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

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EXECUTIVE SUMMARY

- Energy shortages, unpredictable and high energy prices, waste, pollution, and fears of climate change all drive a sense of urgency in the West about reducing its energy dependence on unreliable sources. Europe imports over half its total energy from volatile producers around the globe. While the United States is able to meet somewhat more of its energy demand from domestic sources, its per capita energy consumption level is twice that of Europe's.

- The cheapest and most cost-effective path to greater energy security is energy saving, and the biggest, most certain place to do that is in our built environment, which in developed Western countries uses half of all energy and generates half of all greenhouse gases. Most of this energy usage is wasted by leaking out through walls, windows, roofs, floors, doors, and through inefficient equipment.

- All members of the European Union (27 countries) have adopted highly ambitious **production** targets for renewable energy, and equally ambitious **reduction** targets for CO_2 emissions, down at least 20 percent from 1990 levels.

- Germany is leading the way in developing "green" technologies and has the most ambitious energy-saving program in Europe, aiming for a 30 percent reduction in energy usage by 2020, and a 30-percent renewable energy share, consisting mainly of biomass, wind, and solar.

- Germany's energy saving program is based on three pillars:

    - A clear legal framework and tight regulation at the national level, requiring energy efficiency upgrades to buildings and increased use of renewable energy sources among electricity providers;

    - Strong financial incentives through subsidies and loans to reduce energy consumption in the built environment at all levels of government. At the national level, these are provided via a public investment bank sponsored by the German government;

    - Information, promotion, and behavior change, working through regional and local bodies, developing enforceable standards through Energy Performance Certificates, and supporting model projects all over Germany

- Since 2006, Germany has created nearly half a million new jobs in renewable energy, and over four years, around nearly 900,000 jobs in retrofitting homes and public buildings such as schools. Green investment, new green technology development, and renewable energy exports are all major growth areas in Europe's strongest economy. By having taken these steps, Germany remains on track to meet aggressive greenhouse gas reduction targets by 2020 and 2050.

- Germany's experience—its successes and lessons learned—provide a solid evidence base from which nations like the United States can "leapfrog" Europe, and tackle even more pressing energy and climate change demands through deliberate public and private action.

1. ENERGY USE, GREENHOUSE GASES, AND CLIMATE CHANGE POLICY IN EUROPE

The evidence for climate change, linked to over-reliance on shrinking supplies of fossil fuels, is widely accepted in Europe, and by the most respected scientific circles around the world, including in the United States.[1] In 2000, industrial and post-industrial countries accounted for more than half of the world's energy consumption. China and the United States now produce similar levels of CO_2, by far the highest amounts of any countries worldwide, but the United States uses four times the energy per head of China, and twice that of Europe.[2] By 2030, world energy consumption is forecasted to increase by about 60 percent, and fast developing countries will account for two-thirds of the increase. But previous and ongoing high energy usage in the West is by far the biggest factor behind climate change for the foreseeable future.[3]

The threat of energy insecurity and high energy costs underlines the urgency of energy saving, and it is widely accepted across Europe that investment in energy saving shows by far the quickest and surest return on investment, producing a net negative cost over the investment's lifetime.[4]

Achieving greater energy security, lower energy costs, and more certain long-term accessible energy supplies are all critical issues for the United States. Nevertheless, the United States has not yet adopted broad national policies or strategies to cut energy use or increase energy efficiency overall, and the urgency of retro-fitting buildings is only just beginning to be recognized.[5] In that respect, America can learn from Europe's hard-won experience, and as in other fields, leap ahead.

The European Union (EU) is leading the world in setting ambitious targets for reducing energy use, increasing energy efficiency, and expanding the production of renewable energy in order to drastically cut Green House Gas (GHG) emissions, the most prominent of which is carbon dioxide (CO_2).

Under the Kyoto Protocol the European Union agreed to:[6]

- Reduce GHG emissions by a total of 21 percent by 2012 compared to 1990;
- Reduce GHG emissions by a total of 30 percent by 2020 compared to 1990;
- Increase the use of renewable energies to 20 percent of primary energy consumption by 2020;
- Reduce overall energy consumption by 20 percent by 2020

In 2007, the European Union established a triple goal by 2020 to achieve:

- 20 percent reduction in energy use and CO_2 emissions;
- 20 percent increase in energy efficiency;
- 20 percent of all energy from renewable sources

In spite of this ambition, some European countries are still increasing their overall GHG emissions, although much more slowly than before. By contrast, Germany, which is by far the biggest emitter in the EU, has done the most to reduce its emissions and is on track to hit exceed EU-wide targets. The United Kingdom is also reducing its emissions, though at a slower pace than Germany.

The EU depends on imports for over half of its energy supply. Oil makes up nearly two thirds of EU-wide energy imports; gas contributes a quarter, and solid fuels 13 percent. This dependence on foreign energy sources makes European countries extremely vulnerable to international tensions. Energy production within the EU declined steeply from 2004 onwards, and if this trend continues as expected, vulnerability to supply failures will increase unless Europeans shift from fossil fuel imports to drastic energy saving measures and an expansion in renewable energy production. Most European countries,

including the U.K., have less than 10 years in which to deliver large-scale alternatives to high fossil fuel reliance across the board, given EU commitments to CO_2 reductions.[7]

The EU is united in accepting that energy saving is the quickest and most cost-effective measure to secure its energy future. Buildings and building products are a major focus of EU energy initiatives because they are the biggest users and wasters of energy. Buildings are responsible for at least 40 percent of energy consumption and 36 percent of CO_2 emissions in the EU. In more Northern countries like the U.K., they account for at least half of energy usage and CO_2 emissions. In 2010 the EU set minimum requirements for energy performance in all new and existing buildings; it introduced mandatory energy performance certificates for buildings; and required modern, efficient heating boilers and air conditioning systems.[8]

Renewable energy is also seen as a vital but costly contributor to the shift to a "greener" future, which can only plug the gap in coordination with reduced energy usage.[9] Most European countries are rapidly increasing their renewable energy investment and investment in energy saving.[10] One-third of the EU's electricity supply should come from renewables by 2020; it had reached 16 percent by 2006.

2. GERMANY'S APPROACH

A sense of urgency drives the search for solutions across the EU, leading to an unexpected openness to learning from Germany.[11] Germany is the EU's biggest energy user, with limited internal energy supplies but a strong track record in energy saving in buildings. The country uses energy intensively, at a rate 10 percent higher than the U.K. (Europe's second highest per-capita user), partly because of the large part manufacturing plays in its economy, and partly because of its wealth. Its commitment to energy saving and alternative energy sources has been forged against a backdrop of energy insecurity, steep energy price rises, high CO_2 emissions, and damage to environmental conditions over 50 years of industrial prowess since World War Two. It is now a world leader in the production of renewable technologies and the promotion and adoption of energy efficiency measures.

Germany is governed through a strongly federalist system, with decentralized powers and resources at the regional (land) and city (stadt) levels. Germany is also a highly regulated social democracy with strong public support for action on climate change. Climate change measures are a federal responsibility, but with strong implementation incentives at regional and local levels.

The federal German government drives the development of renewable energy and energy-efficient construction and refurbishment of all types of buildings, both public and private, based on three pillars:

- Reducing energy demand through regulation and legislation;
- Creating financial incentives for energy saving and 'green' investment;
- Providing energy saving information and advice

Box 1 shows these three pillars with their different levels of responsibility and delivery.

Box 1: Three pillars of Germany's energy saving and renewable energy programs

1. Limiting Demand through Legislation and Regulation

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

Responsibility: Federal Ministry, Regional Governments

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2. Promoting Alternatives

- Market Stimulation Program (MAP)
- 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, BAFA, regional and local banks

3. Providing Information and Advice

- Public relations
- Pilot projects
- Market instruments (e.g. Energy Performance Certificates)
- Networking
- Know-how transfer
- International liaison

Responsibility: DENA, regional and local agencies

Box 1 Notes:

- MAP is the Market Incentive Program for the development and application of Renewable Energy (through loans and subsidies)
- Kreditanstalt für Wiederaufbau (KfW) is the public investment bank for the German government
- BAFA is the German Federal Office of Economics and Export Control
- Deutsche Energie Agentur (DENA) is the official government body created to promote energy saving and renewable technologies

a. Pillar 1 – Limiting demand

Energy Conservation Act, 2009 (EnEV)

Germany's primary legal tool in reducing energy use is the *Energy Conservation Act (EnEV)***.** Amended in 2009, it requires the following nationwide:

- Major changes to the building envelope (e.g. roof, exterior walls, window) must be made 30 percent more energy efficient, and the envelope must be 15 percent better insulated;
- Heating, hot water, ventilation, shading, cooling systems must be upgraded to include energy efficient, renewable technologies (e.g., solar thermal);
- Energy sources must reduce climate change impacts and CO_2 emissions (e.g. oil, gas should be increasingly replaced by renewable energies);
- Energy Performance Certificates are mandatory and energy advisers issuing them must have accredited qualifications[12]

Heating Costs Act, 2009 (HeizkostenV)

The *Heating Costs Act* (HeizkostenV), first introduced in 1981, was strengthened in 2009 to underpin the Integrated Energy and Climate Change Program agreed by the EU in 2007. This act regulates the cost of heating and warm water in rented properties. As renters make up 60 percent of German households, these changes are significant. Tenants must now pay a much higher proportion of heating charges based on consumption, creating bigger incentives for them to save energy, and for their landlords to adopt energy saving measures.[13]

Renewable Energy and Heat Act, 2009 (EEWärmeG)

A third key legal instrument is the *Renewable Energy and Heat Act of 2009 (EEWärmeG)*. This act increased the target for renewable sources of energy for heat to 15 percent in all newly constructed buildings.[14] For owners of existing buildings, the target is voluntary.

Renewable Energy Sources Act (EEG), 2009

This act, first introduced in 2000, sets a target for electricity from renewable sources of 30 percent by 2020. Energy providers pay renewable suppliers a fixed payment per kilowatt-hour, known as the Feed-in Tariff, which is in turn passed on to end-users.[15] The act has attracted major investment into renewable technologies and created a strong export market.

b. Pillar 2 – Promoting Alternatives

Government programs to promote energy saving in housing have been in place in Germany since the 1970s. Incentive and support programs are offered through four channels:

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

KfW programs
The KfW, the investment bank of the federal and regional governments, is the main funder of investment in energy efficiency and renewable energy, rather than the federal government itself. It delivers specific programs agreed between the government and the KfW. The government negotiates conditions with KfW, including access to help, the amount of loan funding available, and the level of subsidy to reduce interest rates on loans. There is no legal limit to eligibility for loans and subsidies and there is built-in flexibility to allow some subsidy programs to apply in exceptional cases.[16]

Beginning in 2006, federal funds of €1 billion per year through KfW supported a strong focus on the refurbishment of existing homes and other buildings. Between 2008 and 2011, the federal budget for KfW's energy efficiency programs grew to €1.4 billion a year.[17]

Federal government programs
The German Federal government has three special subsidy programs for existing buildings in addition to the program it channels through KfW:

- A subsidy program to increase market incentives for renewable energy (MAP). This is the government's main instrument for promoting the use of renewable energy in heating with the aim of reducing dependence on fossil fuels. MAP was introduced in 1999 and has grown continually since then;[18]
- On-site energy advice, a program increased in 2009 to help meet the costs of energy performance assessments and expert advice, required for funding applications, to the KfW refurbishment programs; and
- A smaller-scale program for refurbishing federal government buildings, including military buildings, and to test the use of new technologies and innovative methods for efficiency, including combined heat and power. This program formed part of the German government's stimulus package of 2008–2011.

Regional and local programs
There are 16 German Länder (regional governments) responsible for delivering energy savings at the regional and local levels. Municipalities (12,000 communities) are responsible for 70 percent of public sector greenhouse gas emissions, and heating makes up 80 percent of those emissions. Municipal buildings (176,000 in total) are major contributors to the problem, making energy saving an urgent priority at the sub-national level.[19] Although German cities rank high on international sustainability indices, the investment gap is huge and estimated that more than €700 billion by 2020 would be required in order to raise their energy efficiency to Germany's exacting standards.

In addition to KfW and other federal programs, regional and local programs to introduce energy-saving measures in the built environment abound. Municipalities often have their own energy investment

companies, “Stadtwerke” (literally “city works”), which play a major role in energy infrastructure, energy provision, and increasingly energy saving and renewable energy. Hanover, with its own city and sub-regional energy agency, leads the field through ProKlima, a pioneer in energy efficient refurbishment.[20]

c. Pillar 3 – Providing Information and Advice

The German Energy Agency (DENA)

DENA was founded by the German federal government, KfW, and three other major German banks in 2000 to test and implement innovative projects and campaigns at the national and international levels on energy saving. DENA operates as an independent, but government-sponsored, company with 140 staff. It links together government activity, subsidy programs to promote energy efficiency, and market-oriented activities to spread the take-up of energy efficiency and renewable technologies.

DENA’s activities fall into five main categories:[21]

- **Information and motivational campaigns** to stimulate demand and spread information;
- **Training experts** (engineers, architects, craftsmen) in new energy saving skills through documenting evidence and techniques, organizing events, and maintaining online databanks on:
    - measures to achieve target efficiency levels in different buildings;
    - refurbishment of rented homes; and
    - best practices for residential and non-residential buildings (new and existing)
- **Increasing transparency in all energy standards and certification** (e.g., validated Energy Performance Certificates (EPC) , a voluntary Quality Mark, Energy Efficient Building Displays)
- **Developing and promoting model projects** to demonstrate quality standards, implement best practice, and develop regional know-how
- **Simplifying methods and increasing the reliability of renovation.**

DENA plays a crucial role as a conduit of information, expertise, and practical know-how, but does not directly provide advice, deliver projects itself or handle funding for projects. Instead, DENA works with independent regional energy agencies to deliver specific projects. DENA sets out the standards, but regional agencies implement them and pass on the expertise to regional building organizations and professionals.

Energy advice

Multiple projects and programs, organized by DENA and financially underpinned by the Environment Ministry, fall under the “National Climate Protection Program” targeting different groups, such as consumers, schools, local authorities and industry. Consumer projects aim to raise energy awareness and change behavior, encourage the use of efficient technology and renewable energy, and promote emission-free travel in towns and cities. A special program for schools and colleges funds energy saving measures in educational buildings as well as developing teaching aids and teacher training; it also supports model projects to raise awareness of the urgency of climate protection. A local authority program sponsors long-term climate protection ideas, including high-efficiency lighting systems in public buildings as well as the carbon neutral modernization of school buildings.[22]

Targeting low-income communities

Local energy agencies, funded by the Environment Ministry, hire and train energy advisers to visit low-income households and organize local events, using local media and local parishes to inform residents through door-to-door visits offering free energy advice and equipment. Energy advisers are recruited

from among local unemployed people. They must have some relevant building experience but they receive special training in advising low-income households on energy saving. They often come from minority backgrounds, which helps them communicate with mixed populations in poorer neighborhoods. Households receive energy saving kits worth €20 (about $27) per visit, including low-energy light bulbs.

Online energy monitoring

The Federal Environmental Ministry supports the "Climate seeks Protection" (*Klima sucht Schutz*) campaign. The campaign provides online energy saving advice, then records initial energy costs, energy saving measures adopted, subsequent levels of consumption, and user satisfaction, as well as the number of jobs created, both in supply chains and in building work itself. Behavioral change, material costs, employment outcomes, improvements in levels of comfort, and carbon reduction are all recorded, allowing DENA to document energy saving against costs.[23]

Model projects

DENA also promotes the development of model projects as learning tools and test beds for new ideas. For example, DENA developed and tested the standards for Minimum Energy Houses (Niedrigenergiehaus) on 400 individual projects. KfW subsequently adopted these standards to support an additional 5,000 prototype buildings. In this way, the experimental approach strengthens frameworks for energy saving policies and practices.[24] Pilot projects also inspire housing companies to adopt and promote energy saving while convincing the government of what works.[25]

Energy Performance Certificates

DENA drives the adoption of Energy Performance Certificates (EPC), which have been introduced gradually for different types and ages of buildings since 2002. The EPC documents the energy efficiency of the building, and a color code displays the energy performance of the building, with green for good, red for poor, brown to yellow in between. EPCs are now a legal requirement for all new buildings and must be produced when existing buildings are rented out or sold. DENA encourages much higher standards than the basic EPC. Similar energy displays and monitoring are now being widely adopted in the U.K.

3. GERMANY'S ACHIEVEMENTS

According to a recent analysis, Germany ranks first among all G20 countries for its energy efficiency and wider measures to combat climate change, and second for its renewable energy and feed-in tariff programs.[26] Its main achievements in renewable energy development since 2000 include:

- Renewable energy use has more than doubled from 4 percent to 10 percent;
- Renewable electricity generation has risen from 6 percent to 15 percent;
- Renewable heating has doubled from 4 percent to 8 percent;

These trends have put Germany on pace to reach a renewable share of final energy consumption of 20 percent in 2020 (2 percent above Germany's EU target), 32 percent in 2030, and 54 percent in 2050. Renewable energy is projected to meet 35 percent of total electricity generation in 2020.[27]

CO_2 Impacts

The use of renewable energy in electricity, heating, and transport has greatly reduced CO_2 emissions. They fell 21 percent from the 1990 base of 948 million tons to 748 million tons in 2008. Total CO_2 saved in 2009 through renewable energy alone was 109 million tons, a decline of 12 percent.[28] This puts Germany to achieve an 80 percent reduction in CO_2 levels by 2050.[29] By far the biggest savings will be in the electricity sector (320 million tons); heating will save 80 million tons; and transport an additional 48 million tons.

Economic and employment impacts

Energy saving and renewable energy have both underpinned Germany's strong recovery since the financial crisis of 2008. The job impacts of the building refurbishment program are significant, around 240,000 new jobs a year since 2006. At the same time, renewable energy is a major growth sector in Germany. Renewable energy industries have generated increasing numbers of new jobs each year, from 160,000 in 2004 to over 300,000 in 2009, two-thirds of which are estimated to have resulted from adoption of the Renewable Energy Sources Act (EEG). Renewable energy exports have also risen steeply, making renewable energy a major contributor to Germany's strong macroeconomic performance.[30] While other parts of the economy shrank during the downturn, renewable energy manufacturing, export, and production continued to grow. Between 2003 and 2009, total turnover in renewable energy production more than tripled from €10 billion to €33 billion, following €18 billion investment in production plant and €16 billion in the manufacturing and delivery process itself.[31]

The German government estimates that 400,000 further jobs in renewable industries will emerge by 2020, with continuing expansion to 2030 and onwards.[32] The rate of job expansion will obviously depend on energy prices, export demand, and government policy, but the upward trend is currently extremely strong.[33] Germany's global engineering and manufacturing reputation make it an attractive production center for renewable energy technologies, while its energy saving products and systems are being exported across the EU.

Gains in energy efficiency

Energy efficiency investment has halved the energy use in the buildings treated since 2002 when the first energy efficiency building regulation (EnEV) came into force. There are 32,000 new and renovated "Passive House" examples using only 40 kWh per square meter annually, compared with the legal standard of 100 kWh.[34] The 8,000 model retrofitted buildings all over Germany demonstrate that it is possible to achieve a 30 percent reduction on already ambitious energy conservation standards.

KfW's activities have enabled the wider progress on energy efficiency in the built environment. Between 2006 and 2009, its funding programs led to:

- the energy saving refurbishment of 1 million homes and the addition of around 400,000 new highly efficient homes;
- around 240,000 new jobs per year in the building and building supply-related industries for energy efficiency programs, with a total over four years of 894,000; and
- around €27 billion in loans and grants distributed, leading to a total investment in energy efficient homes of more than €54 billion

Outstanding challenges

Of Germany's 39 million homes, 75 percent (29 million) were constructed before 1979, prior to the introduction of higher energy savings standards. Thus far, 9 million of these units have been retrofitted to high energy-efficiency standards, leaving 80 percent of the pre-1979 stock (20 million homes) below the legal energy standard required for existing buildings. Germany currently refurbishes around 200,000 buildings a year, equating to around 400,000 homes. This rate needs to double if Germany is to complete the refurbishment process by 2030.[35] As standards of efficiency rise, retrofitting will continue as a priority.

4. LEARNING FROM GERMANY'S EXPERIENCE

Several features of Germany's approach to stimulating a robust "retrofit economy" underpin its successes thus far:

- The three pillars of the German approach—a clear legal framework; strong subsidy and loan programs; and promotional information, advice, and support—are driving fundamental changes in Germany which both international and national bodies agree are vital to efforts to combat global climate change and secure our future energy needs[36]

- The links between German legislation/regulation and subsidies change energy consumption behavior and drive strong take-up. The level of subsidy and size of loans grow with the level of ambition, as higher energy savings require more public financial support[37]

- The combination of generous subsidies and low-interest loans with highly ambitious standards and a "whole house" approach generates an investment of around €36,000 per home in energy efficiency and renewable technology, compared with £6,000 proposed for the United Kingdom (€8000). In the United States, ambition levels are much lower and the level of federal investment in retrofits is correspondingly small, around €3000.[38] Germany's more generous *and* more exacting approach has led to much higher take-up

- Germany has taken a comprehensive approach to retrofitting the built environment. Almost all domestic buildings—small and large, rented and owner occupied, multi-story and single family, as well as many publicly owned buildings—are eligible for retrofit subsidies. Public policies aim to refurbish the entire housing stock and all public buildings in Germany by 2030

- Energy savings targets are aggressive with respect to both new and existing homes and inspire innovation in energy technologies and building practices. The newest "Passive House" standard achieves energy usage 60 percent below the baseline for new homes, while the latest prototypes achieve 85 percent savings

- Channeling retrofit subsidies through a publicly supported investment bank gives weight to the program, increases efficiency and leverage, and inspires private-sector confidence. KfW does not have to promote itself, and instead relies on local banks to transact business on its behalf[39]

- DENA's extensive access to experts, including architects, engineers, planners, researchers, increases its influence on clients. The agency's guidance and expertise reach a very large audience via local agencies

The German approach is not without its limitations, which should inform the adoption of analogous policies and practices elsewhere:

- The German legal framework for energy efficient buildings is complex, requiring considerable support and strong enforcement.[40] It is hard to transpose literally to other countries

- The range of subsidy programs at federal, regional and local levels, each requiring explanation and publicity, is also complex. Few grasp the whole national picture because of Germany's highly decentralized system and regional variations[41]

- The German energy saving program remains a work in progress and there are frequent new developments that require energy advisers to translate information for public understanding and action. DENA's aim is to summarize, simplify, and standardize this process[42]

- Renewable energy incentives are also complicated, funding many different technologies, through many different subsidies. Ideally procedures would be simpler and more streamlined[43]

Germany's leadership in reducing the carbon footprint of its built environment thus holds a range of lessons for countries like the United States and the United Kingdom which remain at the "shallow end of the pool" on adopting a broad national framework of this kind. Key messages include:

- Create a strong, enforceable legal standard to underpin change and create certainty about the direction of change

- Provide enough incentives to draw people in, but use repayable loans on favorable terms rather than straight subsidies or tax concessions as a more reliable and sustainable funding mechanism

- Provide qualified expert advice so that work is carried out to a high standard and promised energy gains are achieved

- Link renewable energy generation to energy saving measures requiring high energy efficiency investment *before* subsidizing renewable energy through a feed-in tariff. This greatly increases the contribution renewable energy can make to meeting overall demand, saving money, doubling the value of renewable energy, and contributing to climate protection

- Adopt a "whole house" approach to energy saving, even if measures are then adopted piecemeal, so people can prioritize and plan for ambitious levels of energy saving. This also makes it easier for the government, energy suppliers and builders to plan for the future

- Develop new ideas through pilots and models, as this allows for experimentation and innovation in the public eye. In particular, apply retrofit methods to public buildings such as schools, nurseries, and children's centers, which can also provide educational benefits

- Changing attitudes and behaviors are almost as important as retrofit measures themselves

The U.S. economy, with its profligate use of energy, land, and other natural resources, alongside its capacity for innovation and rapid change, has strong grounds for moving ahead extremely fast on the back of hard-won experience in Europe. A serious "energy crunch" may drive public demand for energy saving and renewable energy.[44] Too much public subsidy in the United States has been poured into a collapsed housing market and a finite fossil fuel-based energy system. Repurposing those subsidies to refurbish existing buildings and expand renewable energy resources offers an alternative way forward that can address environmental and energy supply challenges in a cost-effective manner, as long as a comprehensive framework is developed. The United States can piggyback and then leapfrog the European experience, given its wealth, its entrepreneurial flair, its devolved federal system, and the urgency of changing its energy consumption patterns. While the German program has evolved over decades on an incremental basis, the United States, having committed itself to a 17 percent reduction in CO_2 emissions by 2020, can and should outpace Europe by assuming a world-changing leadership role in energy reduction.[45]

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