Cutting Carbon Costs: Learning from Germany's Energy Saving Program

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WHATWORKS COLLABORATIVE

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CONTENTS

12. Multifamily dwelling, Housing Cooperative WOGE Nordstadt eG,Schneiderberg, Hannover (Proklima Model, also included in the DENA programs 'Low Energy House in the Existing Stock')
13. Large residential district with apartment blocks (housing company), Märkische Viertel, Berlin

Annexes

List of Tables

List of Figures

List of boxes

GLOSSARY

Air tightness is the resistance of the building envelope to inward or outward air leakage. Excessive air leakage results in increased energy consumption and draughty, cold buildings.

Biogenic is a substance deriving directly from life processes (also called biomolecules)

Building envelope describes the whole outer shell of a building including roofs, walls, foundation floors, outside windows, doors, extensions.

Buildings in Germany include multi-unit blocks, not just individualhouses.

City-State is a city government. Hamburg, Bremen, and Berlin are city-states. These three city governments are also regional governments, or *Länder*. All other German cities have separate city and regional governments.

Carbon sinks are parts of the natural environment that reabsorb carbon, for example, soil, trees, woodland, peat.

Embodied energy is the energy used to produce materials, transport them, and turn them into buildings, appliances, or elements of building structures.

Energy in use is the amount of energy consumed in heating, lighting, water use, and other activities that burn energy. In Germany, it is usually measured in kilowatt hours per meter squared per year (kwhm² per year).

The euro (€) is the official currency of the Eurozone used by 16 of the 27 member states of the European Union, including Germany, France, Spain and Italy. It is not used in the United Kingdom or in several newer member states from Eastern Europe. The exchange rate as of August 10, 2010 is €1 = $1.31 = £0.83.

Feed-in tariff is the payment to households and other organizations generating electricity from renewable energy sources, either for their own use or as contributions to the energy grid.

G.H.G is green houses gases, of which carbon dioxide (CO_2) is by far the most common. Methane is another GHG (from landfill sites and intensive annual farming), which is far more potent but less common.

Länder are the German regions that elect their own regional governments and have significant devolved powers.

Market incentives are ways of stimulating demand for particular products or activities through financial inducement in the shape of subsidies, favourable loans, grants and tax concessions.

Micro generation is the term applied to home production or small-scale, community-level energy production. It is typically applied to renewable energy from individual solar, biomass, or other small-scale generation.

One- and two-family homes in Germany are typically townhomes (one building with two units). German subsidies favor this form of home.

Passive homes are new homes requiring very little energy. The German new-home standard is 100 kWhm² per year. A passive house standard is 15 kwhm² per year. The highest code (6) in the British Code for Sustainable Homes is near to the passive house standard. The aim to make all new U.K. homes "zero carbon" by 2016 is also linked to this measure.

The efficient house standard is 30 percent higher than the government's ambitious new standard, and close to the passive home standard.

The whole house approach to energy conservation refers to measures (with some subsidies) covering all major elements of the building envelope and energy system.

Tons of CO_s equivalent is a measure used to compare the emissions from various greenhouse gases based on their global warming potential. For example, the global warming potential for methane over 100 years is 21. This means that emissions of one million metric tons of methane are equivalent to emissions of 21 million metric tons of carbon dioxide.

U-value is the measure of how efficient a building element is at retaining heat and insulating against cold.

V.A.T is the value added tax, an EU-wide tax on most goods and services, collected by national governments as an important part of their revenue raising taxes. In the United Kingdom, the V.A.T. is currently 17.5 percent. It is 20 percent in other countries. There are discretionary reductions for energy conservation and certain building refurbishment.

Retrofit means to remodel, adapt, or modernize existing buildings to bring them up to current standards, including energy efficiency standards.

EXECUTIVE SUMMARY

1. The United States uses twice as much energy per head as does Europe. However, Europe is forced to import more than one-half its total energy, often from countries with volatile governments.

2. The cheapest and most cost-effective path to greater energy security is energy conservation. The built environment is the most effective target for conservation. The built environment consumes one-half of all energy in Western, developed countries—much of it through poorly insulated walls, windows, roofs, floors, and doors, and through inefficient equipment. The built environment contributes to one-half of all green house gas emissions.

3. European governments have committed to a 20 percent to 30 percent reduction in carbon emissions by 2020. All members of the European Union (27 countries) have adopted highly ambitious production targets for renewable energy and equally ambitious reduction targets for carbon dioxide (CO_2) emissions (cuts of at least 20 percent by 2020).

4. Germany is leading the way in developing green technologies and has the most ambitious programs in Europe of energy conservation, aiming for a 30 percent reduction in energy use by 2020 and a 30 percent share of renewable energy, mainly in the form of biomass, wind, and solar.

5. The German Climate Protection Program is based on the three pillars:
   - A clear, legal framework and tight regulation at federal level;
   - Strong financial incentives through subsidies and loans, via a public investment bank;
   - Campaigns to change behavior, involving regional and local bodies, backed by enforceable standards, energy performance certificates, and supported model projects throughout Germany.

6. Since 2006, Germany has created nearly 500,000 new jobs in renewable energy and nearly 900,000 jobs in retrofitting homes and public buildings. Green investment, green technology development and export are all major growth areas in Europe's strongest economy.

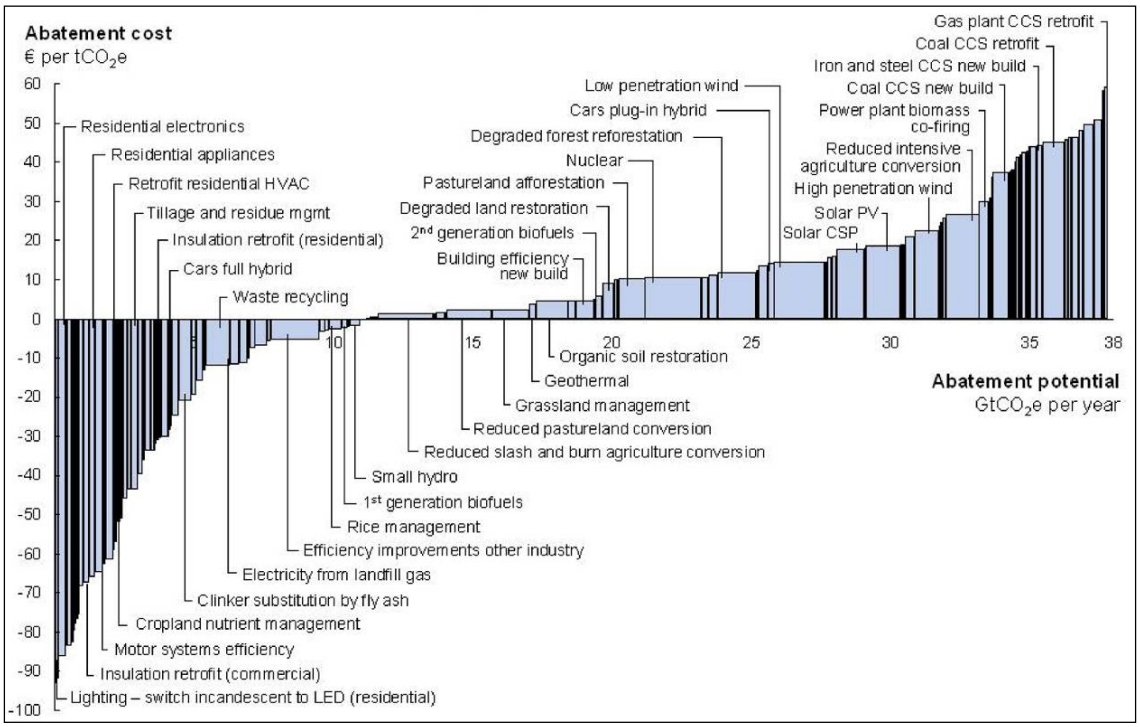
PART ONE

1. INTRODUCTION

Cutting Carbon Costs is about the commitment to reduce fossil fuel use while pursuing ever greater prosperity, comfort, and economic growth. So fast-growing is the world's reliance on energy that it is impossible to meet demand at the current pace without possible irreversible climate change, exhaustion of accessible fossil fuels, and overreliance on nuclear energy.[1] This report explores how Germany has leapt ahead in developing renewable energy, maximizing energy use, and, more important, pursuing energy efficiency and energy conservation, particularly in the built environment.

There are relatively simple and cost-effective ways of reducing overall energy demand through efficiency. Efforts in the United States, Europe, and China are already underway.[2] Vattenfall, the international Swedish utility company, has documented the cost benefits of investing in energy efficiency compared with the relatively high cost of all forms of renewable energy to date[3] (Figure 1).

Figure 1: Global Green House Gas Abatement Cost Curve beyond "Business as Usual," 2030



Source: McKinsey & Co, "Global GHG Abatement Cost Curve v2.0," in Pathways to a Low-Carbon Economy *(2009), online at http://www.mckinsey.com/clientservice/ccsi/pathways_low_carbon_economy.asp [Accessed January 11, 2010]. This evidence-based figure and study was commissioned by Vattenfall and is an updated version of the earlier study.*

A major driver of change is the steep rise in conventional energy prices and the fear that actual levels of production, at least of oil, may soon start to fall.[4] The U.S. government is acutely aware of its vulnerability, and the 2010 oil disaster in the Gulf of Mexico only enhanced fears about "peak oil," rising oil prices, and environmental limits.[5] Most European countries, including the United Kingdom and Germany, are already extremely vulnerable with their overreliance on Russia for the transmission of natural gas, on the volatile Middle East for oil, and a lack of adequate power generation and storage capacity within countries.

As a result, a consensus is growing, driven by cost, fear, and inescapable logic, that energy conservation not only makes sense but is needed on a massive scale. The way forward will not happen automatically, as brilliantly argued by the U.N. Economic Commission for Europe, the British government, and by progressive private companies.[6] The United States is particularly divided on how to move forward. Although it has the know-how, experimental projects, innovative capacity, and path-breaking ideas, it lacks a clear legislative or funding framework, a unified political commitment, and a long-term national plan for energy conservation and renewable energy.[7]

During the last 10 years, the United Kingdom has become increasingly committed to the United Nations and European Union climate change agenda and energy reduction targets.[8] Its Climate Change Unit in the Department for Environment focused on the energy-saving potential of buildings.[9] In 2009, drawing heavily on the German experience of ambitious building refurbishment and energy conservation programs, the Climate Change Unit announced a national drive to adopt a "whole house" approach to energy conservation, with the aim of insulating all the external parts of homes and replacing heating and lighting systems to produce units that use half the energy.

Given the age and poor thermal record of U.K. homes, this is a serious challenge. The UK Coalition government of 2010, however, has embraced it, driven by the logic of cost savings and using Germany and other European countries as models.[10]

Energy conservation, "green" innovation, and recycling buildings are the new pathways to economic growth: they create jobs, they build new skills in the workforce, they support better social conditions, they reduce pollution, and they offer a politically neutral route out of the energy crunch facing the developed world. The United States stands to gain from Europe's trial-and-error approach; it can avoid mistakes and forge its own path. Europe, driven by much more extreme

pressures, is at the cutting edge of energy conservation, with Germany among the most advanced examples.

Europe has inherited many cultural and social traditions that drive its commitment to environmental stewardship: its population density (up to 20 times greater than U.S. density); its urban roots; its highly depleted natural resources; its industrial heritage and decline; and above all, its history of nearly continuous warfare and language barriers, spanning thousands of years. These characteristics have driven innovation as an imperative of survival. Preserving old buildings, living in close proximity, treating renting as the norm, investing in public transport, adapting established engineering and production systems to new purposes, protecting fragile and damaged natural environments – all are the established ways of surviving in a crowded, old continent. Since the devastation of World War II, European political and economic consensus has evolved from a focus on harmonious free trade to implicitly avert the danger of a war over resources, to an imperative to reduce greenhouse gas emissions, create energy security, and significantly reduce reliance on fossil fuels. The target by 2050 is to cut greenhouse gas emissions by 80 percent.[11] Many now question whether this ambitious target is ambitious enough; others challenge the deliverability of such a goal.[12]

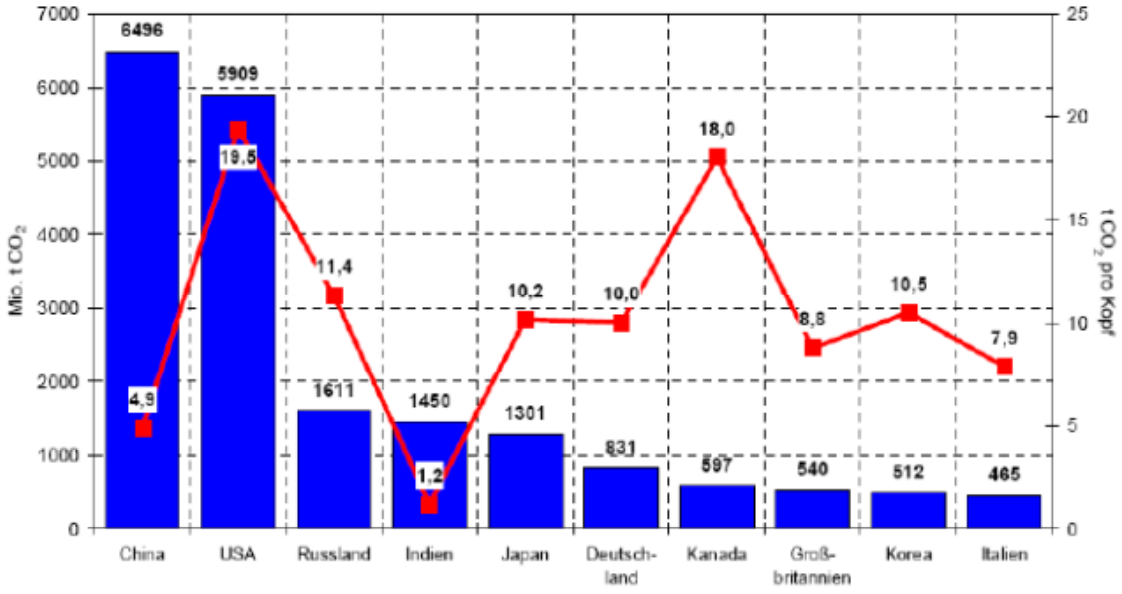
In this report, we briefly outline the emergence of the European Union's clear leadership in energy conservation and renewable energy investment. We then explain in more detail the German experience, as the clearest and most relevant model for the United States, given its focus similar objectives of greater economic prosperity, job growth, and energy security based on lower and more sustainable, long-term energy inputs.

The German example offers no panacea or simple replicable models, but it offers many useful lessons. It illustrates the need for a comprehensive, multilayered approach. It underscores the long-run, slow-moving nature of societal change. It illustrates the high upfront costs but the huge potential benefits of energy conservation, both to the economy and to the environment. These ideas are possibly the key to our survival on a warming planet.

2. INTERNATIONAL ENERGY PROBLEM

Before detailing the German experience, it helps to anchor the efforts in an international context. In 2000, industrial countries accounted for more than one-half of the world's energy consumption, developing countries more than one-third, and transition economies, one-tenth. The United States consumes double the energy per capita of Europe, and Europe consumes more than double the rate per capita of China.[13] By 2030, world energy consumption is forecast to increase by about 60 percent, and developing countries will account for two-thirds of the increase. According to international energy projections, CO_2 emissions will rise as fast as world energy consumption, at 1.7 percent annually.[14] Figure 2 shows the 10 biggest polluters in the world, both in total CO_2 (bars) and in CO_2 per capita (single line).

Figure 2: Ten Largest CO_2 Emitters Worldwide, 2008



Note: The bars represent total carbon dioxide emissions, and the line graph represents per capita emissions. France was higher than Italy in 1990, but has reduced overall CO_2 while Italy's CO_2 has risen

Source: D. Menzer, "Energieeinsparpolitik im Gebäudebereich."(Energy Saving Politics in the Building Sector) Paper presented at Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS) (German Ministry of Transport, Building and City Development) , Ref. UI 41, Berlin, March 23, 2010.

At the G8 meeting in L'Aquila, Italy, in July 2009, heads of government agreed to reduce worldwide emissions by at least 50 percent by 2050, and in industrial countries by 80 percent. Notwithstanding major setbacks—such as the failure to secure a global agreement on energy and emissions reductions in Copenhagen and the rise in climate change scepticism following the leaked email

exchanges from the Climate Change Research Unit suggesting manipulation and suppression of data—scientific evidence continues to support the consensus that climate change is real, relates to human activity, and poses serious risks for the future.[15] The parallel threat of energy insecurity and energy costs underscores the urgency of energy conservation. Action continues in many countries to reduce energy dependence, and the European Union has retained its pre-Copenhagen commitments.[16] The recent agreement in Cancun (December 2010) now underpins these commitments.[17]

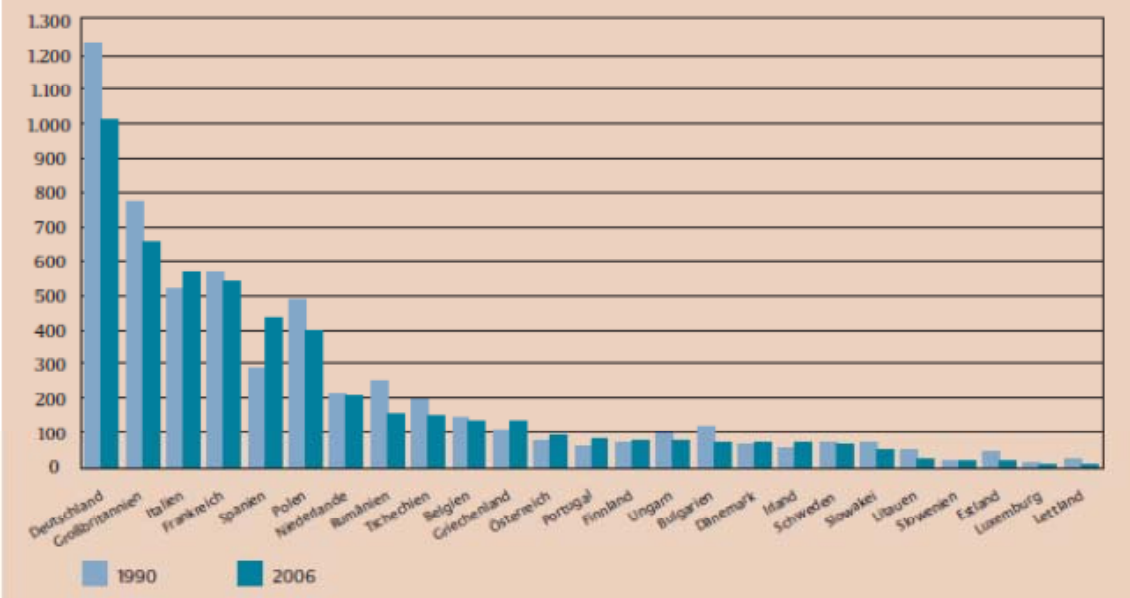
3. EUROPEAN UNION SET HIGH TARGETS FOR CO_2 REDUCTION

The EU energy reduction commitment under the Kyoto protocol aims to:[18]

- Reduce greenhouse gases (GHG) by 21 percent between 1990 and 2012;
- Reduce GHG by 30 percent from a baseline of 1990 by 2020;
- Increase the use of renewable energies to 20 percent of primary energy consumption between 1990 and 2020;
- Reduce energy consumption by 20 percent between 1990 and 2020.

Many countries are still seeing increases in their GHG emissions. Germany is by far the largest emitter in the European Union, but it has also done the most to reduce its emissions, as Figure 3 shows. Germany is also on track to hit its ambitious targets.

Figure 3: Greenhouse Gas Emissions by 25 EU Countries, 1990 and 2006



Note: Chart shows that Germany (Deutschland) is the largest emitter and also reduced its emissions the fastest (in millions of tons of CO_2 equivalent, discounting carbon sinks – forests)

Source: Energie in Deutschland Trends und Hintergründe zur Energieversorgung in Deutschland(Energy Trends in Germany, Background to Energy Conservation in Germany) Bundesminsiterium für Wirtschaft und Technologie, Berlin: 2009 (German Ministry for Economics and Technology) , online at http://www.bmwi.de

The European Union has adopted a renewable energy target of 20 percent and an energy efficiency gain of 20 percent by 2020, captured in the slogan "20:20:20." Different countries within the European Union have set different targets, negotiated according to their agreed capacity. This renewable energy target depends heavily on energy conservation, as well as on production, as lower

demand and consumption make the 20 percent goal achievable. Table 1 shows the variable renewable energy targets, averaging to 21 percent by 2020.

Table 1: National Share of Energy from Renewable Sources in 2005 and Targets for 2020

	Actual Share in 2005 (%)	Proposed Share by 2020 (%)
Belgium	2.2	13
Bulgaria	9.4	16
The Czech Republic	6.1	13
Denmark	17.0	30
Germany	5.8	18
Estonia	18.0	25
Iceland	3.1	16
Greece	6.9	18
Spain	8.7	20
France	10.3	23
Italy	5.2	17
Cyprus	2.9	13
Latvia	32.6	40
Lithuania	15.0	23

	Actual Share in 2005 (%)	Proposed Share by 2020 (%)
Luxembourg	0.9	11
Hungary	4.3	13
Malta	0.0	10
The Netherlands	2.4	14
Austria	23.3	34
Poland	7.2	15
Portugal	20.5	31
Romania	17.8	24
Slovenia	16.0	25
The Slovak Republic	6.7	14
Finland	28.5	38
Sweden	39.8	49
United Kingdom	1.3	15

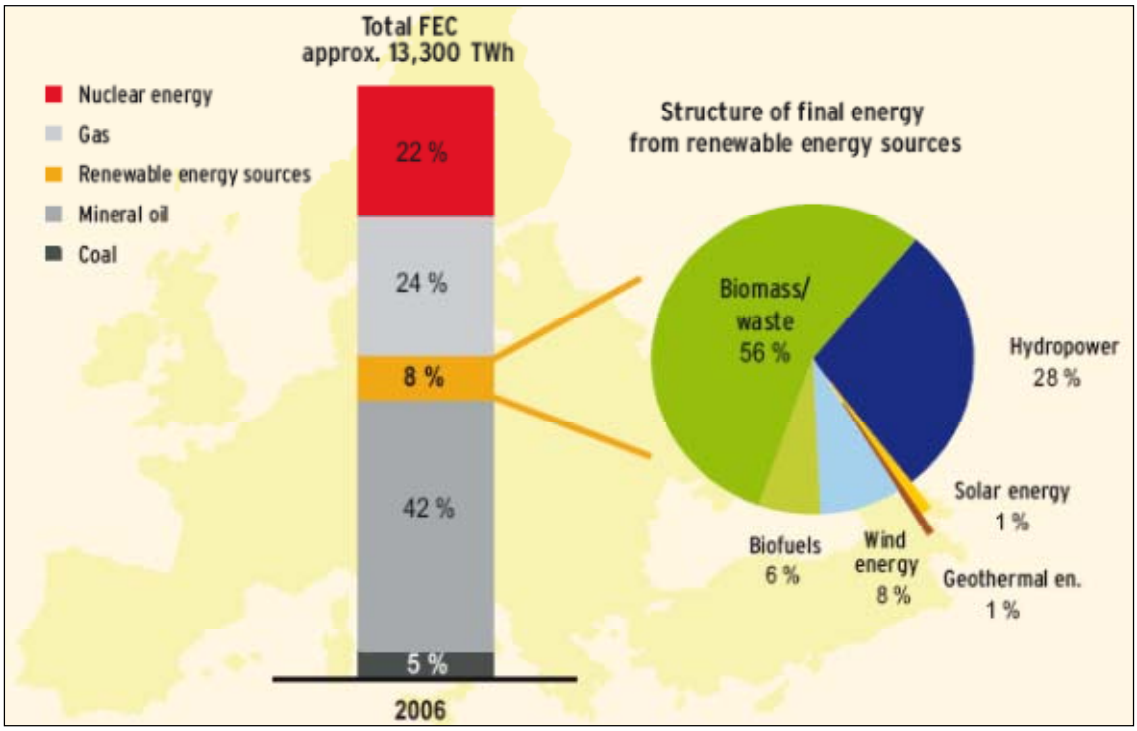
Source: http://ec.europa.eu/energy/renewables/targets_en.htm

3.1 The European Union's Current Energy Problem

The European Union currently produces less than one half of its energy requirements, depending as it does on imports for approximately 54 percent of energy. Oil makes up nearly two-thirds of total energy imports and almost one-half of all energy use. Natural gas makes up one-fourth of total energy imports, and solid fuels, 13 percent. Such energy dependence makes EU countries extremely vulnerable to international tensions in, for example, Russia or the Middle East. Energy production within the European Union has declined steeply since 2004, and if this trend continues as expected, countries will be even more vulnerable to supply failures unless Europeans shift from fossil fuel imports to drastic energy saving measures and greater renewable energy production. Figure 4 shows the different energy sources within the European Union.

Biomass methods that turn waste products into energy provide more than one-half of Europe's renewable energy, and hydropower constitutes one-fourth. Wind provides only 8 percent of total renewable energy, and solar, 1 percent. The European Union understands that energy conservation and renewable energy are crucial to the future, but conservation requires strong policies, particularly concerning buildings and products.[19]

Figure 4: Distribution of Energy in the European Union, 2006



Source: D. Böhme, W. Dürrschmidt, and M. Van Mark, *Renewable Energy Sources in Figures*. *National and international Development.* (Berlin: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2009).

3.2 Europe's Embrace of Renewable Energy

Exploiting renewable energy sources is key to the EU commitment to averting catastrophic climate change, meeting carbon reduction commitments, and ensuring energy security. In 1997, the European Commission agreed that 12 percent of all energy, including electricity and heat, should come from renewable sources by 2010. This target was not met. The European Commission now argues that 34 percent of the EU's electricity supply alone should come from renewables by 2020 (electricity had reached 16 percent by 2006). Wind power offers the greatest potential for meeting this target, by producing 12 percent of EU electricity demand by 2020 (it constituted 8 percent in 2009.[20] Member states are required to meet new national targets, but based on current trends, this looks unlikely.[21]

To aid progress, the European Union aims to achieve:

- a bigger and more interconnected energy pool to ensure more reliable supplies; this involves investing in energy infrastructure, cross-border interconnections, and new energy supply networks, ensuring *greater flexibility and integration* of supply;
- better support mechanisms between EU countries to help deal with shortages, creating *energy supply solidarity* between member states;

- better diplomatic relations with non-EU energy suppliers to smooth the process of "peaceful energy trading" and to secure European investments, reducing geopolitical tensions.[22]

The first EU attempts to integrate EU energy supplies focused on wind energy, under the title "TradeWind." This led to a commitment to develop an integrated grid and power market.[23] In January 2009, Germany, strongly backed by Denmark and Spain and supported by more than 50 other countries, launched the International Renewable Energy Agency (IRENA). Its role is to promote the "transition towards the widespread and sustainable use of renewable energy on a global scale" with practical advice, support, and information about best practices, financial mechanisms, technological expertise, and solutions at local, regional, and national levels.[24]

3.3 Energy Efficient Buildings – the cheapest way to save CO_2

Buildings are responsible for at least 40 percent of energy consumption and 36 percent of CO_2 emissions in the European Union. Consumption is higher in northern countries such as the United Kingdom, where buildings account for 50 percent of energy use. Improving the energy performance of buildings is therefore key to achieving the EU's climate change and energy conservation objectives--the 20-20-20 targets. The European Union has set minimum requirements for energy performance in all new and existing buildings. It introduced energy performance certificates and requires modern, efficient heating boilers and air conditioning systems.[25] It developed three strategies:

1. The European Commission's Action Plan for Energy Efficiency, adopted in 2006, sets a target for residential and commercial buildings to save 30 percent of energy on a baseline of 1990 by 2012. Transportation and manufacturing should save approximately 25 percent. [26] The action plan proposes:
   - Low energy heating and cooling;
   - Changing behavior through publicity, labeling, training, and education;
   - Eco-design and passive house standards (discussed below).

2. In November 2009, the European Union strengthened its commitment by upgrading national building codes and requiring all new buildings to be built to the passive house standard, considered to be as close to zero energy as is realistic, by 2020. On May 18, 2010, the European Parliament adopted a significantly tightened "Directive on Energy Performance of Buildings" to enforce the energy performance standards on all buildings, new or existing.[27] Box 1 shows this plan. The directive provides a legal framework, offering improved information for consumers

through more exacting energy performance certificates. Energy performance ratings must be disclosed at the time of sale and in rental advertisements. Prospective tenants and buyers must receive a validated energy performance certificate.[28]

3. In March 2010, the European Union presented a new energy strategy, "Europe 2020," led by Germany, that expanded EU collaboration in energy research, including carbon capture and storage (CCS); new technologies for extracting carbon from fossil fuels at source; large-scale wind and solar energy (including in North Africa); and a European energy development network.[29]

Box 1: European Union's Recast Directive on Energy Performance of Buildings (EPBD) (2002/91/EC)

The Directive on EPBD, adopted in 2002, is the main legislative instrument affecting energy use and efficiency in the EU building sector. The directive tackles both new buildings and the existing housing stock. In May 2010, an updated directive was approved.[30]

Milestones

- **December 16, 2002**: European Union adopts EPBD
- **January 2006**: Deadline for transposing directive into national law
- **November 14, 2008**: Commission proposes revision of EPBD
- **April 23, 2009**: Parliament adopts first-reading position
- **November 17, 2009**: European Union reaches political agreement on directive
- **May 18, 2010**: Parliament approves new legislation (official publication June 18, 2010)
- **By December 31, 2018**: Public buildings to adopt energy standards that create near-zero consumption.
- **By December 31, 2020**: All new buildings to consume nearly zero energy

The European Union took an integrated approach to calculating efficiency standards. This extends beyond insulation to aspects such as heating and cooling and heat recovery and lighting installations. As a result, regular inspections are mandatory of boilers and central air-conditioning systems and heating installations with boilers more than 15 years old. Moreover, alternative systems must be considered in new buildings with a surface area greater than 1,000meters squared. These alternatives include decentralized energy from renewables, combined heat and power generation, and area district-level heating and heat pumps..o promote greater public awareness and debate on energy savings in buildings, the directive introduced an energy performance certificate, which must be made available each time a house is built, sold, or rented. The certificate help potential buyers or renters gauge the building's energy performance against established national standards and benchmarks and to consider any cost-effective improvements they could make. The public sector was expected to take the lead by displaying energy certificates in "prominent" places in public buildings.

Although European countries are rapidly increasing their renewable energy investment, the focus on energy conservation continues to grow.[31] Most European countries, including the United Kingdom,

have fewer than 10 years to deliver on large-scale alternatives to fossil fuel reliance.[32] Across Europe, it is agreed that energy conservation and efficiency offer the cheapest and most cost-effective ways to reduce energy demand. Such an agreement creates an unexpected openness to learning from Germany,[33] a big energy user with limited internal energy supply.

4. GERMANY'S AMBITIOUS ENERGY PROGRAMME

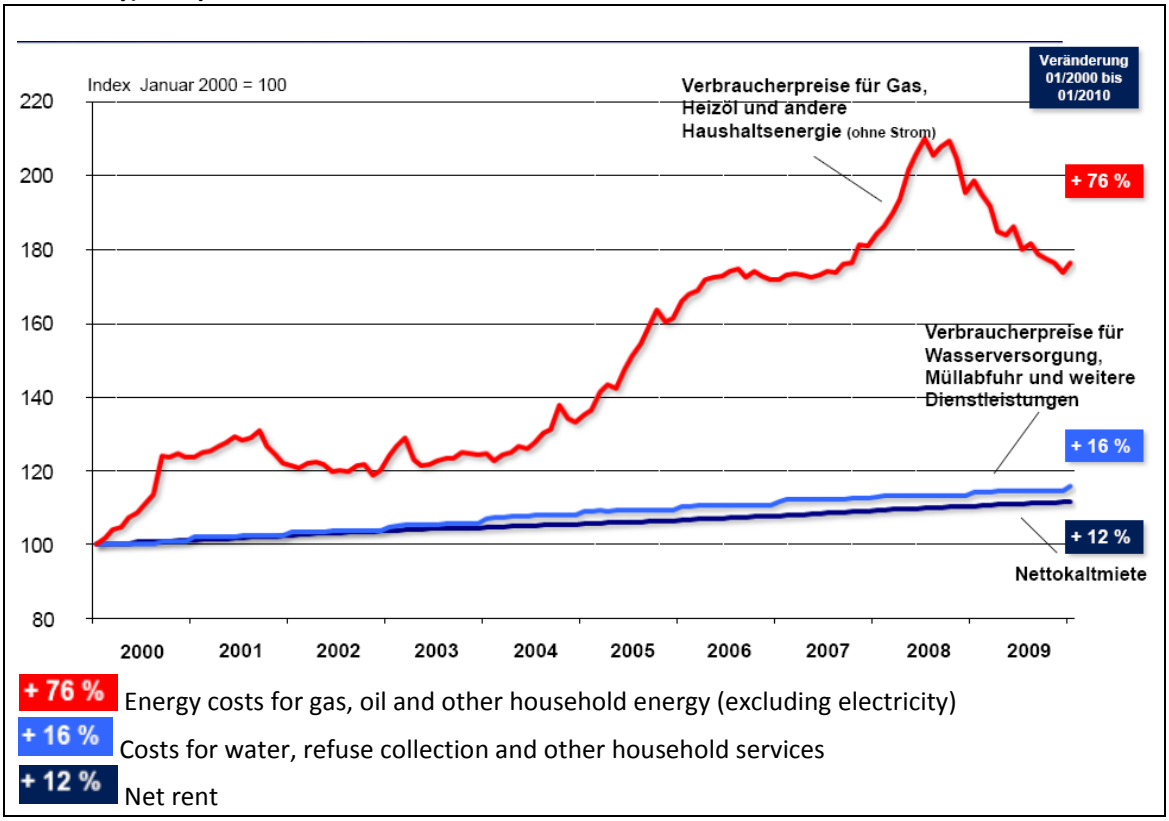
Particular experiences push Germany to the fore. Germany is geographically at the heart of the continent of Europe as figure 5 shows. In 1990, Germany was reunited following the fall of the Iron Curtain, and the German government committed itself to equalizing conditions across the unified country. It inherited an appalling legacy of energy profligacy in Eastern Germany, with up to 8 million uninsulated concrete housing units in the Eastern Länder (regions). The investments required were enormous, and seriously strained the German economy. These pressures, however, drove a very different approach to energy conservation, from heating and repurposing buildings, to recycling, to complex behavioral changes, given the enormous inertia of existing systems.

Figure 5: Map of Germany

Source: ProKlima, 2010

Germany's commitment to energy conservation and alternative energy sources was forged against a backdrop of security issues, steep price increases, and high CO_2 emissions; 62 percent of its energy is imported. Germany, as a federal state with strongly devolved powers to regional (Land) and city (*Stadt*) levels, offers a useful model for the United States. Figure 6 shows the contrast between energy price rises and other household costs in Germany.

Figure 6: Rise in Energy Costs for Gas, Heating Oil, and Other Household Users (Excluding Electricity) Compared with Rises in Rent, Water, Waste, and Other Household Costs, 2000 to 2009

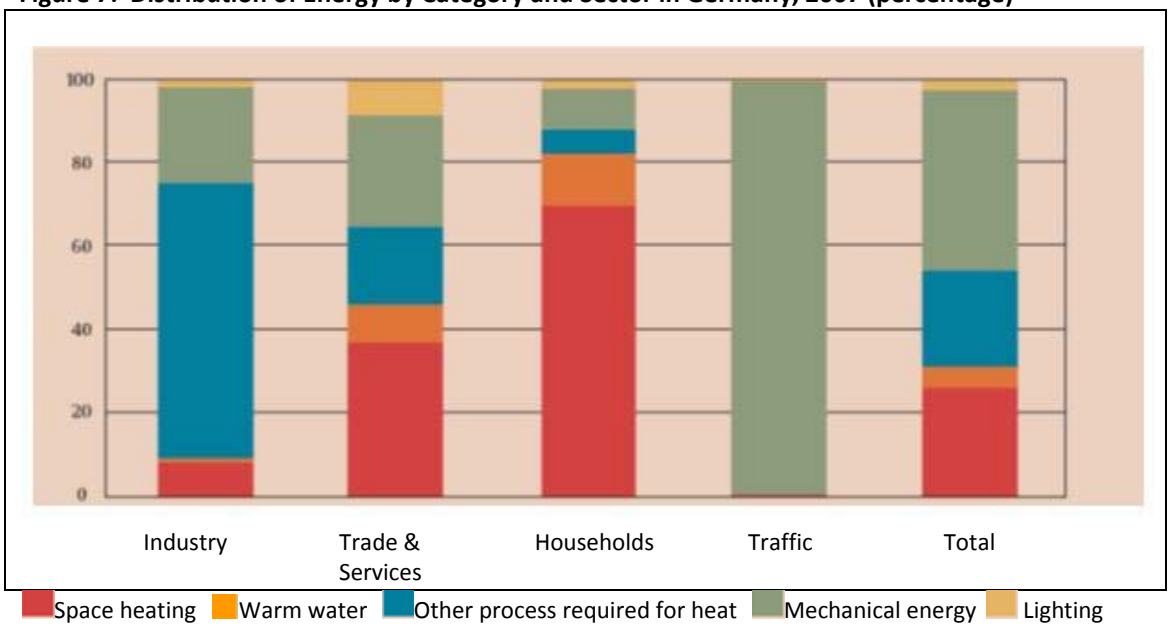


Source: Statistische Bundesamt, Entwicklung der Verbraucherpreise für das Wohnen´ in *Fachserie 17, Reihe 7, Verbraucherpreisindex,* Monatswerte bis 01/2010.(Government Office of Statisitcs: *Development of the Consumer Price of Energy for Dwellings, in the evidence serives, No 17, Section 7, price index monthly)* http://www.gdw.de

4.1 Buildings Consume Energy

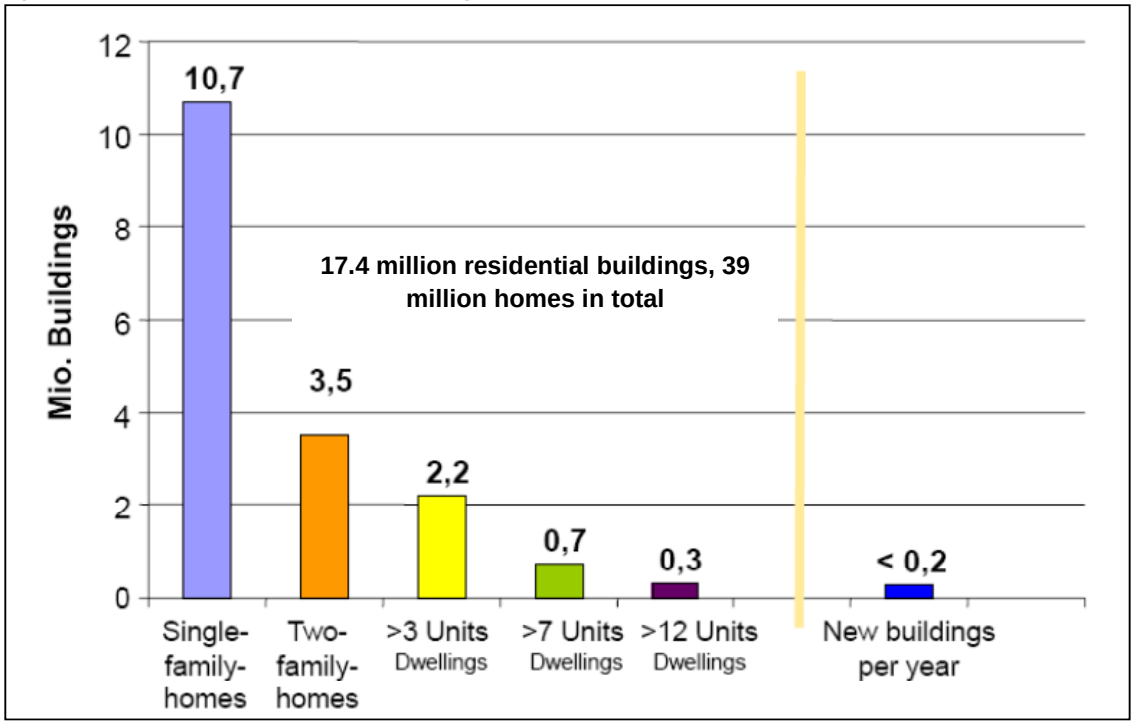
Buildings, Germany's largest energy consumers, offer the greatest potential for conserving energy. More than 80 percent of energy is used heating rooms and water; the remaining 18 percent powers electrical gadgets and lighting. Many experiments show that energy use in buildings can be halved with insulation, draft proofing, energy-efficient systems and appliances, and better controls.[34] Retrofitting is slated to save 20 percent of total energy use in buildings by 2020, avoiding 70 million tons of CO_2.[35] Figure 7 shows the distribution of energy uses and the dominance of heating and hot water in the domestic sector. Big savings are possible in these areas.

Figure 7: Distribution of Energy by Category and Sector in Germany, 2007 (percentage)



Source: Bundesministerium für Wirtschaft und Technologie (2009) *Energie in Deutschland. Trends und Hintergründe zur Energieversorgung in Deutschland* (German Ministry for Economics & Technology; Energy in Germany: Trends and Background to Energy Conservation in Germany [online]. Available from: http://www.bmwi.de

Figure 8: Distribution of German Housing Stock



Source: T. Kwapich, "Germany's Investment in Energy Efficient Existing Homes." Paper presented at, *The Great British Refurb: 40 Percent Energy Reduction in Homes and Communities by 2020 – Can We Do It?* (Conference held at the London School of Economics, December 8, 2009).

4.2 Why Existing Homes?

New construction can be highly energy-efficient, although the energy used to produce materials, equipment and fittings, transport them, and use them (also called "embodied energy") takes 40 years of efficient operation to recoup the embodied energy invested in the building. [36] New construction has plummeted in recent years, with current building at its lowest since 1950, declining almost 40 percent since 2003, with less than 200,000 buildings a year being built.[37] Nor is new construction expected to pick up in the near future.[38]

Since the early 1990s, population decline, economic problems, and rising unemployment, particularly in the former East German regions, have lowered housing demand, and many parts of Germany now have a housing surplus of 10 percent or more. As city governments face increasing financial constraints, refurbishing and modernizing existing homes is a more attractive option.[39]

Approximately 40 percent of German homes are owner-occupied (15 million units). Small landlords lease another 14 million units. More than 10 million homes belong to larger commercial landlords and formerly nonprofit, but now private, companies.[40] This makes for dispersed and diverse ownership pattern, dominated by private rentals. The need for energy retrofitting is large, given that: 75 percent of homes (29 million units) were constructed before 1979, before any energy efficiency regulations were introduced. Only approximately 9 million of the pre-1979 homes have been rehabilitated to high energy-efficiency standards, leaving 20 million still requiring rehabilitation.

In addition, there are 1.5 million non-residential buildings, including 40,000 school buildings and many other public buildings with significant energy saving potential.[41]

4.3 Overview of Germany's renewable energy and energy conservation program

- Germany has a **strong engineering and manufacturing tradition**, export-oriented economy, and commitment to environmental care. **One in five** voters supports the Green Party. Recent German economic growth has been driven by green technologies. German exports are almost on par with the United States, in volume, based on a population one-quarter the size of the U.S. Germany has a highly regulated market economy and a strongly decentralized government structure, facilitating both local experimentation and national enforcement of high environmental and energy efficiency standards.

- Germany is a **high energy user per capita** (10 percent higher than the United Kingdom, but much lower than the United States) and relies heavily on imported energy, much of it from politically volatile sources. German industry is highly productive but until recently was extremely energy-intensive and polluting. Serious environmental worries, such as acid rain and the pollution of the Rhine, greatly accelerated political support for the green agenda.
- The German political drive for energy conservation and renewable energy arose from the ambitious national commitment to reduce carbon dioxide (CO_2) emissions by far more than the European Union (EU) target of 20 percent by 2020. Germany's energy vulnerability and significant energy dependence on foreign sources strengthened the political imperative to act. Although this commitment was driven in part by the urgency of tackling the poor quality and gross energy inefficiency of the East German building stock following reunification, the many post-war West German homes, hastily constructed between the 1950s and late 1970s, were also inadequate and added to this impetus. The recognition of the economic potential of renewable technologies and the direct job creation benefits strengthened Germany's energy conservation resolve.
- **Buildings are high energy users**, producing more than 40 percent of all CO_2 emissions in Europe. They are also relatively easily made more energy-efficient with known technologies and relatively short payback periods. It pays to save energy.
- Germany's **major public investment bank** offers financing for energy conservation and renewable energy. The bank, the Kreditanstalt für Wiederaufbau (KfW), was set up following World War II and backed by major German banks to oversee the large flow of American postwar investment in Germany's infrastructure, housing, and industry. KfW has continued as a public investment bank, facilitating the financing of energy conservation and renewable energy. Other countries do not have a ready-made public investment institution for retrofit.
- Since 1990, three forces drive German government action: **legislation** to save energy and generate renewable energy; **subsidies and loans** (mainly via KfW) to finance CO_2 reduction programs; and **advocacy and technical advice** to drive energy efficiency via the Deutsche Energie Agentur (DENA) and linked regional bodies.
- **Multilayered programs** with incentives, information, and advice channels have created widespread public awareness and action to cut energy use. Germany's experience shows that a stronger economy can go hand in hand with reducing the threat of climate change.
- **Germany ranks top among EU countries** in renewable energy production and plays a leading international role in promoting buildings' retrofitting to save energy. Its renewable energy industries are fast growing, internationally oriented, and job-intensive. Germany's economy

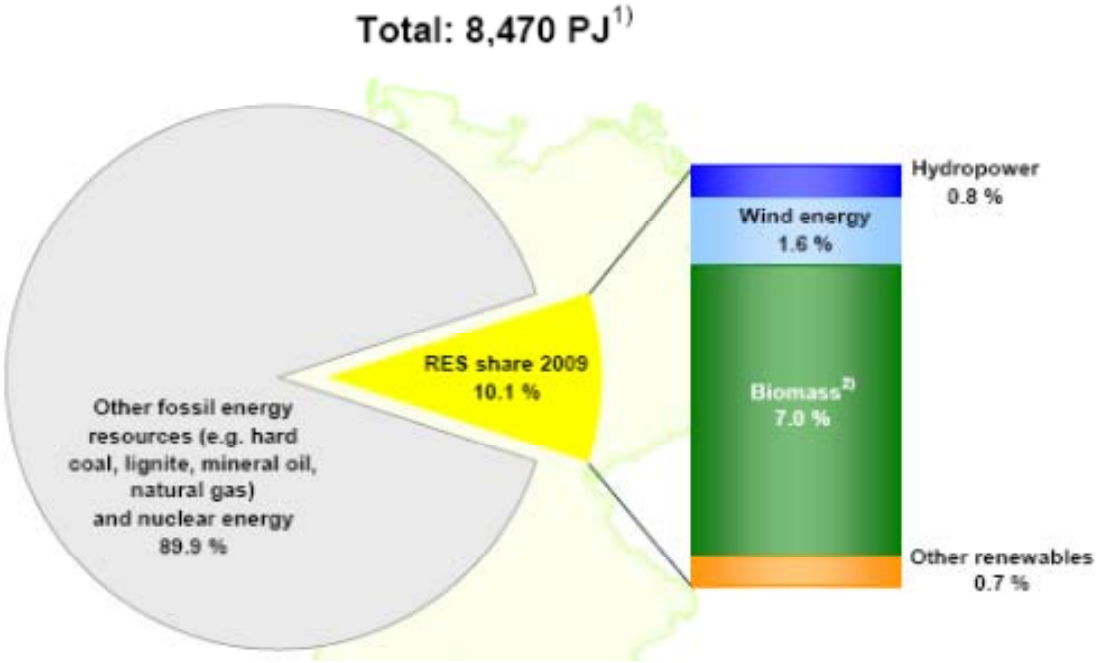
shrank by 5 percent during the worst year of the recent financial crisis (2009), but its renewable energy and energy conservation industries showed strong growth (20 percent) in the same year.

- German renewable energy technologies are one of the country's **fastest growing exports**. For each euro the German government has invested in grants and subsidies for energy efficiency, 9 euros have been attracted in loans. In addition, owners have invested their own personal savings. Repayable loans via KfW recirculate into new finance. At the same time, a million new jobs have been created since 2006, CO_2 emissions have fallen steeply, and 9 million homes have cut their energy use by 40 percent or more.

5. GERMANY GROWS ITS RENEWABLE ENERGY MARKET

Before examining Germany's conservation program in detail, we briefly explore the expansion of renewable energy in home upgrading and energy use because of its central role in CO_2 reduction, energy security, and the German economy. Restructuring the energy system is part and parcel of global climate protection, as well as sustainable development. Germany relies nearly entirely on fossil fuels and nuclear power. Yet the German government is committed to reducing reliance on fossil fuels, phasing out nuclear power (currently under review), and creating greater energy independence within its limited natural energy resources. Reducing energy demand through energy conservation and efficiency is an extremely important part of this strategy, but so is renewable energy.[42] Figure 9 shows that Germany is fast increasing its renewable energy supply. More than 10 percent now comes from renewable sources, almost double since 2005 when it was less than 6 percent.

Figure 9: Renewable Energy Sources as a Share of Total Energy Consumption in Germany



RES=Renewable Energy Sources
1. FEC 2009 based on the Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW)
2. Solid, liquid, gaseous biomass, biogenic share of waste, landfill and sewage gas
Deviations in the totals are due to rounding.

Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, *Development of Renewable Energy Sources in Germany 2009* (graphics and tables version) (Berlin; Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, March 2010), online at http://www.erneuerbare-energien.de, www.bmu.de.

Germany passed its first Renewable Energy Sources Act (EEG) in 2000. It stipulated that energy providers must prioritize renewable energy over nonrenewable energy in their grids, and to pay suppliers a fixed sum over 20 years per kilowatt hour (kWh) (with different rates for different types of energy, depending on the amount supplied and geographic location). The renewable energy supplier receives a payment per kWh from the grid energy provider, known as the Feed-in Tariff (FIT). The cost of funding this renewable energy subsidy is passed on to end users, at, on average, 1.1 cents per/kWh. This is more than they would have paid without a renewable energy subsidy such as FIT. Therefore, the average household consuming 3,500 kWh of energy per month pays an additional €3.10 per month to fund the FIT. There is no cap on the amount of renewable energy that can be fed in.[43] Box 2 describes in more detail the Renewable Energy Sources Act.

Box 2: Renewable Energy Sources Act (EEG)

The first Renewable Energy Sources Act (EEG) was introduced in 2000, replacing the Electricity Feed Act of 1990. The 2000 act expanded the scope of the earlier act. It obliged grid operators to give priority to feeding electricity generated from renewable energy sources into the electricity grid, and paying the relevant statutory minimum rates to the plant operators for a total of 20 years. These minimum rates are based on the individual generation costs and show a gradual decrease (that is, they account for productivity advances in the various sectors and in potential cost reductions over time). Electricity from renewable sources is distributed uniformly—on the basis of a "burden equalization" mechanism--to all electricity distribution companies, which must purchase a growing proportion of their electricity from renewable energy sources. They incur additional costs because the average EEG cost is usually higher than the wholesale price of the electricity (most of which is not generated from renewable energies), creating a direct incentive to increase their renewable energy supply.

The 2009 EEG set a higher target (30 percent by 2020) for using electricity from renewable sources. It brought the majority of tariffs into line with the current market situation and improved the framework conditions to help achieve the target, including more attractive repowering arrangements, improved conditions for offshore wind power, and an improved grid integration structure for installations generating electricity from renewable energies, including provisions on feed-in management.

In 2007, the German government agreed on an "Integrated Energy and Climate Program" to deliver on ambitious targets for energy conservation and renewable energy, aiming to reduce greenhouse gas emissions by 40 percent by 2020, 10 percentage points higher than the highest EU target (see Appendix 2 on public support). Germany achieved its Kyoto target (a 21 percent reduction in CO_2 emissions by 2012) by the end of 2007. Although existing measures are on target to achieve a 30 to 34 percent reduction by 2020, depending on economic conditions, federal government officials argue that existing measures are insufficient to achieve reductions of 40 percent.[44]

Renewable energy generation for electricity in 2008 alone saved 75 million tons of CO_2, nearly 10 percent of all German CO_2 emissions. Regular monitoring shows progress on several fronts. [45] For example, in 2009, a report recorded, "more attractive re-powering arrangements, improved conditions for offshore wind power and a more integrated grid structure to allow for electricity from renewable energy, including provision for feed-in management."[46] These changes facilitated better integration of renewables into the electricity system and special marketing of renewable electricity.

Wind is the biggest renewable electricity source. It contributes more than 40 percent of electricity from renewables. The next biggest contributor, at more than 30 percent, is biomass, bio-gas, and other biofuels. Photovoltaics and solar thermal are both still relatively small contributors, at nearly 7 percent and 4 percent, respectively. Heat generation, biomass, and other biogenic sources (substance deriving directly from life processes) account for more than 90 percent of the renewable heat supply.

Renewable Heat

Renewable energy generation became easier with the Renewable Energy Heat Act (EEWärmeG) of 2009 and the revised Renewable Energy Sources Act of 2009. These are now the main legal instruments to help achieve the ambitious targets.

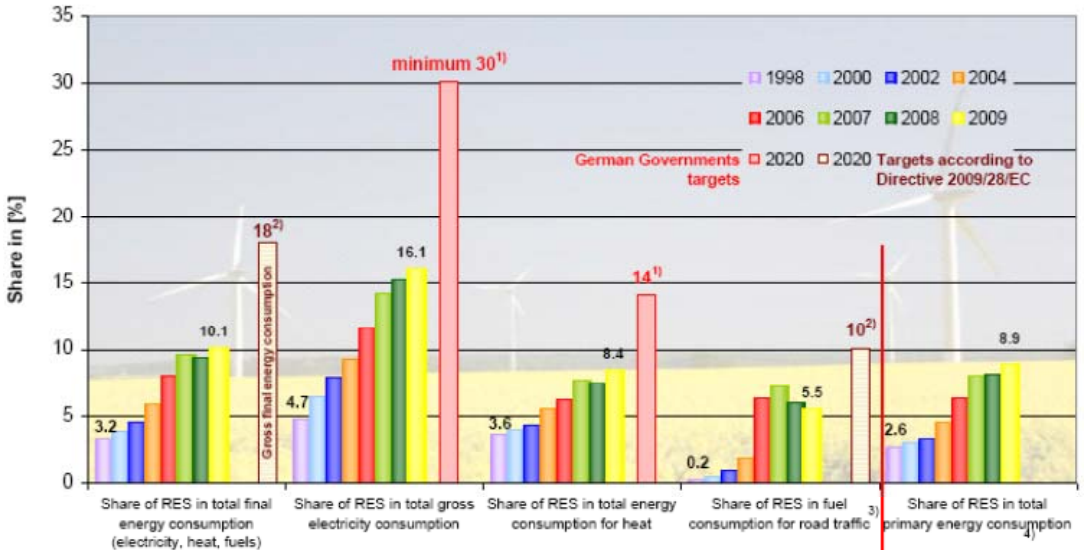
Since 2009, the Renewable Heat Act requires all owners of new buildings to meet 15 percent of their heating requirements from renewable energy sources, using a combination of renewables. For existing buildings, the use of renewable energy is voluntary. The government expanded its subsidy, or "market incentive program" for renewable energy to encourage building renovators to adopt renewable energy options. Municipalities and local authorities can prescribe connections to a district heating supply grid for climate protection and supply reasons.[47] Box 3 explains the two main heating and renewable energy acts. Figures 11 and 12 show the sources of renewable energy for electricity and for heat.

German energy policy aims for a diverse mix of energy sources, competitive energy prices, and much greater energy savings. The Integrated Energy and Climate Program, agreed in 2007, prioritized energy efficiency with tighter legislation and tougher targets, in the following ways:

- The Energy Conservation Order of 2002 required buildings and energy systems to use 30 percent less energy by 2009;
- Programs were extended that promote energy-efficient residential buildings that reduce CO_2;
- The Heating Cost Order was amended;

- The share of renewable energy to be used in heat production increased from 8 percent in 2010 to 14 percent by 2020;
- The "Future Building" research initiative was launched;
- Combined heat and power and renewable energy in the electricity sector were to be promoted.[48]

Figure 10: Expanding Renewable Energy Sources as a Share of Energy Supply in Germany, 1998-2009 (including 2020 Targets for Germany and the European Union)



RES = Renewable Energy Sources

Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, *Development of Renewable Energy Sources in Germany 2009* (Berlin; Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, , March 2010), online at http://www.erneuerbare-energien.de, www.bmu.de

Box 3: Heating Costs Act and Renewable Energy Heat Act

Heating Costs Ordinance (HeizkostenV)

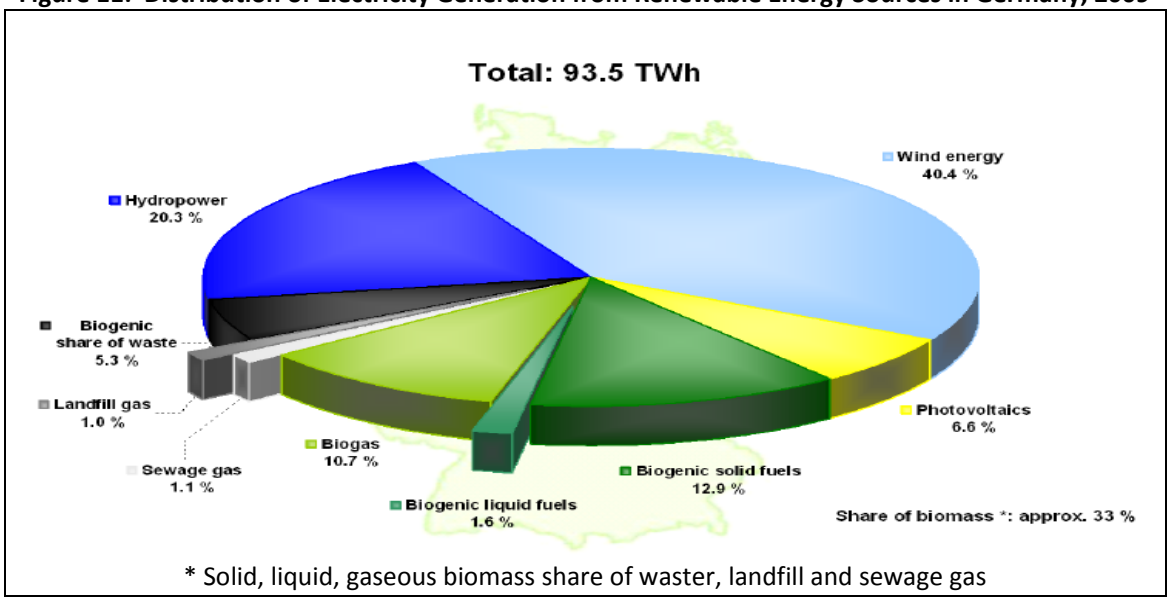
The first Heating Costs Ordinance of 1981 introduced the obligation to record energy consumption for central heating and hot water, and the distribution of costs between landlords and tenants. Its main aim was to regulate the distribution of costs for central heating and hot water for rental properties on the basis of the size of unit and consumption.

The 2009 amendments changed the proportions of heating and hot water costs to create incentives for tenants to save energy. The proportion for individual consumption was increased to 50-70 percent (varying by the insulation standards of the building), with the remaining costs to be allotted between tenants according to the size of unit. Although the 1981 ordinance regulated the charges to tenants in operating heating systems, the 2009 reform allotted more costs to the individual tenants to make energy conservation more attractive.

Renewable Heat Act (EEWärmeG)

The act was introduced in 2009 and regulates the use of renewable energies for heat supply in newly constructed buildings. The act increased the target for renewable sources in Germany's heat consumption to 14 percent by 2020. To help achieve this target, the act makes the use of renewable energies obligatory. Owners of new buildings must devote 15 percent of their heat requirements to renewable sources. For existing buildings, the use is voluntary.

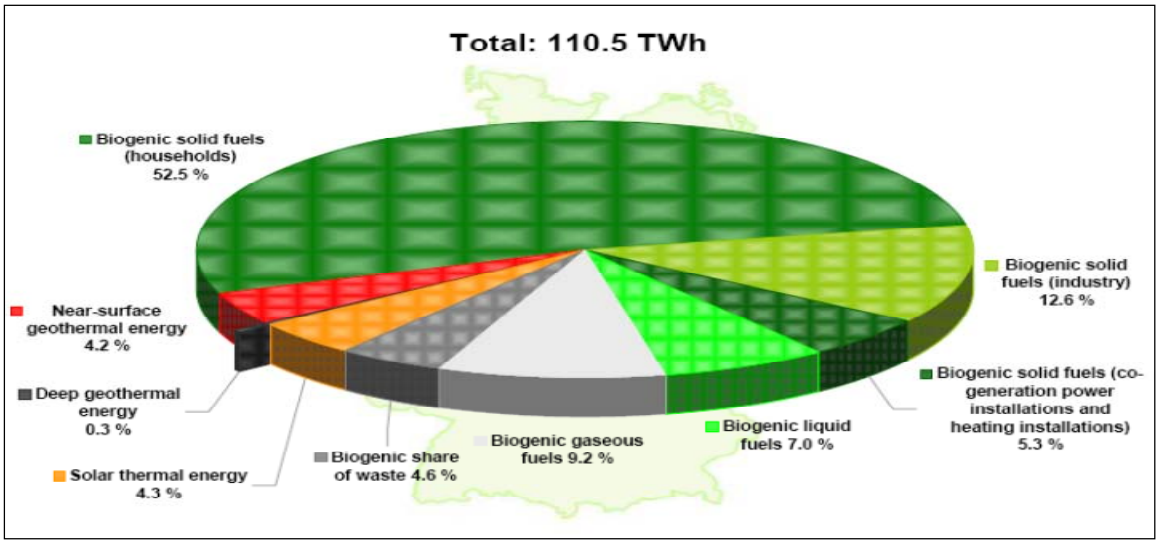
Figure 11: Distribution of Electricity Generation from Renewable Energy Sources in Germany, 2009



* Solid, liquid, gaseous biomass share of waster, landfill and sewage gas

Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, *Development of Renewable Energy Sources in Germany 2009* (graphics and tables version) (Berlin; Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, , March 2010), online at http://www.erneuerbare-energien.de, www.bmu.de

Figure 12: Heating Generation from Renewable Energy Sources In Germany, 2009



Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, *Development of Renewable Energy Sources in Germany 2009* (graphics and tables version) (Berlin; Federal Ministry for the Environment, Nature Conservation and Nuclear Safety March 2010), online at http://www.erneuerbare-energien.de, www.bmu.de

6. GERMANY'S LEGAL REQUIREMENTS FOR ENERGY USE IN NEW AND REFURBISHED BUILDINGS

Minimum Standards for New and Refurbished Buildings (EnEV 2009)

New building requirements set an ambitious target for energy performance and a minimum standard for all new buildings' "envelopes" as measured in U-values.[49] All new buildings must meet a legal standard of energy performance (measured against a baseline of 100). Existing buildings must also achieve the maximum performance possible for the part of the building being renovated, but they are allowed 40 percent leeway (that is, an overall energy use of 140 against the baseline standard of 100). Germany has progressively expanded the requirements for energy saving and CO_2 reduction, as shown in Box 4.

Germany's climate change, renewable energy, and energy conservation programs have evolved rapidly over the past decade. Box 4 shows the timeline for the main policy changes. Box 5 describes the energy conservation act, showing how that pivotal legislation has progressively tightened its expanding requirements.

Box 4: Timeline of Energy Conservation Measures in Germany

1979	First energy standards for buildings introduced
1981	Heating Cost Act (HeizkostenV)
1999	Market Incentive Subsidy Program for the Development and Application of Renewable Energy (MAP)
2000	Renewable Energy Sources Act (EEG)
2001	'Kreditanstalt für Wiederaufbau' (KfW) banking group begins program for energy-efficient buildings
2002	Energy Conservation Act (EnEV)
2007	Revision of Energy Conservation Act, in line with EU guidelines
2007	Federal government agrees to Integrated Energy and Climate Change Program
2009	Renewable Energy Heat Act (EEWärmeG)
2009	Energy Conservation Act tightened
2009	Renewable Energy Sources Act tightened
2009	Heating Cost Act revised

Box 5: Energy Conservation Act (EnEV), 2002

The EnEV is part of the German Building Code and applies to residential and nonresidential buildings. The first EnEV, introduced in 2002, superseded and combined the previous Heat Protection Act (WSchV) and the Heating Systems Act (HeizAnlV).

The EnEV sets minimum energy requirements for buildings and heating, cooling, and ventilation systems and hot water, and it regulates the energy performance certificates.

The first major revision was in 2007 to translate EU 2002 guidelines on energy efficiency. Many of the earlier regulations for energy requirements in residential buildings remained or were minimally revised. The act made more significant revisions or additions to the energy assessments of nonresidential buildings (for example, the standard building procedure, "referenzhaus"), the consideration of alternative energy sources, and the inspection of ventilation systems. The act introduced the gradual obligation of energy performance certificates for existing residential buildings and the right for potential buyers and tenants to demand an energy certificate.

The latest Energy Conservation Act of 2009 tightened the requirements for new and existing buildings, raising standards by 30 percent and heat insulation by 15 percent (compared to the 2002 act) and made energy performance certificates mandatory for all new buildings/units and for existing buildings/units when sold or rented.

7. THE THREE PILLARS OF GERMANY'S INTEGRATED PROGRAM OF ENERGY EFFICIENCY IN BUILDINGS

Energy-efficient construction and refurbishment are based on three pillars:

- energy demand regulations and legislation;
- financial incentives for energy conservation;
- energy-conservation information and advice.

Box 6 shows the components of these three pillars. Below we explain how each pillar works in practice.

Box 6: Three Pillars of German Energy Conservation and Renewable Energy Programs

1. Demand reduction through regulation and legislation

- Energy Conservation Act (EnEV 2002) – Amended 2007 and 2009
- Heating Costs Act (HeizkostenV, 1981) – Amended 2009
- Renewable Energies Heat Act (EEWärmeG, 2009)
- Renewable Energy Sources Act (EEG, 2000) – Amended 2009

Responsibility: Federal Ministry, Regional Governments

↓ ↓

2. Promote alternatives

- Market-Incentive Subsidy Program (MAP) for the Development and Application of Renewable Energy (through loans and subsidies)
- KfW energy-efficient construction and refurbishment programs
- KfW funding programs for municipalities to invest in sustainable infrastructure
- Renewable energy
- Program for energy consulting
- Regional and local programs for delivery

Responsibility: KfW,[1] BAFA,[2] regional and local banks

3. Information and advice

- Public relations
- Pilot projects
- Market instruments, such as energy performance certificate
- Networking
- Know-how transfer
- International liaison

Responsibility: DENA,[3] regional and local agencies

Notes:

1. Kreditanstalt für Wiederaufbau (KfW) is the public investment bank for the German government.
2. BAFA is the German Federal Office of Economics and Export Control.
3. Deutsche Energie Ageutur (DENA) is the official government body created to promote energy saving and renewable technologies.

7.1 Pillar 1: The Regulatory Framework to Limit Demand

The primary legal tool in reducing energy use is the Energy Conservation Act, which was amended in 2009, as detailed below.

Modernization of old buildings

- For major changes to the building envelope (such as the roof, exterior walls, window), the energy-efficiency requirements will be tightened by 30 percent.
- Following modernization, the annual energy requirement must be 30 percent lower than before and the building envelope must be 15 percent more energy efficient.
- Technical systems for heating, hot water, ventilation, shading, cooling should use the most efficient technology (such as solar thermal).
- Energy sources should be selected according to their climate change impacts and their CO_2 emissions (for example, renewable energies rather than oil or gas).
- Energy Performance Certificates are mandatory. The professionals who issue them must have recognized qualifications (see Box 19).
- Retrospective requirements are in effect for existing buildings, particularly for attic, top floor ceiling, and roof insulation; also and ventilation systems that were installed under earlier much lower requirements. Old heating boilers must be replaced, and after January 1, 2020, night storage heaters more than 30 years old must be discarded.[50]

A second legal instrument is the strengthened Heating Costs Act of 2009. This act forms part of the integrated energy and climate program agreed by the European Union in 2007. The act regulates the distribution of costs for central heating and hot water in rental properties based on size of unit and consumption. With the 2009 reform, the proportion of heating charges tenants pay greatly increased to create incentives for energy conservation.[51]

A third key legal instrument is the Renewable Energy Heat Act of 2009. This act regulates the use of renewable energy for heat supply in newly constructed buildings. This act was introduced for three main reasons:

- climate protection and sustainable energy production;
- reduced dependence on energy imports;
- further development of renewable energy technologies.[52]

The act increased the target for renewable sources of energy for heat to 14 percent by 2020. To help achieve this target, owners of new buildings are obliged to meet 15 percent of their heat requirements from renewable sources. For owners of existing buildings, the target is voluntary. The aim of the higher target is to increase incentives for renewable energy.

7.2 Pillar 2: Government programs to promote energy conservation

Government programs to promote energy conservation in housing have been in place since the 1970s, although initially on a small scale, such as for roofs (1970s) and windows (1980s). Subsidy programs are offered through four channels:

- the Kreditanstalt für Wiederaufbau (KfW)
- the federal government
- regional governments (Länder), and
- municipalities.

The KfW, a bank of the federal and regional governments, is the main funder, rather than the federal government. The government and the KfW enter into contractual agreements on the delivery of programs, defining the specific requirements and conditions, such as who has access, the amount of funding available, the level of subsidy to interest rates. Box 7 summarizes the main features of KfW bank.

7.2.1 KfW Programs

The KfW Program for Energy Efficiency in Buildings began in 2001 with funding for specific measures, such as the replacement of windows and heating systems as a way to promote energy-efficient construction and refurbishment. This program, which ran from 2001 to 2006, provided about 450,000 loans, totaling approximately €24 billion. It improved energy performance in more than 1.2 million housing units, averaging €20,000 per unit in subsidized loans, mainly for new housing.[53] The strong focus on refurbishing residential homes began in 2006, supported by €1 billion per year in federal funds. The 2008-2011 federal budget for energy-efficiency programs totals approximately €1.4 billion a year.[54] KfW improves the existing housing stock through loans, grants, and special subsidies.

The federal government sponsors KfW funding streams for energy-efficient refurbishment under the CO_2 Building Rehabilitation Program. The value of the loans, subsidies, and repayment levels is based on the value attached to energy-efficiency standards, shown in Figure 13. The Energy Conservation Act dictates the energy standards. The energy-use level advocated for **new** buildings is 55-94 kWh/ per square meter per year. An “efficient” new home consumes 85 percent of the baseline (that is, at least 15 percent less energy than the baseline of 100 in the energy conservation act), and a “passive” new home consumes 40 percent of the baseline of 100. Such energy-efficient homes require innovative heating technology using renewable energy and the highest possible level of thermal insulation. They are therefore considerably more expensive than average new homes.

Box 7: KfW Banking Group

The KfW is a public institution with more than 4,000 employees, set up after WWII to run major public investments in rebuilding Germany, particularly its largely damaged or destroyed housing stock. The federal and regional governments of Germany own the KfW bank, and the federal government appoints all members of the supervisory board. The board includes representatives of several ministries, the upper and lower Houses of Parliament, public and private banks, industry, associations of municipalities, agriculture, the crafts, trade and the housing industry, and trade unions.

KfW's functions are to:

- promote particular activities through favorable finance mechanisms;
- grant loans and other forms of financing to regional and local authorities and special purpose agencies as regulated by public law;
- finance measures with purely social goals, including educational development; and
- grant financial support on wider issues that are in the interest of the German and European economy.

Examples include:

- start-ups for small- and medium-sized enterprises, including professions and businesses;
- risk capital;
- housing development and renovation;
- environmental protection;
- infrastructure;
- technical developments and innovation;
- internationally agreed subsidiary programs;
- development cooperation.

Other promotional activities relate to laws, regulations, and official guidelines deriving from the federal or regional government related to economic policy.

KfW bank has a registered share capital of 3.75 billion euros. The federal government participates in the share capital with 3 billion euros and regional governments with 750 million euros. However, the 3.3 billion euros for the registered share capital is a one-off payment that remains within the institution. The rest is share capital that may be requested by the Board of Supervisory Directors of KfW from the government when required to meet the institution's agreed liabilities.

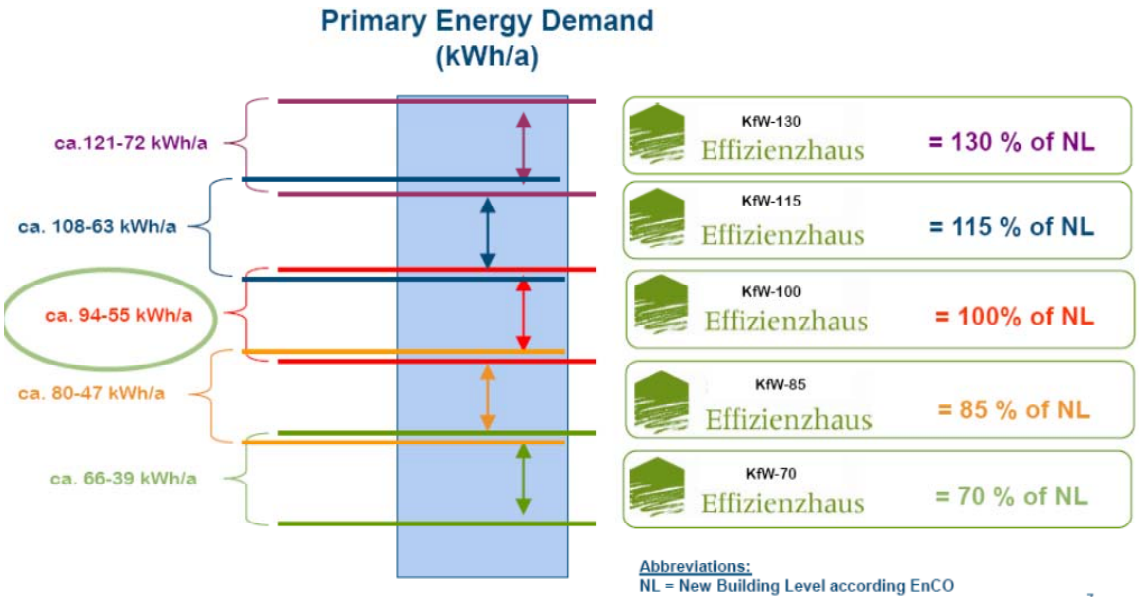
The bank itself has three banking groups, each providing particular programs geared to the different needs of different bodies:

- the Privatkundenbank supports diverse owners of residential housing;
- the Kommunalbank supports municipalities and public and nonprofit organizations that own schools, kindergartens (nurseries), and other public buildings;
- the Mittelstandsbank supports owners of commercial buildings.

The federal government guarantees all obligations of the bank in respect of loans and bonds issued by the bank, commitments or agreements entered into by the bank and other funds extended to the bank as well as funds extended to third parties in as much as they are expressly guaranteed by the institution.

KfW operates with the key guideline that their social responsibilities must be met with a full commitment to sustainability.

Figure 13. KfW Efficient Housing Standards (energy use in kWh / square meter / year)



Notes: A typical German apartment is 85 square meters. A typical home in the United Kingdom is approximately 100 square meters. U.S. homes tend to be bigger. The left-hand column shows the bands of kilowatt hours (kWh) consumed per square meter per year used to measure the efficiency of the house. The right-hand column shows the KfW levels of efficiency used to assess the eligibility for different subsidies and loans. NL stands for the new building standard baseline rating of 100. The *lower* the rating, the *greater* the energy efficiency. The best performance is the lowest use of kWh per annum per metre², i.e. 40 KwH/pa/m² or below, the 'Passive House' standard.

Source: M. Schönborn, "Germany's 'Pot of Gold': Paying for Retrofit." Presentation at the conference *The Great British Refurb: 40 Percent Energy Reduction in Homes and Communities by 2020 – Can We Do It?*, London, December 8, 2009.

The standard for existing homes is 140 percent of baseline levels, owing to their much greater energy demands and generally lower efficiency standards. Financial support for energy-efficient refurbishment is available to homes that perform at 130 percent after remodeling. To meet the energy standard for an efficient home, heating systems, thermal wall insulation, roof and floor insulation and windows are required.

KfW's Efficient House level of 85 for **existing** houses is close to the new building standard, 15 percent better than the new build baseline standard of 100 and 55 percent better than the legal minimum requirement for existing homes.

KfW funds are provided as loans or subsidies, or sometimes both. Box 8 and Figure 14 explain the steps to secure a KfW energy-efficiency loan. Box 9a outlines the loan conditions and levels; Box 9b explains the procedures for different types of housing; Box 9c outlines the actual amounts and how

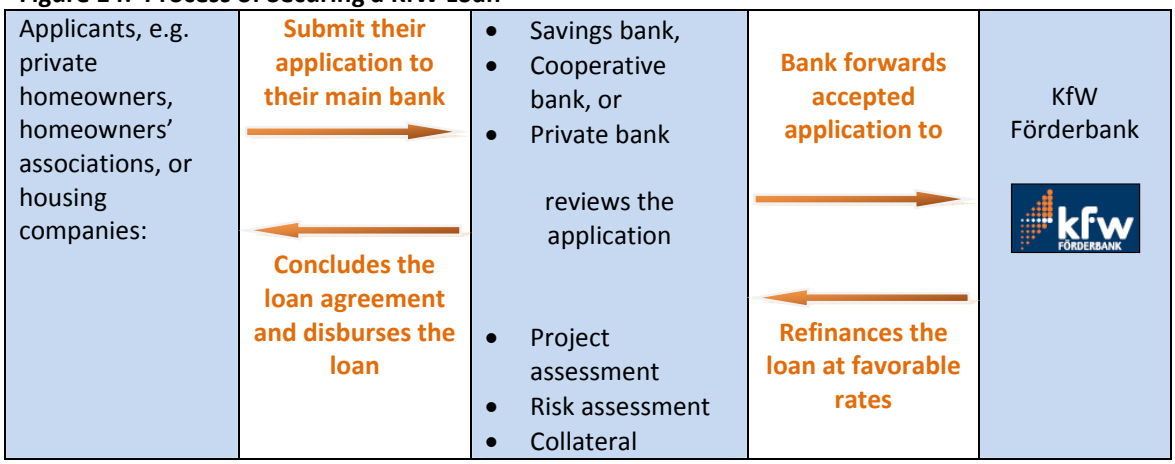
subsidies work. Box 10 explains the additional special support funds available for technical advice and other specialist requirements. Funded programs for municipalities and public and nonprofit organizations are shown in Box 11. Programs for municipalities and public and nonprofit organizations are shown in Box 12. The KfW uses a network of local commercial banks to process applications, loans, and repayments and to help borrowers. The KfW also runs a special modernization program for applicants who fail to meet the tough requirements of the government-sponsored KfW programs. These loans are less generous because the qualifying conditions for borrowers are less stringent.[55]

Small-scale owners who rent out their properties fall under the "*de minimis*" regulation (that is, their scale of operation is too small to fall within the regulations) of the European Union, according to which they may only receive funding for three years and a maximum of €200,000.

Box 8: Steps Required to Secure a KfW Loan

1. A qualified and registered energy adviser confirms the applicant's CO_2 savings.
2. The borrower's local bank submits the application to the KfW with the CO_2 certificate, on behalf of the borrower.
3. The KfW checks that the technical specifications meet the requirements of the specified program and sends a confirmation of the loan to the borrower's bank, which is legally responsible for the agreed loan.
4. The borrower's bank uses the credit approval to draft a loan contract with the client.
5. The borrower's bank receives the money from the KfW within 12 months of receiving the loan approval, although an extension can be granted for up to 24 months if necessary.
6. The loan must be used either in full or part within three months of receipt.

Figure 14: Process of Securing a KfW Loan



Source: M. Schönborn, "Germany's 'Pot of Gold': Paying for Retrofit." Presentation at the conference *The Great British Refurb: 40 Percent Energy Reduction in Homes and Communities by 2020 – Can We Do It?*, London, December 8, 2009.

Box 9a: Details of KfW Loans Available for Remodeling Residential Housing at Different Levels of Energy Efficiency

Loans are available for up to 100 percent of investment cost, including additional costs (for example for an architect or an energy-conservation consultation), depending on the planned energy efficiency. The "whole house" approach is funded more generally than individual measures or combination of individual measures:

- Maximum €75,000 per housing unit for "efficient house" standards (a comprehensive approach). Bonuses are available; the highest bonus applies to homes that achieve an efficiency of 85 (see Figure 11).
- Maximum €50,000 per housing unit for individual or combined measures.
- A combination of KfW loans and other funding in the form of loans, grants, or subsidies is allowed so long as the total amount does not exceed the total expenditure.
- Loans last for 10 to 30 years.
- The higher the energy improvements, the lower the interest rate. For the "efficient house" standard, the current interest rate is 1.75 percent, while for individual measures, it is 2.45 percent. The interest rate is fixed for the first 10 years.

Owner-occupiers, landlords, and buyers of newly refurbished residential units, including individuals, housing companies, housing cooperatives, municipalities, district bodies, community groups, and other public or nonprofit bodies, are eligible for the loans.

Box 9b: Qualifying for KfW Subsidies

Subsidies are available for remodeling homes to meet "efficienct house" standards and also for a combination of measures. Subsidies cover a percentage of the investments over €300. The higher the energy efficiency, the lower the rating; 85 is the lowest and 130 is the highest rating to qualify for a subsidy:

- Subsidies are only available to owners of up to two housing units, to purchasers of newly refurbished one- to two-family units, and to owner-occupied cooperatives.
- Applicants apply directly to the KfW and not via credit institutions.
- "Efficient house" subsidies require a certificate from an approved energy adviser.
- Houses in conservation areas or that are protected (listed) can be exempt from some technical requirements. Exemptions must be approved by the German Energy Agency (DENA) (see below), and must include a statement from the conservation authority confirming the conditions attached to the refurbishment.
- The proposed measures must be completed within 36 months of the subsidy approval.

Subsidies cannot be combined with loans from federal or regional governments, but they can be combined with subsidies from other bodies so long as the total subsidies and bonuses do not exceed 10 percent of the investment cost.

Box 9c: KfW Investment Subsidies by Energy Efficiency Levels

Subsidies are available for remodeling to meet "efficient house" standards and also for individual and combined measures. Subsidies cover a percentage of the costs over €300. The higher the energy efficiency, the greater the subsidy.

Efficient House Standard	**Investment costs that can be met by KfW program**	**Maximum subsidy per housing unit (€)**
130	10 percent	7,500
115	12.5 percent	9,375
100	17.5 percent	13,125
85	20 percent	15,000
For individual or combined measures:		
	5 percent	2,500

- Applicants apply directly to the KfW.
- Subsidies are available regardless of an applicant's income. Applicants qualify so long as they fall into the group of persons/housing units requiring energy-efficient investment (that is, owners of two to four family homes for rent or personal use; to purchasers of newly refurbished one- or two-family units; to owners of apartments within cooperatives (for rent or own use); and to owner-occupied cooperatives. For these applicants, it is generally more difficult to obtain a loan from their local bank because of the smaller amounts of funding required.
- Larger landlords and landlords of multi-unit buildings are eligible for loans.
- The work must be undertaken by paid workers and meet the technical requirements of the program.
- Applications require a certificate from an approved and certified energy adviser.
- Houses in conservation areas or that are protected (listed) because of their special significance can be exempt from some technical requirements. Exemptions must be approved by the German Energy Agency (DENA) and include a statement from the conservation authority confirming the conditions attached to the refurbishment.
- The proposed measures must be completed within 36 months of the subsidy approval.

KfW subsidies cannot be combined with loan subsidies from federal or regional governments. They can be combined with subsidies from other bodies so long as the total subsidies and funding from other sources do not exceed 10 percent of the eligible cost.

Box 10: KfW Special Support for Specific Energy Saving Functions

Special support subsidies are available:

- To cover 50 percent of the cost of expert advice on technical building issues during the refurbishment phase, with a maximum grant of €2,000 per measure.
- To dismantle and dispose of night storage heaters (€150 per storage heater)
- To upgrade existing heating systems (25 percent of the cost).

These subsidies are available for "efficient house" renovation, and also when more than one energy saving measure is adopted – payable for costs above €150.

Box 11: KfW Loans for Nonresidential Units

Energy efficient refurbishment by municipalities

Loans are restricted to local government and their legally related organizations and community associations.

Social investment loans for energy-efficient refurbishment

These loans are restricted to nonprofit organizations, including churches:

- For refurbishments meeting the Efficient House standard and for individual and combined measures, loans are available.
- Refurbishments meeting "efficient house" standards can receive a maximum of €350/square meter. For individual measures, funds are available up to €50/square meter. For a combination of at least three measures, loans are available for up to €200/square meter. For more than three measures, an additional €50/square meter for each additional individual measure can be obtained.

Loans of up to 100 percent of investment costs for public buildings and buildings that qualify within the "Regional Infrastructure Improvement Program" are available.

7.2.2 Federal Government Programs

The federal government runs three subsidy programs in addition to the KfW programs:

- A subsidy program for renewable energy (MAP)
- An energy advice program
- A program for remodeling federal government buildings, including military buildings

The Market-Incentive Subsidy Program for the Development and Application of Renewable Energy (MAP) is the government's main instrument for promoting renewable energy in home heating, with the aim of reducing the dependence on fossil fuel. It was introduced in 1999 and has grown in scale since then.[56]

The subsidy programs for on-site energy advice was expanded in 2009 to help defer the cost of energy assessments and expert energy advice required for housing refurbishment funding applications. This subsidy is linked to the KfW energy-efficient refurbishment programs, either to meet the "efficient house" standard, involving a combination of at least two individual measures. A qualified energy adviser must be the applicant. Eligible advisers include:

- Engineers and architects with a specialist qualification or at least two years experience in energy consultation.
- Trained and certified building energy adviser belonging to trade organizations.
- Individuals who have done certified training in relevant subjects.

Professional advice is widely used and followed through. In 2005, 95 percent of those who received accredited, professional advice subsequently modernized their units. In 2005 alone, €86 million was

invested. Following advice, individuals invested approximately €36,000 per retrofit home in energy-saving measures, totaling €460 million in 2005.[57] Box 12 shows how the advice is funded.

Box 12: Federal Subsidies for On-Site Energy Consultation

Refurbishments to meet "efficient house" standards and refurbishments of buildings constructed before 1995 and where the building envelope did not change by more than 50 percent require validation from an energy adviser. The adviser's report includes an assessment of existing standards, a refurbishment plan, and advice on funding possibilities.

A subsidy of €300 covers an assessment of a one- to two-family home, and a subsidy of €360 covers a building with at least three housing units. The adviser receives the subsidy directly. Only advisers with no personal interest in the investment decisions are eligible. Extra funding is available for savings advice and special tests. For example, €50 is available for the integration of energy-saving advice, €100 for air tightness tests, and €25 for thermal imaging (up to a maximum of €100). The total subsidy (including extra bonuses) is limited to 50 percent of the adviser's costs.

The Federal Office of Economics and Export Control (BAFA) maintains an up-to-date list of approved training courses and only recognizes courses that meet the BAFA requirements. The training and qualifications of advisers are assessed as the part of the process of applying for the subsidy. Subsidy approval validates the training and qualifications and automatically entitles the adviser for future subsidy applications. The adviser will then be registered on the BAFA approved adviser list. The on-site energy adviser is distinct from the registered, qualified assessor for energy performance certificates for buildings, to avoid any conflict of interest.

For more information see BAFA, *Energiesparberatung,* online at: http://www.bafa.de

A smaller-scale funding program supports the refurbishment of federal government buildings to improve energy efficiency, test the use of new technologies, and promote innovative products and methods, including combined heat and power. This programs formed part of the German government's stimulus package of 2008-11, and fosters high-tech innovations.

Regional and Local Programs

In addition to KfW and federal programs, various regional and local programs implement energy-saving measures in housing, funded through regional and local governments using their strong, decentralized powers and resources.

Regional governments and municipalities can institute additional requirements from those set by the federal standards. Regional governments also promote particular approaches, such as targeting specific social needs or types of building. This funding complements KfW and federal funding. Cooperation between KfW and regional governments often leads to funding for particular projects.[58]

7.2.3 Municipalities

Germany's 12,000 local municipalities are responsible for 70 percent of public sector emissions. Municipal buildings (176,000 in number) are responsible for two-thirds of the problem.[59] Energy costs associated with these buildings are extremely high, with 80 percent spent on heating alone. More than €700 billion of investment is needed by 2020, according to Federal officials[60]. Public authorities attempt to make their cities greener, but they are stymied by lack of information, personnel and financial ability, and a systematic approach. In response, the German Energy Agency offers municipalities:

- support in creating energy management systems;
- assistance in reducing inefficiency;
- energy services (through, for example, Energy Performance Certification, energy saving plans, and contracting);
- information on funding possibilities.

Local municipalities and community-level government are increasingly involved in energy management, including long-term strategic planning, contracting, ongoing monitoring, resident involvement, funding checks and the establishment of data banks. As the importance of energy rises, local government takes on greater responsibility.[61] Many communities have participated in the European Energy Award competition, which uses a point system to assess the energy-based activities of communities. The process is based on stock-taking and the development of a comprehensive action program. If more than 50 percent of prescribed measures are implemented, the community receives an award. If 75 percent of the possible measures are implemented, the community receives a Gold European Energy Award. The impact of the award system on local performance is evaluated every three years. Lörrach, a community near the Swiss border, won the award in 2007 with 67 percent of its plan implemented.[62]

Educational Buildings

The Ministry of Economics and Technology and KfW's programs for municipalities have funded some model modernization projects for schools, kindergartens, and student halls of residence. Results have been very positive.[63] For example, Käthe-Kollwitz-Schule, a vocational college built in the 1950s in Aachen, reduced energy consumption for heating and hot water by 68 percent through retrofitting energy-conservation measures and reducing electricity consumption by 15 percent. Plappersnut, a kindergarten in Wismar, reduced its energy consumption by more than two-thirds. This huge gain in energy efficiency, along with reductions in health-related absences, has

encouraged 300 other kindergartens to retrofit their buildings. See Part 2 (Case Studies) for more details on refurbished schools and day nurseries.

Stadtwerke

Municipalities also have their own programs, which vary widely because of different political, economic, and social conditions. Many municipalities have their own investment bodies, called Stadtwerke ("city works"), which play a major role in energy infrastructure and energy provision. Box 13a describes their role in more detail. Box 13b explains the role of small, community-owned green energy companies created in the wake of the climate change agenda.

Box 13a: The Role of Stadtwerke

Stadtwerke have provided cities with energy, materials, and electricity services for more than 100 years. They invest in the local infrastructure, in grids and mains, in new power stations, and in new services. Because they are municipal organizations and therefore not profit based, the monies they collect are used to supplement local public funds or to finance costly local services that need subsidies, such as swimming pools and public transport.

The Stadtwerke are major players in new developments in energy and water systems. Many Stadtwerke support the installation of photovoltaic plants, the operation of natural gas vehicles in their area, and other new technology fields. They convert their vehicles to natural gas or electric power, operate natural gas supplies at petrol stations, and install photovoltaics on public buildings. Many Stadtwerke produce their own energy through combined heat and power plants, thus contributing to a competitive energy market.

The Stadtwerke are more than simply supply companies. Deeply embedded in a town's history, these organizations are unusually public spirited and community and citizen oriented. They remain current on local issues through their constant association and interaction with local agencies, cultural bodies, and social initiatives, and their strong sense of corporate social responsibility often make them the leaders in changing social, ecological, cultural, and economic conditions, as well as in contributing to wider societal goals, such as climate change and energy conservation. Several major cities, including Munich and Hanover, have highly successful *Stadtwerk*e that offer models of energy conservation investment and renewable energy innovation.
Source: www.meine-stadtwerke.de

Box 13b: Eco-electricity Companies

Approximately 10 years ago, many smaller, **eco-electricity companies** (Öko-Strom Firmen) were created to provide specifically environmentally friendly electricity and to actively pursue energy policy in contrast to the large companies. Their popularity has led to consumers becoming increasingly critical of "traditional" providers, including Stadtwerke. The growing demand for eco-electricity has led to the development of hundreds of eco-electricity providers. Currently, approximately 600 providers offer 100 percent eco-electricity products (100 percent from renewable energies, combined heat and power plants, or a mix of the two). Consumers in almost all regions of Germany can get a better eco-electricity tariff than the general electricity tariff charged by the standard providers.

The city of Hanover provides one of the best examples of municipal initiative coupled with the local energy company or Stadtwerke. Hanover is particularly active in the promotion of energy-efficient housing. In 1998, the city, along with twenty surrounding towns and municipalities, and the publicly owned energy supply body founded a city-based energy-conservation agency, ***Enercity-Fonds proKlima***. This agency spends about €5 million a year to supplement federal and KfW programs. It runs on a co-operative structure, making it unique among European energy agencies. At its founding, the co-operative partners created an annual fund of €5 million to promote energy efficiency. Approximately 80 percent of this fund comes from the local energy supply company's profits from the previous year, including a share of the gas sales price.

ProKlima has become a model of how to forge the pace of change through Germany's decentralized government structure. Box 14a explains in detail the way proKlima operates. Box 14b outlines its special projects.

Box 14a: ProKlima's City and Metropolitan Model

In 2008, Climate Alliance Hanover 2020 outlined the ProKlima goal of significantly reducing CO_2 emissions by 2020. CO_2 emissions from electricity and heat generations are expected to fall by 40 percent in comparison with 1990 levels, a reduction of 1.84 million tons a year. **The Hanover Stadtwerke**, the local energy supply organization, will work toward this goal through district heating and energy efficiency gains in power plants; it will also increase the proportion of renewable electricity. Industry, commerce, individual households, and the city administration itself are expected to contribute to the energy savings. ProKlima's programs provide financial support and expert advice for achieving this goal.[64]

Using funding from the KfW and the federal government, **ProKlima supports only work that advances energy conservation beyond than the legal requirement**. Its aim is to supplement, rather than replace, funding available at the national level. The ProKlima catchment area covers nearly one million inhabitants. ProKlima funds several separate local support programs, including, existing buildings, renewable energies, combined heat and power plants, and initiatives in schools.[65] Seventy percent of the annual budget of €5 million goes to the following:

- Modernization of existing residential buildings (€2m per year)
- New construction – "Passivhaus" Standard (€300,000 per year)
- Renewable energy (solar and biomass) (€300,000 per year)
- Expansion of combined heat and power plants
- Energy-conservation advice for households
- Provision of teaching materials on climate protection and solar energy for schools

The remaining €1.5 million go toward individual measures not eligible for public support. One of the main aims of the program is to boost the local economy. Therefore, the work is usually funded only when it is delivered through paid workers. The work also includes special projects, such as development of a residential area, promotional events about solar energy, the installation of bio-gas plants and hydroelectric power stations.

There are **four fixed criteria for support**:

- CO_2 emissions reductions
- Efficiency (i.e., cost per ton of CO_2 saved)
- A multiplier effect, that is, reaching expanding numbers
- Increased innovation

ProKlima promotes community energy conservation through local organizations. These partner organizations fund advice through energy conservation parties. If a household agrees to hold an energy conservation party for its neighbors, friends, and family, ProKlima will send an expert who will measure the energy use of the host household, calculate the savings that can be achieved both in energy bills and CO_2 emissions, and provide addresses and prices for energy conservation products. The host of the party also receives a free energy conservation device that saves 130 kg CO_2 and reduces energy bills by €40 per year.[66]

ProKlima focuses strongly on quality assurance and further education through its funding mechanisms. For example, the complexity of modernizing old buildings makes it difficult for a lay person to create and adopt energy conservation practices unaided. This situation has led ProKlima to introduce special energy advisers. These energy advisers must have experience with major modernization to 'Passivhaus' standards, such as the building envelope, ventilation with heat recovery, or proof of high-efficiency project delivery. Persons interested in becoming a ProKlima adviser need to provide full documentation regarding their training and qualifications and to undergo an interview with ProKlima before becoming officially designated a "ProKlima adviser."

ProKlima provides financial support for energy advice to householders needing expert guidance, , issues certificates to qualified advisers, and supports courses to acquire the relevant skills. Energy advice for new building has a maximum subsidy per building of €500. For existing buildings, ProKlima has a sliding scale, depending on the complexity of the modernization project; the maximum subsidy ranges from €500 for the implementation of at least one energy conversation measure to €2,500 for multiple measures. The energy requirements of the building after the modernization is completed must be at least 50 percent lower than the new building standards (based on the Energy Conservation Ordinance) to qualify for this subsidy. It is more generous than what the federal government provides, but the standard is more exacting.[67]

ProKlima promotes innovation to avoid the problems of complex building requirements. For example, heating systems in multi-story buildings tend to lose pressure when they are working, and they end up distributing heat unevenly. Residents solve this problem by raising the overall temperature of the water, thus ensuring that all radiator surfaces are warm enough. This expensive and wasteful approach is avoided with the use of new decentralized heat pumps, which provide an even flow of heat in every area of the building, thus avoiding the loss of pressure and resulting energy losses.[68]

ProKlima will fund building-wide heating systems only if decentralized heat pumps to balance the system are installed. EnEV 2009 made this a legal requirement, but it serves to illustrate the value of local innovation. ProKlima now organizes courses for workers to gain skills and qualifications in these new technologies.[69]

ProKlima's wide-ranging information campaign with the local climate protection agency (Klimaschutzagentur Region Hannover) has been similarly successful. The company has seen a significant response to its documentary and online material, hotline, solar parties, a weekly drop-in service in which an engineer provides free advice, and other events for particular groups, such as

companies, older single-family homeowners, and students. Events in 26 schools in 2008 reached 10,000 pupils.[70]

ProKlima also acts as an international model in retrofitting buildings, pioneering the "passive house" standard in existing homes, and promoting the city-based approach across Europe. In November 2010, it hosted its third international "Efficient Building" conference, which promoted Germany's pioneering standards and programs and invited other countries to contribute their knowledge and experience.

Box 14b: ProKlima's Special Programs

ProKlima supports:

- 400 special projects; and
- 18,000 smaller projects for the general public.

ProKlima develops:

- innovative products, supplies, and services;
- skills of builders and planners;
- publicity campaigns;
- higher standards for new buildings (e.g., passive house construction); and
- low-energy-use certificates, promoting follow-up measures.

ProKlima supplements existing programs in:

- modernization;
- new and retrofitted passive houses;
- solar installations;
- school programs; and
- combined heat and power (CHP).

ProKlima prioritizes:

- energy-efficient building and modernization;
- energy-conservation advice for tenants;
- solar water heating;
- district heating and decentralized energy centers; and
- teaching materials for schools on climate protection and solar energies.

The Enercity-Fonds ProKlima climate protection fund helps local, voluntary, and co-operative bodies deliver climate protection measures. It was the first climate protection fund of its kind in Germany or Europe.

Source: ProKlima, *The Partnership Contract "proKlima" as a Model for Cooperative Climate Protection*, online at http://www.proklima-hannover.de (Accessed January 28, 2010); Tobias Timm, "How Germany delivers." Paper presented at The Great british Refurb, conference held at the London School of Economics, December 8, 2009.

7.3 Pillar 3 – Inform (spreading the word)

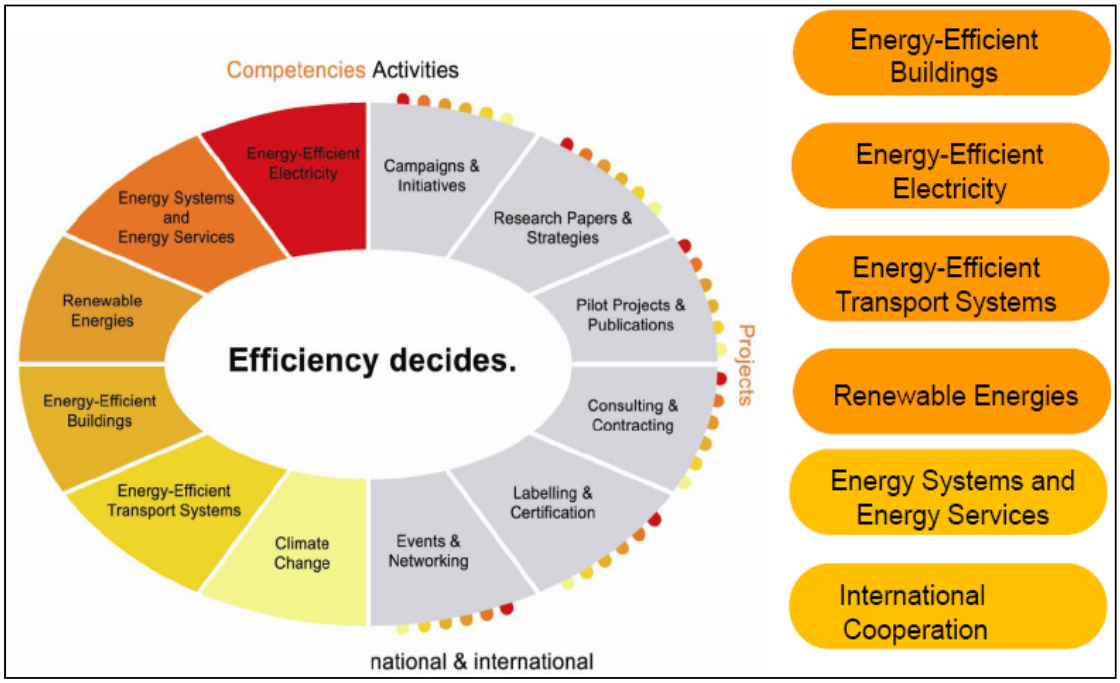
7.3.1 The German Energy Agency (DENA)

DENA was founded by the German federal government, KfW, and three other major banks in 2000 to initiate and implement innovative projects and campaigns on energy conservation at both the national and international level. DENA operates as an independent company with 140 staff member. It links together government activity, subsidy programs to promote energy efficiency, and market activities to spread the adoption of energy efficiency and renewable technologies. DENA's activities fall within five main categories:[71]

- **Developing information and motivational campaigns** to stimulate demand and spread information;
- **Training experts** (engineers, architects, and skilled workers, for example) in new energy conservation skills through documenting evidence and techniques, organizing events, and maintaining online databanks on:
  - modernization of rented homes;
  - standard measures to achieve different efficiency levels in different buildings;
  - best-practice examples for new building and modernization for both residential and non-residential buildings.
- **Increasing transparency in all energy standards and certification** through providing clear evidence and generating support *(*e.g., validated Energy Performance Certificates [EPC] , the voluntary Quality Mark for EPC, Energy Efficient Building Displays);
- **Developing and promoting best-practice projects** to raise quality standards, implement best practices, and establish regional know-how (excellence networks). DENA has developed and tested proposed standards for Minimum Energy houses (Niedrigenergiehaus) on 400 individual projects. This led KfW to adopt these standards and support an additional 5,000 prototype buildings.
- **Simplifying methods and increasing the reliability of outcomes from renovation projects.**

DENA plays a crucial role as a conduit of information, expertise, and practical know-how, but it does not directly provide advice, deliver projects, or handle funding support for projects. In 2010, DENA launched a service to answer queries from experts on assessment methods for buildings at different standards. Queries can be registered online; responses come from experts and are published by DENA. Figure 15 shows the range of DENA's activities and operations. Box 15 summarizes DENA's programs.

Figure 15: DENA's Activities and Operations



Source: DENA, 2010.

Box 15: DENA's Campaigns, Information Services, and Development Projects

- Central information and communications clearing house for implementing the Energy Services Directive (www.energieeffizienz-online.info).
- Central portal for energy efficiency in local government: the key information, links, and recommended actions for energy and climate protection management in local government in Germany (www.energieeffiziente-kommune.de).
- Introduction of DENA "Efficient House" quality mark to increase public awareness of particularly energy-efficient housing. "Efficient House": definition, trial, and market launch of innovative energy standards for buildings.
- The Future House model (www.zukunft-haus.info) to help property owners, local authorities, and professionals; promoted through a vigorous information campaign based on live models and updated annually at the *Zukunfthaus* conference in Berlin.
- Energy Efficiency Initiative, often a complete information service for individual households, industry, and the service sector.
- Low-energy mobility program to help businesses and local government reduce energy use in transportation.
- DENA research: German power generation and integrated grid planning in Germany to 2020 and 2030. Follow-up study on the grid of renewable and on conventional power supplies up to 2025, incorporating 30 percent renewable energy sources into the electricity system.
- "Biogas Partners": a world-leading platform to promote the use of biogas in the natural gas grid.
- Partner in the Russian-German Energy Agency (RUDEA) to boost energy efficiency in Russia and promote Russian-German cooperation, partly to reduce concerns about energy supplies and gas-related political tensions.

DENA also promotes energy-efficient construction in China, offering advice with planning and constructing climate-friendly, energy-saving buildings.

The role of regional and local agencies in DENA work

DENA works with independent regional energy agencies on specific projects. For some projects, DENA sets the standards, but the regional agencies implement them and pass on the expertise to regional bodies, organizations and professionals. Results are fed into DENA's database and shared as widely as possible.[72]

Regional governments, regional energy providers, and municipalities have supported the development of independent or publicly sponsored energy agencies. The agencies' purpose is frequently economic development, and a growing number of agencies focus on specific areas within regions, very much in the model of ProKlima.

7.3.2 The Role of Energy Performance Certificates

DENA plays an important role in Energy Performance Certificates (EPC). The color-coded certificate documents the energy efficiency of a building, with green for high efficiency, moving through yellow and orange, and finally red for poor energy efficiency (for more detail see Box 16). Beginning in 2002, Germany has gradually introduced EPCs for different types of buildings. The certificates are now a legal requirement for all new buildings, and owners must certify any existing buildings when they are rented or sold. Existing tenancies and tied or dedicated accommodations are normally exempt. EPCs are also being widely adopted in the United Kingdom. Figure 16 shows both the energy requirements (top bar) for a particular building and the actual energy use (bottom bar).

Figure 16: Energy Efficiency Requirements and Actual Standards, as Shown on the Energy Performance Certificate

Energiebedarf = Energy requirements
Primärenergiebedarf „Gesamtenergieeffizienz“ = Actual energy use

Source: M. Schönborn, "German Framework and Incentives for Owners and Landlords - Energy Efficiency for Residential Buildings." Paper presented at the conference, Can Existing Homes and Communities Halve Their CO_2 Emissions? Learning from Germany's Experience, London School of Economics, December 10, 2008.

Box 16: Energy Performance Certificates

There are two EPCs: the Energy Requirement Certificate (*bedarfsausweis*) and the Energy Consumption Certificate (*verbrauchsausweis*). The Energy Requirement Certificate contains an objective assessment of energy needs on the basis of a technical analysis of the building structure and the heating system. This allows for energy efficiency comparisons between buildings. This certificate is only legally required for new buildings and for existing building with fewer than five units and built before 1978.

The Energy Consumption Certificate provides an owner information on heating and hot water consumption during the previous three years, using data from invoices issued by energy suppliers and meter readings. This certificate does not allow a direct comparison between buildings because the measurement reflects the behavior of the occupants.[73]

An EPC is valid for 10 years. Information is widely available for particular groups including tenants, town halls, schools, and hospitals.[74] EPCs are issued only by approved energy assessors. The Energy Conservation Act (EnEV) regulates the EPCs, though these regulations vary in some aspects between regions. There are, however, problems of uneven quality among assessors.

The revised EU directives on EPCs from November 2009 aim for wider adoption. A survey of the EPC in Germany in 2008 showed that two-thirds of private landlords did not have an EPCs and fewer than one-half of owner-occupiers were planning to apply for one.[75]

DENA, with partners, also developed a voluntary certificate of quality (*Gütesiegel*) for the Energy Performance Certificate in 2008. The certificate invokes higher standards in order to establish reliable quality measures and to win consumer trust.[76] In November 2009, DENA, with the Ministry for Housing and KfW, introduced a more exacting "Energy Efficient Buildings Label" (*Effizienzhaus*-Label). This identifies particularly energy-efficient houses and larger buildings.[77] The Energy Performance Certificate and the voluntary seal are prerequisites for the more exacting Energy Efficient Buildings Label.

7.3.3 Additional Energy-Efficiency Incentives and Programs

The federal Environmental Ministry has initiated several projects and programs under the "national climate protection initiative." The initiatives target different groups, including consumers, schools, local authorities, and industry. Initiatives include:

- Consumer projects to raise energy awareness and change behavior, encourage the use of energy-efficient technology and renewable energy, and promote emission-free travel in towns and cities;
- Funds for energy conservation in schools and colleges as well as supplying teaching aids and teacher training in energy saving, environmental conservation and climate change, and uses model projects to raise awareness about climate change.
- Programs that fund long-term climate protection ideas at the local authority level, high-efficiency lighting systems in public buildings, and carbon-neutral modernization of school buildings.[78]

The Environment Ministry's also focuses its outreach on low-income households. Local energy agencies hire energy advisers to visit low-income households with free advice on electricity conservation and an energy saving kit worth €20. The ministry recruits energy advisers among those looking for work at local job centers. They require some experience in technical and building work, and they also receive special training. Many are from migrant backgrounds to help reach the diverse populations of poorer neighbourhoods.

The Environment Ministry co-funds the "Climate Seeks Protection" campaign by the nonprofit company C02online gGmbH. The online energy conservation advice lists relevant subsidy programs, records energy costs, recommends ways to reduce energy consumption, records the adopted measures and subsequent levels of satisfaction. This service documents the impact on CO_2 emissions, its costs, and the jobs created in product supply chains and in the building work required to install energy saving measures. Close monitoring of the data on energy savings allows the ministry to better estimate the carbon reduction, behavior change, material inputs, new jobs, and improvements in levels of comfort.[79] Box 17 shows the results of DENA's activities and outreach during the last seven years.

Box 17: Results of DENA's Activities, 2003 to 2009

General public use:

1. DENA's Internet portal (www.zukunft-haus.info) is accessed by 100,000 visitors per month, and 65,000 searches are conducted per month on companies or specialists who can issue Energy Performance Certificates.
2. The free energy hotline receives 60,000 queries about energy efficiency in buildings every month.
3. Approximately 660 million copies of different publications (reports, bulletins and information sheets) have been distributed.

Specialists' use:

- 5 million copies of technical publications (brochures, leaflets, guidebooks, CDs, DVDs) have been distributed to specialist companies.
- 20,000 downloads of the legal/political requirements per year.
- 15 events a year for professionals in the field.

Model Projects

DENA promotes model projects as learning tools, best practices, and idea incubators. Part 2 contains 13 case studies, based on DENA's and ProKlima's best-practice models for existing buildings, including a description of the building, the modernization measures, and the energy rating before

and after modernization. These projects illustrate the impact of the full range of German energy initiatives: legislation, standards, subsidies, loans, advice, publicity, expert advice, new technologies, training of skilled builders and advisers, and others.[80]

8. WHAT GERMANY HAS ACHIEVED

Overall, the three-pillar approach of the German government to energy conservation—legislative framework, reliable funding streams, clear information and promotion—have resulted in strong momentum toward a lower carbon, more sustainable economy.

In an international study of "green" measures and their economic benefits among the G20 countries, and more widely, Germany's energy-efficient buildings efforts were ranked first among 100 policy measures to combat climate change, among all developed countries; its renewable energy and tariff programs were ranked second.[81] Here we summarize Germany's main achievements.

8.1 Progress in Renewable Energy

Since 2000 with the first Renewable Energy Sources Act:[82]

- Renewable energy use has more than doubled from 96,288 GWh to 233,228 GWh in 2008 (from 4 percent to 10 percent of total energy use).
- Renewable electricity generation has risen more than twofold, from 37,217 GWh to 93,543 GWh in 2009 (from 6 percent to 15 percent of total electricity).
- Renewable heat generation has doubled from 57,739 to 110,491 GWh in 2009 (from 4 percent to 8 percent of total energy use).

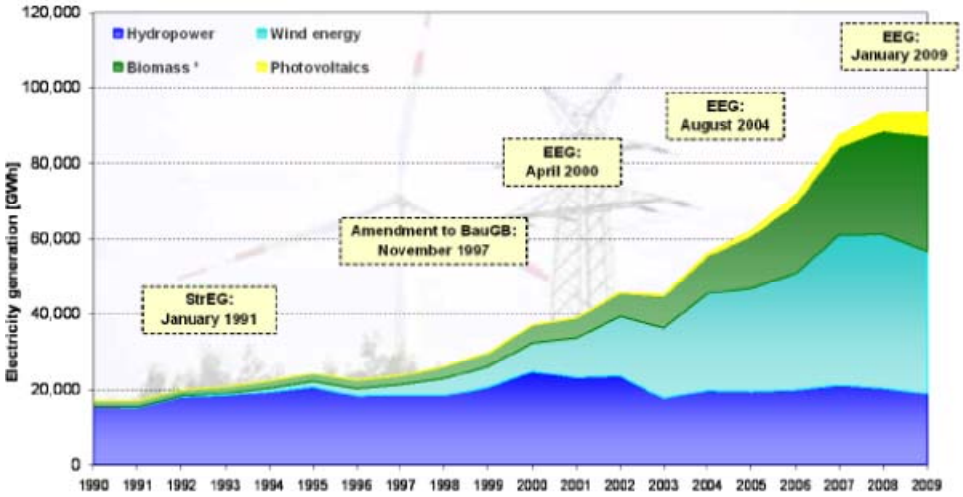
8.1.1 Electricity

The Renewable Energy Sources Act prioritizes renewable sources of electricity in the national grid at largely fixed tariffs over 20 years. In 2009, the act subsidized 72 billion kWh (or 77 percent) of all electricity generated from renewables. The installed capacity for generating renewable electricity rose from 12,000 MW in 2000 to 45,300 MW in 2009.[83]

8.1.2 Heating

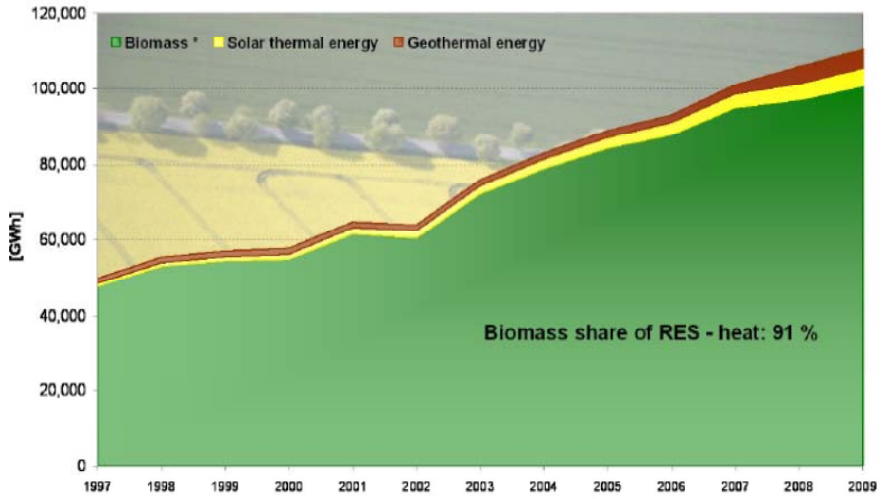
Renewable energy sources contributed more than 110 billion kWh in 2009 compared with just under 58 billion kWh in 2000. Biomass was the largest source, contributing 101 billion kWh. Less than 5 billion kWh was from solar thermal and geothermal energy. All three have expanded rapidly. Wood pellets for biomass have grown rapidly as well, resulting in the installation of approximately 125,000 new pellet boilers in 2009. Heat pumps have also become more popular, with about 400,000 in operation in 2009.[84] Figures 17a and 17b show the growing contribution of renewable energy to electricity and heat production.

Figure 17a: Contribution of Renewable Energy Sources to Electricity Generation in Germany, 1990-2009



*Solid, liquid, gaseous biomass share of waster, landfill and sewage gas

Figure 17b: Contribution of Renewable Energy Sources to Heat Supply in Germany, 1997-2009



* Solid, liquid, gaseous biomass share of waster, landfill and sewage gas

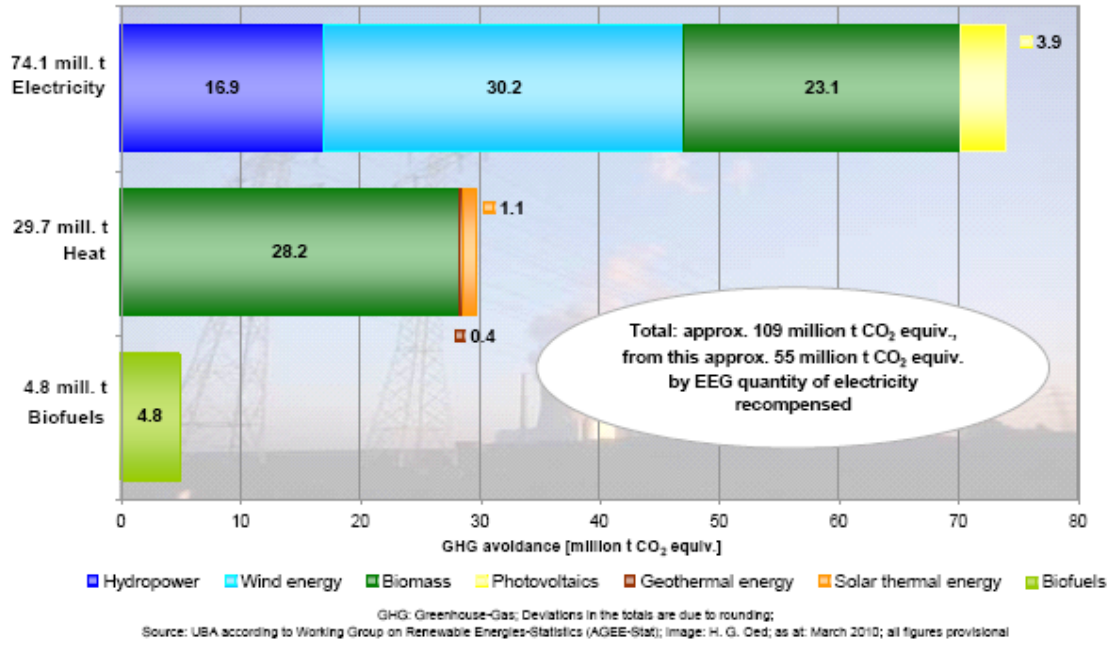
Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Development of Renewable Energy Sources in Germany 2009*, Graphics and Tables Version (March 2010), available from* http://www.erneuerbare-energien.de, www.bmu.de.

8.1.3 CO_2 Impacts

Renewable energy used in electricity, heating, and transport greatly reduced CO_2 emissions. Emissions have declined 21 percent from 948 million tons in 1990 to 748 million tons in 2008. The total CO_2 saved in 2009 through renewable energy was 109 million tons, and the Renewable Energy

Sources Act was responsible for more than one-half of the reduction. CO_2 emissions were 15 percent lower as a result of renewable energy (see Figure 18).[85]

Figure 18: Total CO_2 Emissions Saved Through Renewable Energy Sources in Germany, 2009 (In millions of tons CO_2 equivalent)



GHG: Greenhouse-Gas; Deviations in the totals are due to rounding

Note: Biofuels are increasingly used in transportation

Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Development of Renewable Energy Sources in Germany 2009, *Graphics and Tables Version (March 2010), available from: http://www.erneuerbare-energien.de, www.bmu.de.*

A recent study by the Federal Ministry for the Environment, using updated demographic and economic data, documents improved energy efficiency and energy policy levers, resulting in the following conservation projections:[86]

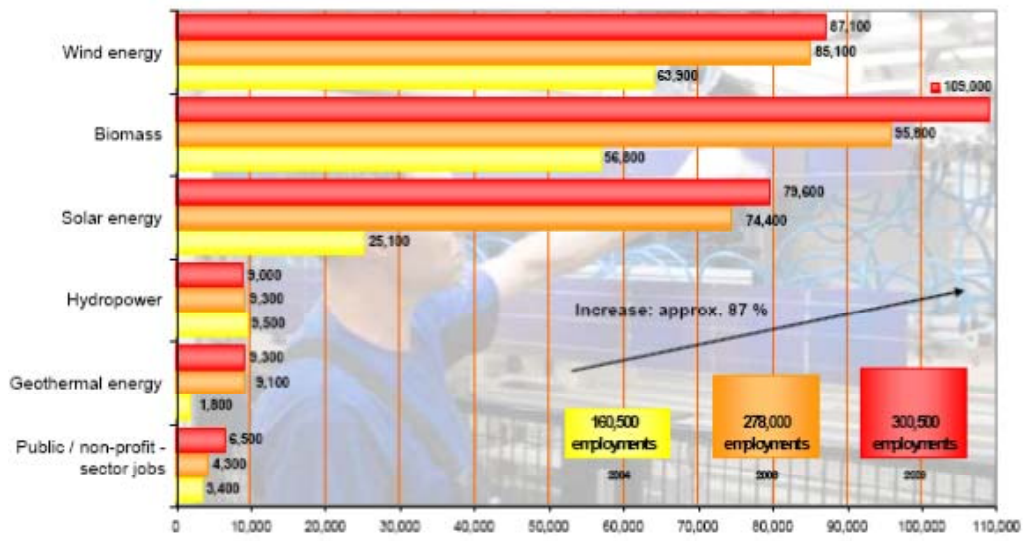
- The share of renewable energy will be 20 percent by 2020 (that is, 2 percent higher than the EU target), 32 percent in 2030, and 54 percent in 2050.
- Renewable energy will meet 35 percent of total electricity generated and 18 percent of heat demand excluding electricity in 2020.

On the basis of current trajectories, the Federal Ministry for the Environment estimates CO_2 savings of 790 million tons per year by 2050, an 80 percent reduction from 1990. The biggest savings will be in the electricity sector (320 million tons), heat (80 million tons) and transport (48 million tons).

8.1.4 Renewable energy's economic and employment effects

Renewable energy is a growth sector in Germany, creating many jobs in production and installation. Jobs in the field increased from 160,000 in 2004 to more than 300,000 in 2009, two-thirds of which result from the Renewable Energy Sources Act. The job growth in building refurbishment programs is likewise significant (around 240,000 new jobs a year since 2006) (see Figure 19). Renewable energy technology exports have also risen, helping the larger economy.[87] Between 2003 and 2009, total turnover in renewable energy production increased from €10 billion to €33.4 billion, including €18 billion investment in production plants and €16 billion in actual manufacture of renewable energy equipment. The biggest investment increase was in electricity generation with a 50 percent increase for biomass, 22 percent for photovoltaics, and 15 percent for wind. Solar thermal and biomass systems now attract the biggest investments overall, albeit starting from a low base.[88]

Figure 19: Jobs in the Renewable Energy Sector in Germany, 2004, 2008, and 2009



Figures for 2008 and 2009 are provisional estimate

Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Development of Renewable Energy Sources in Germany 2009*, Graphics and Tables Version (March 2010), available at* http://www.erneuerbare-energien.de, www.bmu.de

In 2009, the German economy shrank by 5 percent (price-adjusted gross domestic product), with the export sectors particularly hard-hit by the global crisis. Overall price-adjusted investments declined by 12.5 percent between 2008 and 2009. Yet investment in renewable energy technology and plant increased by 20 percent and sales by 10 percent. Similarly, jobs in the renewable energy sector continued to grow, suggesting solid demand for renewable energy sources even in the crisis.[89]

Renewable energy expansion and its related job growth, supported by strong legislation, have been helped by a stable regulatory and funding framework, which aids long-term planning and investment. Continued adaptation, based on clear monitoring and feedback, boosts confidence in the sector.[90]

Germany remains an attractive production center for renewable energy because of its engineering and manufacturing reputation. The German government estimates that up to 400,000 additional jobs in renewable industries will emerge by 2020, with continuing expansion through at least 2030 despite of financial and economic uncertainties. [91] The rate of expansion, however, depends on energy prices and export demand.[92]

8.1.5 Progress in energy-efficient buildings from 2006 through 2009

By far the biggest gains in energy saving can be made in existing buildings. Two-thirds of KfW's loan and subsidy programs between 2006 and 2009 were dedicated to existing homes and one-third were dedicated to new homes. The gains over a four-year period include:

- retrofitting 1 million existing homes with energy-efficient products and building approximately 400,000 new highly efficient homes;
- creating approximately 894.000 jobs in the building and building-supply industries, eventually becoming long-term jobs because of the continuing growth in energy saving activity;
- generating approximately €27 billion in loans and grants;
- generating more than €54 billion total investment;

€2 billion public investment generates investment loans of €9 billion plus the personal investment households make. In total €19 billion of investments were made in energy efficiency in 2009. Low-interest loans to cover part of the cost, and with modest public subsidy, have leveraged major additional investment from private households. [93]

8.2 Energy conservation

Between 2006 and 2009, residents and landlords saved €1 billion per year in reduced heating costs due to KfW energy-saving loan and subsidy programs.[94] Assuming a 30-year term for building investments, and 20 years for renewable technologies, the energy conservation measures will achieve a lifespan savings of 288 metric tonnesCO_2.[95] Energy efficiency has halved energy use in buildings since 2002, from approximately 120kWh per square meter per annum to 60 kWh/sqm/p.a. in new buildings and 80 kWh/sqm/p.a. in existing buildings following retrofit.[96]

There are now 8,000 "Effizienz haus" model retrofits using 30 percent less energy than the ambitious Energy Conservation Act EnEV standard. There are also 32,000 passive homes, using the lowest possible energy, only 40 kWh/m²/p.a.[97] Box 18 illustrates the advances in one region of northern Germany.

Box 18: Energy Conservation Efforts and Results in Northern Germany

Members of the regional association of housing and real estate organizations in Bremen have saved 40 percent in energy consumption after modernization measures, and they have used 16.6 percent less CO_2 across the total stock. The greatest savings were in buildings built before 1978.[98] Neue Vahr, a neighbourhood in Bremen, showed a reduction in energy consumption of 45 percent between 1980 and 2005, largely because of strict insulation standards and the introduction of a combined heat and power district energy plant.

Although the gains are promising, the potential for CO_2 savings through energy-efficient refurbishment is not yet fully realized.[99]

The demand for KfW subsidy and loan programs has grown rapidly since 2001. Table 2 shows the growth of KfW programs since 2006. In 2009, it took a new leap forward, spurred by several incentives, including:

- Low interest rates (1 percent in 2006).
- A severe winter in 2006-2007, which raised fossil fuel prices and demand for insulation and energy conservation.
- The revised Energy Conservation Act in 2009, which raised the requirements for both new and existing buildings.
- Successful information campaigns by DENA and ProKlima, and special projects under the national Climate Protection Initiative.

On the other hand, the increase in the value-added tax in 2007 and again in 2010, has raised the cost of building materials and labor, making investment in retrofit more expensive.

Table 2: Growth of KfW Programs, 2006 to 2009

Year	2006	2007	2008	2009	Total since 2006
Loan commitments (in millions of euros)	6,998	4,782	6,343	8,863[a]	26,986
Housing units (in 1,000s)	328	204	280	617	1,430
CO_2 reduction (in 1,000 tons p.a.)	1,038	568	837	1,452	3,897
Jobs (in 1,000s)[b]	217	177	208	292	894
Investments (in millions of euros)	11,845	10,682	13,248	18,335	54,110

[a] Equals 3,094 million euros for energy-efficient new building plus 5,769 million euros for energy-efficient refurbishment.
[b] Jobs lasting for at least one year

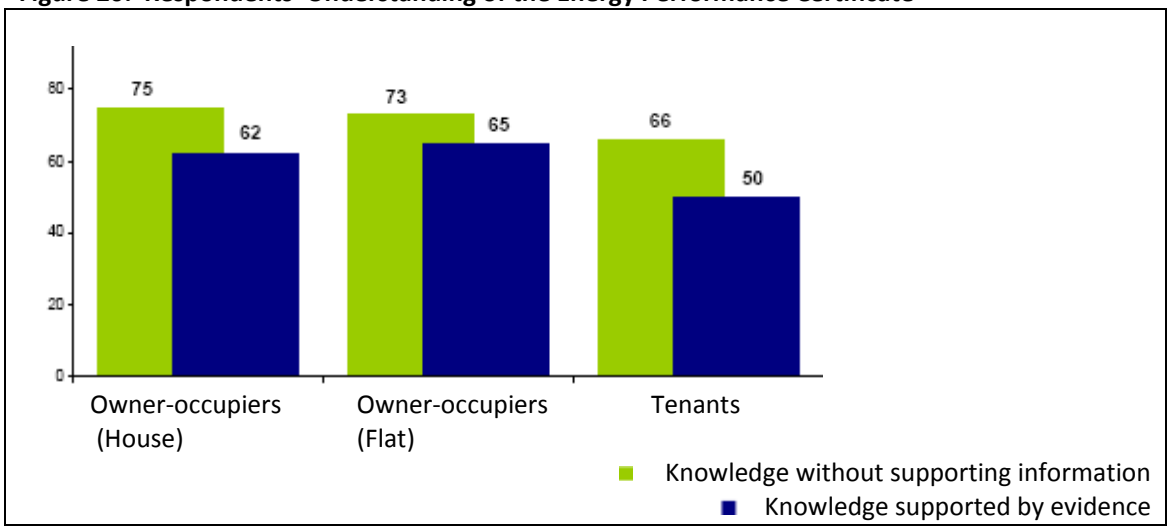
Source: KfW, Ziele und Potentiale der KfW-Wohnraumförderung – Auswirkungen der EnEV 2009 auf die Programs für Energieeffizientes Bauen und Sanieren (Frankfurt: KfW Bankenschulung, Markus Schönborn, March 2, 2010).

8.3 Adoption of Energy-Saving Measures and Future Advances

A survey of tenants and homeowners in 2008 showed that more than two-thirds of the respondents knew about Energy Performance Certificates, and nearly two-thirds were able to explain what EPCs did, including half of tenants, as Figure 20 shows. In 2009, 20 percent of tenants planned to save energy over the next 12 months.[100] Despite the gains, more could be done to improve energy efficiency, including:[101]

- Applying the 2009 Renewable Energy Heat Act to existing buildings, which would require them to devote 15 percent of total energy expenditures to renewable sources.
- Legally prohibiting renewable energy subsidies without proof of substantial insulation. Subsidies for renewable energy would only apply *after* insulation had been installed, not before, thereby doubling the impact on energy supply and CO_2.
- Consolidating many laws and regulations into a single heating and energy conservation act.

Figure 20: Respondents' Understanding of the Energy Performance Certificate



Source: DENA, *Energieausweis für Wohngebäude. Umfrage unter Mietern und selbstnutzenden Hauseigentümern.* Deutsche Energie-Agentur GmbH (dena) / TNS Emnid, November 2008 [DENA, Energy performance certificate for residential buildings. Survey among tenants and owner-occupiers. German Energy Agency (dena) / TNS Emnid, November 2008.]

9. GAPS STILL TO BE CLOSED

To date, 9 million pre-1979 units have been rehabilitated to high energy-efficiency standards. This leaves 70 percent of the existing pre-1979 stock performing below the legal requirement for existing buildings.Refurbishment is still slow in spite of Germany's incentives, publicity and progress. With 20 million units still to be tackled, at the present rate of refurbishment, it will take 80 years to refurbish the remaining stock. Meanwhile, renewal of building parts and demands for ever higher standards will accelerate.[102] The current annual refurbishment rate of 200,000 buildings (around 400,000 homes) must double to complete the process in 20 years.[103] Box 19 shows the main barriers and how they could be overcome.

Box 19: Barriers to Upgrading Current Housing Stock to Energy-Efficient Standards

- **Lack of clarity on standards:** Energy Performance Certificates are far from universal. Only one-third of private landlords have them.[104] Although a high proportion of individual owners who had received professional energy advice later implemented energy-efficiency measures, far more outreach is necessary.
- **A complex refurbishment process and lack of trust in experts, builders, and results**: Networks of architects, engineers, and other building experts should work together to overcome the complexities inherent in the subsidies and standards. Too often they contradict or undermine one another, and this problem is exacerbated when there are two sets of advisers: the Energy Performance Certificate Advisers and the onsite energy advisers.
- **A lack of training in complex building refurbishment issues**: Some architects undermine energy efficiency efforts in believing, for example, that "walls need to breathe" and therefore should not be insulated; architecture students then adopt and spread these myths.[105]
- **Costs of refurbishment:** The most energy-efficient steps are sometimes more expensive, with a long horizon to recoup the costs. For example, it may take 20 years to recoup the cost of installing 20-centimeter-thick insulation in exterior walls, the optimal insulation.
- **Impending higher standards as subsidies are limited:** The Energy Conservation Act will raise insulation standards under the current billing codes and loans are availabke to help financially, even thogh the federal government is currently cutting back somewhat on subsidies, loan agreements and levels of the feed-in tariff.
- **Costs in relation to home ownership:** In Germany, homeownership comes later in life than in other countries and the housing is of a high standard. Clearer cost-benefit evidence would drive older homeowners to invest more. Energy efficiency mandates could drive high-cost investments in renewable energy if enforced.[106]

Limitations of the German System

The main drawbacks to the German energy saving programme are:

- The **legal framework** for energy efficient buildings is complex, requiring considerable support and enforcement.[107]

- The **subsidy programs** at federal, regional, and local levels, each requiring explanations and publicity (Merkblätter), are complex. There is no comprehensive national picture because of Germany's highly decentralized system.[108] The German program is a "work in progress," and there are frequent new developments, requiring professional help from energy advisers. DENA's aim is to summarize, simplify, and standardize this process.[109]
- **Renewable energy programs** are complicated, funding many different technologies, with different subsidies and incentives. The renewable heat incentive has generated a large response, but there is a danger of overlap.[110]
- **Regional governments** are responsible for historic building conservation, but municipalities are responsible for the process of protection, resulting in different interpretations of the energy efficiency measures.
- For **landlords**, tenancy laws, legal standards, rent regulation, and loan repayments all complicate decisions about investment in energy conservation. Modernization is a legally valid reason for rent increases, but rent increases cannot by law exceed 11 percent a year. Any public subsidies a landlord receives for modernization must be deducted from the rent increase. This limits what a landlord can invest in energy conservation. Tenants are often in favour of energy efficiency modifications and are willing to accept some increase in their rents, but they also want tighter regulation of rent increases.[111]
- **Renting** is so common in Germany that competition for potential tenants drives landlords to make the best offer possible, including energy efficiency gains. But low-income households will often choose the lowest rents, ignoring future energy bills. Therefore, there is too little pressure on landlords to improve energy performance.[112]

10. LOOKING AHEAD

In 2009, KfW disbursed more than €2 billion in government funds for energy efficiency efforts. In 2010, the amount had declined to €1.25 billion. To achieve the climate protection aims, financial support must at least double. Yet future demand for energy is uncertain. If oil and gas prices decline, even the strongest subsidies will be inadequate. If oil and gas prices rise, as is predicted, energy efficient refurbishment will likely continue, even if government funding is reduced and taxes rise. There are no reliable forecasts for energy prices, subsidies, and value-added tax rates.[113] The German government is nervous about raising standards even further, as implementing them would be expensive and may offer diminishing returns.[114] It would also be harder to enforce standards higher than now.[115] The most likely way forward is to keep pushing in the same direction and allow the pressures on energy supply to push too.

10.1 Learning from Germany's Efforts to Increase Energy Efficiency through Retrofitting

- The three pillars of the German approach—legal framework; subsidy programs; information, advice, and support—build firm foundations for fundamental changes that both international and national bodies agree are vital to the future.[116]
- The links between subsidies and German laws mandating energy-efficiency changes are direct and drive adoption. The minimum standard for energy efficiency in existing buildings is 140 percent of the baseline for 100 new buildings; financial support becomes available when existing buildings reach 130 percent of the baseline, increasing as property owners improve their energy efficiency (see Figure 13). [117]
- Channelling funds through the KfW investment bank underpins the programs and provides government with an investment tool that is immensely powerful across all regions of Germany. KfW does not have to promote itself. It relies on existing local banks to transact business[118].
- Almost all domestic buildings and many publicly owned buildings are eligible for subsidy for retrofit. The goal is to refurbish all homes and public buildings in Germany to make them more energy efficient. Only applicants who are not credit-worthy or who propose over costly measures are excluded from financing. There is no legal limit to eligibility, and particular subsidy programs can apply to exceptional cases.[119]
- A step-by-step approach using pilot projects to develop standards, helps promote programs. A central energy agency like DENA can develop and test individual measures, which are then incorporated into the KfW subsidy programs. Its experimental approach reinforces the legal

framework.[120] Pilot projects persuade housing companies to adopt and promote energy conservation measures, but they also show the government what works.[121]

- DENA's publicity and marketing activities are effective owing to the organization's access to experts (architects, engineers, planners, researchers), who in turn influence clients. Their guidance and expertise reach a very large audience via local agencies.[122]
- Generous subsidies and low-interest loans are combined with highly ambitious standards and a **"**whole house" approach, creating combined investments in energy efficiency and renewable technology (at approximately €36,000 per home) far greater than levels proposed for the United Kingdom (approximately £4,000 to £10,000 in the United Kingdom (up to €12,000). In the United States, ambitions are much lower and the level of investment in retrofitting is correspondingly small, around €3,000.[123] The rate of adoption in Germany shows that a more generous and more exacting approach clearly works. Box 20 summarises renewable energy and energy saving gains.

Box 20: Renewable Energy and Energy Conservation Highlights

- Renewable energy generation and use tripled
- Renewable electricity generation increased 2.5 times
- Renewable generating capacity quadrupled since 2000
- Renewable heating more than doubled, mainly from biomass
- Wood pellet boilers (125,000 sold) and ground-source heat pumps (400,000 sold) are spreading rapidly
- CO_2 emissions from electricity, heat, and transportation have fallen 21 percent since 1990. Germany is on track to surpass its EU-agreed renewable energy target for 2020 and also to achieve an 80 percent reduction in CO_2 emissions over 1990 rates.
- The Feed-In-Tariff funded 77 percent of renewable energy generation
- Economic activity in renewable energy tripled in six years
- 300,000 new jobs were created in 2009 alone
- The financial crisis has not halted growth in renewable energy production or jobs in energy security
- One million homes have been refurbished according to high energy saving standards
- A quarter of a million jobs have been created in the building and supply chain
- Every €1 in subsidies generates €9 in loans and private investment
- €1 billion was saved on the direct cost of heating
- CO_2 savings over the lifetime of the investments total 72 megatons of CO_2
- Energy use in buildings has been halved since 2002
- Energy conservation in buildings has reached 40 percent in parts of Northern Germany

10.2 Lessons

The German energy conservation and renewable energy programs are hard to transpose to other countries. (Box 21 at the end contrasts German's experience with other countries, particularly the

United Kingdom.) Yet, the clear lessons learned there can help us avoid the same mistakes. Key lessons can be summarised under 8 headings:

- Create a **strong, enforceable legal standard** to underpin change and create a measure of certainty about the direction of change.
- Rely on **loans with favorable terms** rather than straight subsidies or tax concessions from the investors to provide enough incentives to draw people in
- Employ building and retrofitting experts so projects are of a high standard and promised energy gains are achieved.
- **Link renewable energy generation to energy conservation measures,** before subsidizing renewable energy through a feed-in tariff. This step can greatly increase the contribution of renewable energy in overall demand and lead to a much greater contribution to the goal of climate protection. This would both save money and double the value of renewable energy.
- Adopt a **"whole house" approach** to energy conservation, even if the measures are implemented in stages, so people can prioritize and plan for ambitious levels of energy conservation. This makes it easier for the government, energy suppliers, and builders to plan for the future.
- Use **pilots and models** to develop new ideas, as this allows experimentation and innovation. It also publicly tests new approaches.
- Retrofit **public buildings as well as private homes** to provide conspicuous examples to the public of what can be done. This is particularly successful in schools, child care centres, and colleges.
- **Changing attitudes and changing behavior** is almost as important as actual retrofit measures.

In wealthy countries like Germany, transitioning to a low carbon economy is extremely challenging, even though it is widely accepted as necessary. Given the challenges, a comprehensive and thorough approach to energy conservation seems both necessary and cost-effective. The German economy gains; jobs and small businesses (builders, suppliers, professional, and technical firms) expand; new skills, innovative approaches, and public engagement gather momentum. The "energy crunch" that all European countries will face in the coming decade becomes more real to people in their daily lives, thus enhancing public support for tackling climate change.

10.3 Pathways to Energy Conservation for the United States

The U.S. economy, with its profligate use of energy, land, and other natural resources in contrast to its capacity for innovation and adaptation to rapid change, could readily follow on the back of hard-won experience in Europe. Federal government subsidies have supported a collapsed housing

market and an oil-driven energy system. It must be possible to subsidize energy conservation, eco-friendly building and remodeling, and a strong renewable energy industry in just as comprehensive a way[124], given the rapid pay-back on new jobs, energy saving and green technologies. Given the US's growing energy and climate pressures, its vulnerability in the global energy scramble, its extreme climate, and its rich sources of renewable energy, it must make perfect sense to race ahead in energy conservation and 'green' innovation.

Box 21: Differences between Germany and the United Kingdom	
Germany	**UK**
Germany's owner-occupied sector is just over 40 percent. The largest sector in Germany is private-renting at 60 percent.	Private renting is relatively small in the UK but growing – form 8 percent (1980) to 15 percent (2009). Owner occupation (70 percent) requires different incentives to encourage investments in energy saving renovation.
In Germany, the main target group for energy saving is private housing companies/**landlords;** but also public bodies e.g. schools	In UK the main target will be **individual home owners** but social landlords offer models and target poorest. Private landlords will be legally obliged to meet energy performance.
Germany's financial support system offers loans and to a lesser extent on subsidies; major shift away from tax incentives (of the 1970s-1990s). **Loans** encourage energy saving because recipients have to pay back so they calculate savings more carefully. Feed-in tariff for renewables shrinking but still very significant.	UK support also shifting from grants to loans for investment in energy efficiency upgrading. Feed-in tariff introduced in 2010- very popular with rapid take up.
The building standards and requirements for energy efficiency are tied to German loan and subsidy programs eligibility and the levels of support are determined by these standards. KfW funding requires specified technical standards, but any measures can be used to achieve the required standards.	Building standards, legislation and financial support programs in the UK increasingly draw on German experience and is setting even tougher targets e.g. the Climate Change Act, the Green deal etc.
Most German homes are flats. Heat requirements and the type of insulation technologies, materials and methods are different.	Most UK housing stock is in single family homes where insulation is more crucial. Flats make up 15 percent of the stock, is easier to insulate and less energy consuming.
Germany has very few *large energy companies* operating nation-wide but many local and regional public supply companies (Stadtwerke) providing electricity. Many small 'green' renewable energy supply companies were set up since 2000 to generate and sell 100 percent green i.e. renewable energy.	In the UK, only two companies provide 100 percent renewable electricity (Ecotricity and Green Energy UK)., but more energy companies are now investing heavily in renewables.
KfW, the German national investment bank, is the major conduit for government subsidies and loans- operating on a very large scale	In the UK major funding for carbon reduction (energy saving and renewables investment) comes through a legal obligation on energy companies to offset their carbon emissions through a 'supplier obligation'.

Germany	UK
In Germany, there is a *legal limit on annual rent increases* (up to 11 percent per year maximum) even after the refurbishment. This restricts how much landlords invest and how much tenants will contribute.	In the UK *rent limits* only apply to social housing. Private landlords have little incentive to invest in energy saving since usually tenants benefit, and rents would become uncompetitive. This conundrum also faces the US, and too a lesser extent Germany.
Germany's programs of loans and subsidies are offered by the KfW Bank but also by regional and local federal governments. The complex financial supports are cash limited as a total. A lay person has to rely on expert advisers to help secure funding. On-site energy advice is subsidised in Germany, to help home owners, but the sheer volume of decisions to take on all the elements of refurbishments is off-putting.	The UK now has much tighter buildings standards, Energy Performance Certificates, renewable energy obligations on energy suppliers, energy saving programs, delivered through energy companies to low income households, Feed-in-Tariffs and many other ideas taken from Germany.
Housing companies and landlords are the largest housing investors in Germany. They have their own experts to call upon and a lot more experience with planning and delivery of refurbishments than individual owners, therefore they can do more.	Energy advice comes through the Energy Saving Trust and directly from energy suppliers. Social landlords in the UK are at the forefront of radical energy saving initiatives; alongside growing numbers of individual owners.
Germany has developed comprehensive information programs (face-to-face events and online) for the general public, educational institutions, local/public authorities and private companies. These both raise awareness and offer free energy assessments, products or vouchers, and recommend approved experts and programs. Germany's efforts to target fuel poverty are much less than the UK. Poor households can receive a payment supplement to help with extra energy costs during extreme weather.	In the UK, large scale awareness programs have been effective when coupled with incentives. There is major press interest in refurbishments (Grand Designs, Heritage Programs etc). energy companies fund Warm Front', a programs to combat fuel poverty with Boiler Replacement, loft and cavity wall insulation, double glazing etc.
Germany's legal, funding and information 'pillars' are well established and far reaching.	The 'whole house approach', 'passive house' standards, feed-in tariff, E.P.C. are in the early stages of development in the UK.
Germany has pioneered the 'Passive House', a model using negligible amounts of energy (and mostly renewable sources) (new build and retrofit). It has also pioneered legal and funding frameworks for renewable energy and energy saving. It out performs all other European countries in these developments.	The UK adopted a Code for Sustainable Homes, emulating German Passive House standards at the highest level of the Code- known as 'Zero Carbon Homes'. The UK has broken new ground with the Climate Change Act setting legally binding commitments to reduce CO_2 emissions by specified and increasing amounts.

PART TWO: CASE STUDIES

DENA Projects

1. One-/two-family home, Hanover
2. Multifamily dwelling, Lichte Weiten, Berlin-Lichtenberg
3. Conservation-protected multifamily dwelling, Berlin-Köpenick
4. Multifamily dwelling, Schulze-Boysen Straße, Berlin
5. Guesthouse, Kanalstraße, Esslingen am Neckar
6. Day nursery, Wolgast
7. School, Ortrand (near Dresden)
8. School, Ludwigshafen am Rhein

ProKlima Projects

9. Single-family dwelling, Bruchstrasse, Ronnenberg
10. Multifamily dwelling, Schaufelder Straße, Hanover (also included in the DENA "Low Energy House in the Existing Stock" program)
11. Multifamily dwelling, Ostland Housing Co-operative, Röttgerstrasse, Hanover (also included in the DENA "Low Energy House in the Existing Stock" program)
12. Multifamily dwelling, Housing Cooperative WOGE Nordstadt eG,Schneiderberg, Hanover (also included in the DENA "Low Energy House in the Existing Stock" program)

Housing Company Project

13. Large residential district with apartment blocks, Märkische Viertel, Berlin

1. One-/two-family home, Hanover (DENA)

About the project:
Housing units: 1
Heated occupied area: 162 square meters (3 stories)
Year of construction: 1954
Modernization completed: 2008

Aim: To open up the corridor and staircase areas, restructure the layout of the living space, and turn the extension into a terrace.

Modernization measures attracting subsidies and loans: Gas-condensing heating boiler (14 kW); solar thermal appliance for hot water (collector area 6 square meters); polystyrene hard foam for the insulation of the exterior wall (20 cm, U-value 0.156) and the basement wall (16 cm, U-value 0.188); roof made of wood rafter, insulation 18 cm (U-value 0.19); triple glazing with insulate protection and "passive house" frame (U-value 0.8).

Energy demand[1]:
Before 555 kWh (square meters per year)
After 80 kWh (square meters per year)

Outcome: Better than the requirements for new building standard (EnEV 2007): **33 percent**

CO_2 savings: 18.07 tons per annum (t/a)

One-/Two-Family Home, Hanover – before modernization

One-/Two-Family Home, Hanover – after modernization

[1] The data are calculated from the energy performance certificate and are therefore estimates.

2. Multifamily dwelling, Lichte Weiten, Berlin-Lichtenberg (DENA)

About the project:
Housing units: 11
Year of construction: 1900
Modernization completed: 2009

Aim: To modernize the building for energy efficiency and for cross-generational, communal, and ecological living. The project is a member-managed housing co-operative with residents of all ages and socio-economic backgrounds with strong ecological and social concepts.

Modernization measures attracting subsidies and loans: Wool-pellet oven and gas-condensing boiler; solar thermal appliance for hot water and heating (collector area 19.4 square meters); decentralized room ventilation; exterior wall insulation with mineral wool (16 cm, U-value 0.18); basement wall insulation with polystyrene hard foam (10 cm, U-value 0.38); top-floor ceiling with wood fiber (30 cm); triple glazing with insulate protection and frame (U-value 1.0); ecological and health-friendly building materials; own water purification system; generation of drinking water from rain.

Energy demand[2]:
Before 217 kWh (square meters per year)
After 32 kWh (square meters per year)

Outcome: Better than the requirements for new building standard (EnEV 2007): **56 percent**

CO_2 savings*:* 84 t/a

Communal Living "Lichte Weiten," Berlin-Lichtenberg

– after modernization

[2] The data are calculated from the energy performance certificate and are therefore estimates.

3. Conservation-protected multifamily dwelling, Berlin-Köpenick (DENA)

About the project:
Housing units: 12
Occupied area: 795 square meters
Year of construction: 1888
Modernization completed: 2009

Aim: To modernize to the legal requirement (EnEV) for new buildings minus 50 percent and do so within conservation guidelines.

Modernization measures attracting subsidies and loans: Individual heating system; central hot water system; decentralized room ventilation system; exterior wall insulation with mineral wool and basement wall with polystyrene hard foam (both 18 cm); roof insulation (46/22 cm); triple glazing (U-value 0.8–1.1).

Energy demand[3]:

Before	238 kWh (square meters per year)
After	39 kWh (square meters per year)

Outcome: Better than the requirements for new building standard (EnEV 2007): 53 percent

CO_2 savings: 129 t/a

Conservation-Protected House, Berlin-Köpenick – before modernization

Conservation-Protected House, Berlin-Köpenick – during modernization

Conservation-Protected House, Berlin-Köpenick – completed building plan

[3] The data are calculated from the energy performance certificate and are therefore estimates.

4. Multifamily dwelling, Schulze-Boysen Straße, Berlin (DENA)

About the project:
Housing units: 296
Occupied area: 18,090 square meters
Year of construction: 1974
Modernization completed: 2007

Aim: To modernize a large high-rise panel building (Plattenbau), making it energy efficient while taking costs into account. The building is the largest low-energy house in Germany at this time.

Modernization measures attracting subsidies and loans: District heating and block-heat power plant; central hot water system; ventilation system in individual housing units; insulation of exterior wall with mineral wool (12 cm, U-value 0.21); triple glazing with insulate protection and insulated frame (U-value 1.1 and 1.3).

Energy demand[4]:
Before 90 kWh (square meters per year)
After 44 kWh (square meters per year)

Outcome: Better than the requirements for new building standard (EnEV 2007): **33 percent**

CO_2 savings*:* 439 t/a

Multifamily House, Schulze-Boysen-Strasse, Berlin

[4] The data are calculated from the energy performance certificate and are therefore estimates.

5. Guesthouse, Kanalstraße, Esslingen am Neckar (DENA)

About the project:
Occupied area: 2,900 square meters
Year of construction: 1835
Modernization completed: 2009

Aim: To both modernize the building to make it energy efficient and provide training and employment in the hotel sector for young people who are difficult to integrate into the labour market.

Modernization measures attracting subsidies and loans: Heat pump (105 kW); electric central hot water system; mineral wool insulation of exterior wall (8 cm, U-value 0.36), top floor (20 cm) and roof; double glazing with insulated protection (U-value 1.3).

Energy demand[5]:
Before 351 kWh (square meters per year)
After 108 kWh (square meters per year)

Outcome: Better than the requirements of new building standard (EnEV 2007): **52 percent**

CO_2 savings: 135 t/a

Guesthouse for Young People, Kanalstrasse, Esslingen am Neckar – before modernization

Guesthouse for Young People, Kanalstrasse, Esslingen am Neckar– after modernization

[5] The data are calculated from the energy performance certificate and are therefore estimates.

6. Day nursery, Wolgast (DENA)

About the project:
Occupied area: 2,339 square meters, 2 stories
Year of construction: 1973
Modernization completed: 2009

Aim: To provide an energy-efficient day nursery, kindergarten, integrated groups, and care center for primary school children.

Modernization measures attracting subsidies and loans: District heating and central hot water system; centralized ventilation system; exterior wall insulation with mineral wool (15 cm, U-value 0.22); roof insulation (30 cm, U-value 0.12); double glazing with insulate protection (U-value including frame 1.4).

Energy demand[6]:
Before 158 kWh (m^2a)
After 116 kWh (m^2a)

Outcome: Better than the requirements for new building standard (EnEV 2007): **46 percent**

CO_2 savings: 70 t/a

[6] The data are calculated from the energy performance certificate and are therefore estimates.

7. School, Ortrand (near Dresden) (DENA)

About the project:
Occupied area: 240 square meters
Year of construction: 1953
Modernization completion: 2009

Modernization measures attracting subsidies and loans: Gas-condensing boiler (16 kW); decentralized hot water system; centralized room ventilation system; exterior wall insulation with polystyrene hard foam (10 cm, U-value 0.26); double-glazed windows (U-value 1.4).

Energy demand[7]:
Before 640 kWh (square meters per year)
After 131 kWh (square meters per year)

Outcome: Better than the requirements for new building standard (EnEV 2007): **44 percent**

CO_2 savings: 16.8 t/a

8. School, Ludwigshafen am Rhein (DENA)

About the project:
Occupied area: 6,678 square meters
Year of construction: 1976
Modernization completed: 2009

Modernization measures attracting subsidies and loans: New heating and central hot water system; decentralized room ventilation system; exterior wall insulation with mineral wool (16 cm, U-value 0.2); basement wall with polystyrene hard foam (4 cm, U-value 0.77); roof insulation (18 cm, U-value 0.10); double glazing with insulated protection (U-value 1.3).

Energy demand[8]:
Before 348 kWh (square meters per year)
After 117 kWh (square meters per year)

Outcome: Better than the requirements for new building standard (EnEV 2007): **79 percent**

CO_2 savings: 335.8 t/a

[7] The data are calculated from the energy performance certificate and are therefore estimates.

[8] The data are calculated from the energy performance certificate and are therefore estimates.

9. Single-family dwelling, Bruchstrasse, Ronnenberg (ProKlima)

About the project:
Housing units: Single-family dwelling that could be divided into two-family home
Heated occupied area: 258 square meters
Year of construction: 1922
Year of conversion/enlargement: 1956–57
Modernization completed: 2004–2005

Aim: To modernize the building by making it energy efficient with high-quality insulation.

Modernization measures attracting subsidies and loans: Gas-condensing boiler for heating and warm water; ventilation via the window; exterior wall insulation, including basement walls, with mineral foam (a vapor-permeable material based on glassmaking sand, cement, lime, and water) (U-value 1.55); basement ceiling insulation with polystyrene (10 cm, U-value 0.32); improvement of roof rafters to 30-cm beams; insulation with mineral wool and sealed with a vapor retarder (U-value 0.15); triple-glazed windows filled with inert gas and frame made from solid timber (U-value 0.73).

Energy demand[9]:

Before	Approximately 400 kWh (square meters per year)
After	118 kWh (square meters per year)
Saving	**70 percent**

CO_2 emissions:

Before	Approximately 110 kWh (square meter per year)
After	27 kWh (square meters per year)
Saving	**75 percent**

Single-Family Home, Bruchstrasse, Ronnenberg – before modernization (left)

Single-Family Home, Bruchstrasse, Ronnenberg – after modernization

[9] The data before modernization are projections based on past consumption. The data after modernization are calculated using “passive house” projections.

10. Multifamily dwelling, Schaufelder Straße, Hannover (also included in the DENA "Low Energy House in the Existing Stock" program)

About the project:
Housing units: 30
Occupied area: 2,014 square meters
Year of construction: 1950
Modernization completed: 2006–2007

Aim: To create units for people with restricted mobility and to modernize to "passive house" standard.

Modernization measures attracting subsidies and loans: Central heat pump plant for room heating and hot water; decentralized ventilation system with heat recovery; polystyrene hard foam for the insulation of exterior walls (22 cm, U-value 0.13); roof insulation with mineral wool (36 cm, U-value 0.106); basement wall construction (36.5 cm); basement ceiling insulation with cellulose (U-value 0.12); triple-glazed windows with insulate protection and insulated frame.

Energy demand[10]:
Before Not available
After 27 kWh (square meters per year)

Outcome: Better than the requirements of the new building standard EnEV 2007 reduction in energy use: **61 percent**

Multifamily House, Schaufelder Strasse, Hannover – After Modernization

[10] The data after modernization are calculated using "passive house"" projections.

11. Multifamily dwelling, Ostland Housing Co-operative, Röttgerstrasse, Hanover (also included in the DENA "Low Energy House in the Existing Stock" program)

About the project:
Housing units: 10
Heated occupied area: 839 square meters
Year of construction: 1950
Modernization completed: 2006–2007

Aim: To modernize all building parts, construct an extension, and insulate the building to contemporary standards. A total demolition was considered, but a cost comparison suggested that highly energy-efficient modernization was the more economic solution.

Modernization measures attracting subsidies and loans: District heating; heat distribution via the ventilation system and a radiator in the bathroom; decentralized ventilation system with heat recovery; exterior wall insulation (30 cm, U-value 0.11); insulation of basement ceiling (12 cm, U-value 0.19); new wooden attic insulation (30 cm, U-value 0.13); flat-roof insulation (24–30 cm and 14–22 cm, U-value 0.14); triple glazing (U-value 0.8).

Energy demand[11]:

Before	128 kWh (square meters per year)
After	31 kWh (square meters per year)
	Saving 76 percent

CO_2 emissions:

Before	28 kg (square meters per year)
After	7 kg (square meters per year)
	Saving 75 percent

Multifamily Unit, Röttgerstrasse, Hanover

[11] The data before modernization are projections based on past consumption. The data after modernization are calculated using "passive house" projections and realistic estimates.

12. Multifamily dwelling, Housing Cooperative WOGE Nordstadt eG,Schneiderberg, Hanover (also included in the DENA "Low Energy House in the Existing Stock" program)

About the project:
Housing units: 10
Heated occupied living area: 637 square meters
Year of construction: 1895–1900
Modernization completed: 2006

Aim: To refurbish the units with solid equipment and fittings for affordable rents and modernize with passive house components.

Modernization measures attracting subsidies and loans: Wood-pellet central heating boiler (25 kW) with 500-liter buffer storage and 300-liter drinking water storage; heat distribution by supply air and radiator in the bathroom; insulation of exterior wall with mineral wool (20 cm, U-value 0.16); new roof truss and insulation with cellulose fibers made from recycled paper (35–42 cm, U-value 0.11); insulation of basement ceiling (20 cm, U-value 0.17); passive-house wooden windows triple glazed (U-value 0.5).

Energy demand[12]:

Before	480 kWh (square meters per year)
After	20 kWh (square meters per year)
Saving	**96 percent**

CO_2 emissions:

Before	114 kg (square meters per year)
After	5 kg (square meters per year)
Saving	**96 percent**

[12] The data before modernization are projections based on past consumption. The data after modernization are calculated using "passive house"" projections.

13. Large residential district with apartment blocks (housing company), Märkische Viertel, Berlin

About the project:
Housing units: 17,000 (15,000 owned by GESOBAU)
Units refurbished by 2008: two apartment blocks with a total of 538 units
Year of construction: early 1960s
Entire modernization completion (estimated): 2015

Aim: To modernize all remaining apartment blocks to make them as energy efficient as residents can afford. The apartment blocks worked on so far have been modernized to a standard 30 percent better than that of the new construction standard of the Energy Conservation Ordinance (EnEV 2007). Later modernization aims to achieve the standard of the energy efficiency house 100 based on EnEV 2009. The aim is to refurbish the entire heating provision from a natural gas–fed district heating plant built in the 1960s to a district heating plant fueled by biomass and use of power-heat coupling the share of renewable fuel will be 50 percent.

Modernization measures attracting subsidies and loans: The old single-pipe system has been replaced with a two-pipe plant. Heating and hot water have been equipped with automatically controlled fixtures and are hydraulically balanced. All apartments have been equipped with small heating units. The district heating connections have been modernized by the addition of central water heaters. Ventilation in kitchens and baths with windows has been discontinued, and in other units it has been upgraded. The entire building envelope of the two apartment blocks has been insulated (80–140 mm) as well as the top- and the lowest-story ceilings. Most windows have been double glazed, and some have been triple glazed for noise protection.

(End) Energy demand (2007)[13]:

Before	174 kWh (square meters per year)
After	Estimated at 70 to 80 kWh (square meters per year)

CO_2 emissions:

Before	4.4 t/a (one apartment) or 43,000 t/a (Märkische District)
After	Estimated at 11,000 t/a (for Märkische District)

Residential District Märkische Viertel, Berlin – After Modernization

[13] The data are calculated from the energy performance certificate and are therefore estimates.

Appendix 1: Germany's Federalist System of Government and Its Relevance to Stimulating the Retrofit Economy

Responsibilities for energy and climate regulations are divided among the EU, the German federal government, the 16 federal states (Länder), and the more than 12,300 municipalities. This multi-level system of governance has worked well in policy making related to climate change primarily because of the formalized coordination and long-standing cooperation that exists among the different levels.[125] The European Commission has been a strong supporter of an active EU climate change policy, but the German government has often been the initiator of target setting at the EU level; this has certainly been the case since the late 1990s. Some individual Länder and municipalities have been highly proactive contributors to meeting EU and national targets, although the primary responsibility for determining climate change policies lies with the federal government.

The basic idea governing German political decision making is that of subsidiarity, as laid out in the Basic Law (constitution). Under the constitution, the Länder have wide-ranging responsibilities for the administration of both federal and state law. The Länder hold exclusive authority in education, health, cultural affairs, and police, and in matters of legislative powers that are shared with the federal government, such as the production and use of nuclear energy, the Länder have been more active than the federal government. In areas such as land consumption and regional planning, the federal government sets the framework and conditions within which the Länder must pass their own legislation. The federal government is responsible to parliament (the Bundestag), and the Länder are represented in its lower chamber (the Bundesrat). Besides the considerable power that the Länder hold in legislative terms, the Bundesrat approves the federal budget and has the right of veto over any lawmaking that directly affects Länder interests. In addition, the federal government depends largely on the Länder for the implementation of policy.

The Länder have the primary responsibility for organizing and delivering the functions of local government, though municipalities have some permanent legal powers guaranteed in the Basic Law. Some of the responsibilities of the Länder are delivered through municipalities. There are two types of local government functions: the so-called compulsory responsibilities (for example, schools, fire protection, and streets and sanitation maintenance) and some acquired responsibilities carried out on behalf of the Länder or federal government (for example, tax collection, housing, and health care).

In contrast to many other environmental policy areas, the 16 Länder have almost no delivery responsibilities with respect to national climate change policies. The Länder can use their veto power in the lower chamber regarding federal government initiatives, but thus far federal climate change policies have generally been well received and accepted by the Länder governments. Cooperation between federal and Länder governments is supported by a bi-annual Conference of Environmental Ministers at state and federal levels and by federal-state government working groups. In March 2007 the federal and state governments signed the joint Düsseldorf Declaration, outlining the new national and EU climate targets. Each of the 16 Länder developed a comprehensive climate protection plan (with concrete targets), and many have established their own measures affecting greenhouse gas emissions. The degree of support for climate policy varies by state, according to

their special interests and abilities. Länder support has been most significant in developing renewable energy (for example, wind power in Schleswig-Holstein, wind power and biogas in Lower Saxony, hydropower and photovoltaics in Bavaria, biomass in Brandenburg, waste and landfill gas in North Rhine-Westphalia, and geo-thermal in the Ruhgrgebiet). Most of these Länder have a Christian-Democratic (conservative) government and therefore tend to work well with the federal coalition now in power. Few Länder policies or action have a focus different from federal policies.[126]

At the same time, German municipalities have become increasingly active in climate-related matters. Their contribution to climate protection depends strongly on local leadership, especially a highly committed mayor, sufficient finances, the involvement of environmental organizations, and networking skills.[127] Municipalities have focused on promoting renewable energy and cogeneration via municipal power plants (Stadtwerke), providing information about available subsidies and technologies, retrofitting public buildings (for example, 40,000 schools and 48,000 kindergartens), contracting for renewable heat and electricity, changing street lighting to more energy-efficient forms, and promoting public transport and public bus fleets. A growing number of small- and medium-sized municipalities actively promote zero-energy consumption, and numerous initiatives in municipalities in all Länder aim at a 100 percent renewable energy supply. Several smaller municipalities have already realized this target. For example, the Barnim and Uckermark (Barum) region in Brandenburg, with a combined population of more than 300,000, has already achieved an all-renewable electricity supply for the region.[128]

Appendix 2: List of study visits, March-April 2010

Interviews
V. Zulauf, Application for KfW Credit Funding, December 2009

Dietmar Menzer, Deputy Head of Department Ul 41, Energy and Climate Protection – Building and Transport, Federal Ministry for Transport, Building and Urban Development, 25 March 2010

Urte Hertrampf, Department Promotion of Energy Saving and Climate Protection in the Building Sector, Federal Ministry for Transport, Building and Urban Development, 25 March 2010

Thomas Kwapich, Head of Energy Efficient Buildings, DENA 26 March 2010

Ralf Preussner, Expert for Product Development, Private Banking, KfW Bankengruppe 26 March 2010

Tobias Timm, Deputy Head, ProKlima, Hannover, 29 March 2010

Lori Bamberger, San Francisco, via telephone 14 June 2010; 25 June 2010; 6 July 2010

Projects Visited
- Multi-Unit House (10 units) – Schneiderberg, Hannover
- Multi-Unit House (10 units) – Röttgerstrasse, Hannover
- Multi-Unit House (30 units) – Schaufelderstrasse, Hannover
- Multi-Unit Communal Living (11 units) – Lichte Weiten, Berlin-Lichtenberg
- Multi-Unit Conservation-Protected (12 units) – Berlin-Köpenick
- High-Rise Building (296 units) – Schulze-Boysen Strasse, Berlin
- High Rise Housing District (15,000 units) – Märkische Viertel, Berlin

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