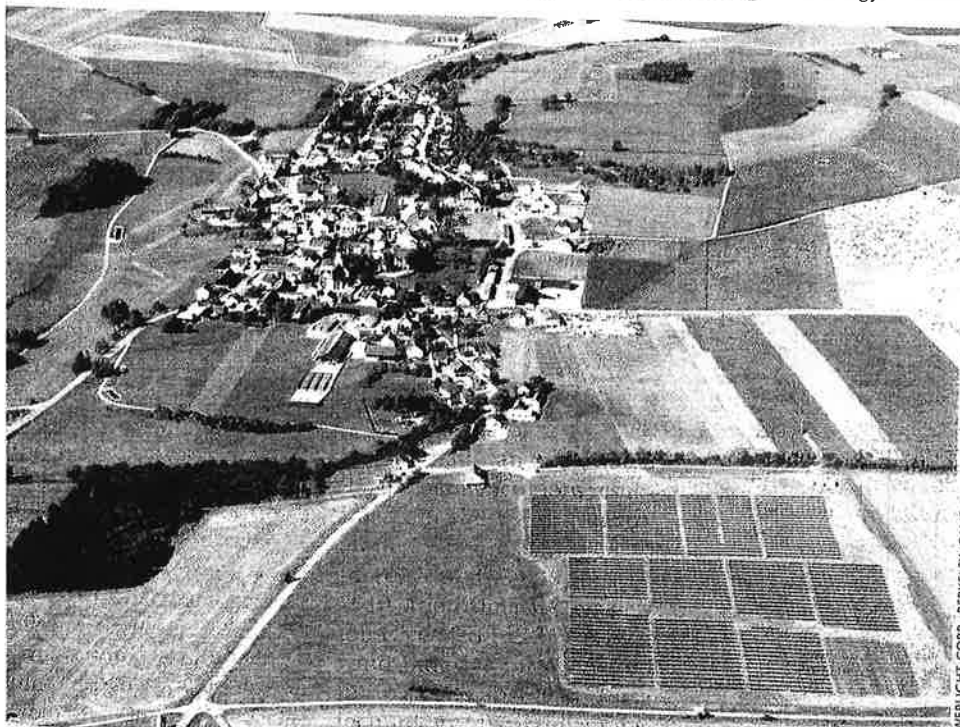
Federal government leadership, through the adoption, in 2002, of a national strategy for sustainable development, and through the government's consistent, long-range support for energy-efficiency and renewable energy sources.

Involved citizens who, mostly working through cooperatives, own 90 percent of the wind turbines, as well as most of the PV systems.

Scientific analysis used as the basis for developing governmental policy. The German parliament formed the Enquete Commission in February 2000 "to furnish scientific evidence to be used as a basis for the German Bundestag's future decision-making in the field of energy policy." In its 2002 report to the parliament, the commission concluded, "It is possible to cover the total energy demand [for Germany] by means of solar/renewable energy sources." Subsequent German governmental policy is based on this premise.

The government's energy-efficiency policies: On April 1, 1999, the federal government implemented the first step in "environmental tax reform," by which it increased the taxes on oil, gas and electricity. Further increases occurred each year through 2003. The estimate is that these taxes, which have yielded tens of billions of euros, produced 100,000 new jobs in new energy-efficiency-related industries, while contributing to Germany's commitment to reducing greenhouse gases.

The government's ethical commitment to the future and the world. Germany has demon-



POWERLIGHT CORP., BERKELEY, CALIF

Solarpark Günching, 1.9 megawatts of the three neighboring ground-mounted "Bavaria SolarPark" systems, which together total 10 megawatts. Energized in December 2004, this PV system is the world's largest.

stated this commitment by agreeing to raise its goal for reducing greenhouse gas emissions from the Kyoto Accord's requirement of 21 percent by 2008–2012 to 25 percent by 2005 (Germany is a Kyoto signatory), and by adopting the Enquete Commission's conclusion that "The global energy supply system must be designed in such a way that they will no longer generate any highly radioactive waste in the future."

The government's long-term commitment. The German government has established firm goals for renewable energy growth and carbon dioxide abatement for 2010 and 2020. The policy horizon extends to 2030, when nuclear power is to have been fully phased out, and then to 2050, when a dominant share of Germany's energy will be produced by renewable energy sources. In other words, Germany's goals extend sufficiently long to assure Germany's renewable energy transition.

The figure on this page is an example of the many scenarios Germany has commissioned by scientific organizations to serve as input in the development of federal governmental policy. The table represents fairly accurately the present government policy to 2050. It shows that in order to realize a goal of 45 percent penetration of renewable energy into Germany's total primary energy mix by 2050, energy productivity must also improve by a significant factor, so that total energy use in 2050 will need to be about 37 percent less than it is today.

Ten Years On, New Jobs and Revenues Mount

By the end of 2003, Germany had an estimated 45,400 permanent jobs resulting from the wind industry alone, a figure expected to increase to 103,000 jobs by 2010. Approximately one new job is created in the German wind industry for every 300 kW capacity installed, for a technology that contributes 6.2 percent of the nation's demand for electric energy. In contrast, the German nuclear

industry, which supplies about 30 percent of the nation's electricity, employs 38,000 people. The German wind industry therefore produces about 10 times as many jobs per unit of installed capacity as does the German nuclear industry, and more than 20 times the jobs in terms of delivered electrical energy.

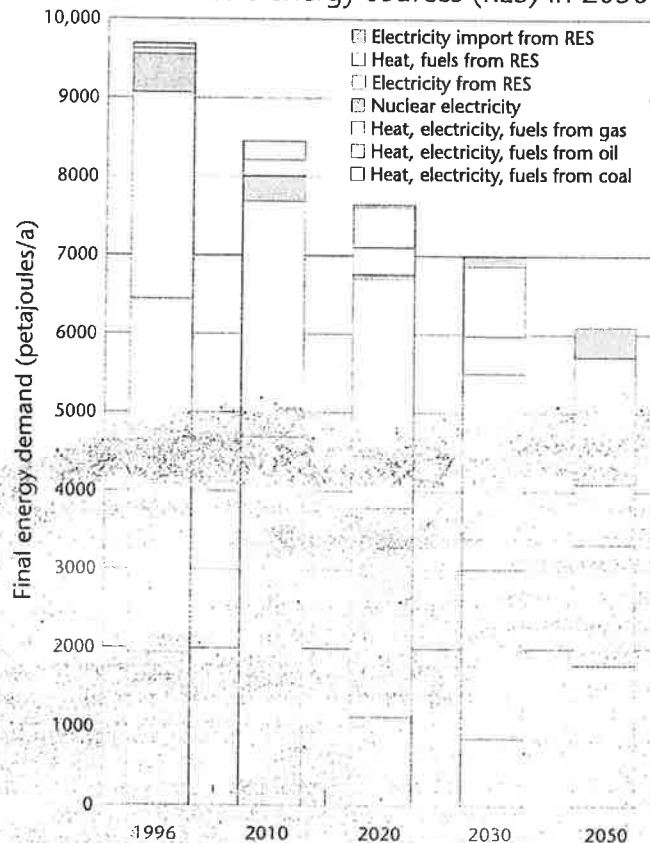
That is not the whole story. About 30,000 people are employed in the combined PV and solar thermal industries in Germany, with 12,000 of these jobs in or related to PV industries and installers. The German solar energy industries added 5,000 new jobs in 2004. That brings total employment in Germany's renewable energy industries to over 75,000 jobs. Total solar sales grew by 60 percent in 2004, to more than 2 billion euros (about \$2.6 billion U.S.).

Starting from almost no renewable energy applications, Germany has moved to the forefront of global renewable energy applications in just 10 years. Governments need no longer doubt if it is possible. If policymakers can stay the course toward their year 2050 goals and beyond, Germany will have assured its renewable energy transition. Other governments would do well to follow suit, by recasting their national energy policies to capitalize on nature's renewable bounty. ●

Donald Aitken, the grandson of a German passenger liner captain (his parents met on shipboard), spent his first year of graduate study in theoretical physics in Germany, where he became fluent in the language. He has returned many times, especially during his eight years on the board of the Germany-based International Solar Energy Society. In 2002, the U.S. State Department sent Aitken and his partner/wife Barbara Harwood to Germany to be the United States' Earth Day speakers in eight cities. He can be reached at donaldaitken@earthlink.net, or access www.donaldaitkenassociates.com.

Germany's policy horizon extends to 2050, sufficiently long to assure the nation's renewable energy transition.

Projections to 45 percent energy from renewable energy sources (RES) in 2050



Source: M. Fischedick, Ph.D., Wuppertal Institute for Climate, Environment and Energy

This table represents fairly accurately a projection of present German policy to the year 2050, when renewable energy should deliver 45 percent of the energy to fulfill a total need that is 37 percent less than at present.