ENERGY TRANSITIONS IN GERMANY AND THE UNITED STATES

TRANSATLANTIC PERSPECTIVES, CHALLENGES, AND THE WAY FORWARD

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Energy Transitions in Germany and the United States

Transatlantic Perspectives, Challenges, and the Way Forward

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On the cover: Solar PV panels in Furth, Germany, image courtesy of Siemens.
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Preface

Germany and the United States have embarked on an exciting historic venture in their energy systems. In both countries, diverse factors are motivating the transition away from the burning of fossil fuels—which enabled rapid human and economic development in the 19th and 20th centuries—and toward a cleaner energy system. Among these factors are the desires to mitigate climate change, improve energy security, respond to rising energy prices, reduce air and water pollution and their related negative health impacts, stimulate technological innovation, and create new markets and jobs.

To analyze current trends, challenges, and opportunities of the *Energiewende* (Energy Transition) in Germany and the United States, the Worldwatch Institute organized the strategic dialogue, "Energy Transitions in Germany and the United States," on December 9–10, 2013 at its headquarters in Washington, D.C. With support from the German Embassy and the Transatlantic Climate Bridge Program, the dialogue brought together 20 leading experts from both countries. The discussion was organized around three roundtables on: 1) renewable energy support mechanisms (chaired by Todd Foley and Michael Mehling), 2) energy efficiency and demand-side management (chaired by John Jimison and Alexandra Langenheld), and 3) the future of the electric power industry (chaired by Christopher Flavin and Robert Werner). Kyle Arons, Georg Maue, and Alexander Ochs gave introductory remarks.

The presentations, agenda, and list of chairs and participants are available at the Worldwatch Institute Project Webpage (www.worldwatch.org/energy-transitions-ge-us). We wish to thank our participants and the chairs for their input. This strategy paper is based upon the facts and findings discussed during the roundtables, but it does not necessarily represent the opinions of all participants.

1 | Perspectives on the Energy Transition: How Far Germany and the United States Have Come

Both Germany and the United States have made substantial and promising progress toward a cleaner energy system over the past decade. In Germany, federal legislation has driven implementation of the *Energiewende*, whereas in the United States, individual states and municipalities have been the key drivers of change. In both countries, energy efficiency and renewable generation capacity have grown enormously, and these trends are expected to continue, despite challenges. Already, many tangible benefits have materialized.

1.1 Sustainable Energy's Rapid Growth

Global clean energy production has grown at an unforeseen pace over the past two decades, and improvements in energy efficiency have made substantial progress as well. Renewable energy technologies, such as solar photovoltaics (PV) and wind turbines, have become mainstream markets. Global investment in renewables—totaling USD 254 billion in 2013—is now roughly equal to investment in fossil fuel and nuclear technologies combined.[1]

Germany and the United States have been among the leaders of this development. Future growth in renewable energy capacity and investment, however, faces technical, market, and political challenges that need to be addressed to enable the next successful phase of the energy transition. Large potentials for clean energy generation remain untapped and will need to be utilized quickly to help prevent disastrous climate change.

Renewable Energy

On both sides of the Atlantic, electricity generation from renewable sources has grown substantially over the past decade. Germany has been able to significantly increase its share of renewable energy (including hydropower) in overall power production, from just 3 percent in 1990 to nearly 23 percent today; in the United States, the renewables share has remained relatively stable and currently stands at 12 percent.[2] (See Figure 1.)

Several other European Union (EU) member states are making rapid progress as well. The share of renewables in electricity production exceeded 40 percent in Denmark in 2011, 42 percent in Spain in 2013, and 70 percent in Portugal in the first quarter of 2013.[3] Other countries in Europe have had far less success in advancing renewables—a diversity that is mirrored in the varying performance of U.S. states on this front.

Wind power has dominated the German renewable energy market over the past decade. In 2012 and 2013, the country added 2.4 gigawatts (GW) and 2.5 GW, respectively, of new wind capacity to the grid.[4] But solar energy has come on strongly in the past two years. In 2012, Germany accounted for 7.6 GW of the roughly 30 GW of solar PV capacity added worldwide.[5] In 2013, Germany's contribution dropped to 3.3 GW of added capacity, in part because of a reduction in the supporting feed-in-tariff for large-scale

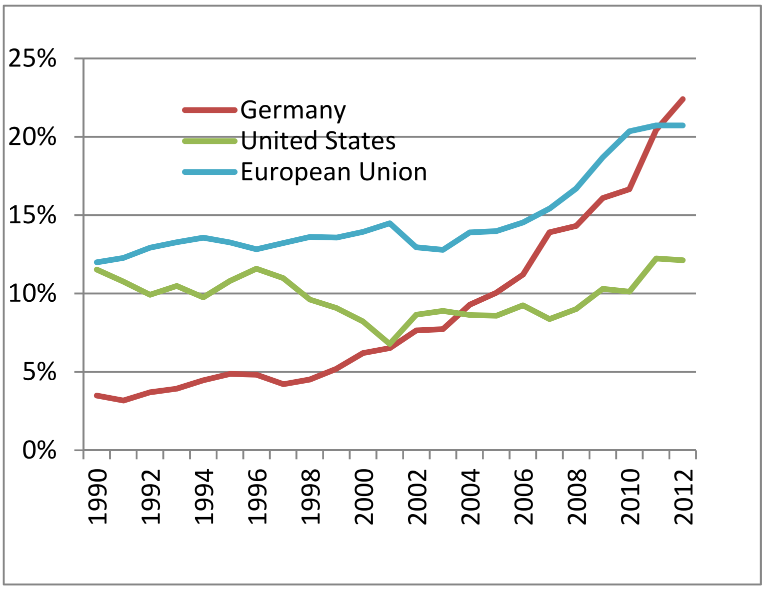

Figure 1.

Share of Generation from Renewables (including hydropower) in Germany, the United States, and the EU, 1990–2012

Source: EIA; World Bank; EUROSTAT; Solarify

installations.[6] Nevertheless, the country added 10,000 new solar PV systems each month, the result of stronger support mechanisms for smaller installations such as rooftop systems.[7]

In the United States, the share of renewable energy (including hydropower) in electricity generation has grown only modestly over the last two decades, from 11.8 percent in 1990 to just over 12 percent in 2013 (it rose from 3.3 percent to 5.5 percent if hydro is excluded).[8] However, the pace has accelerated, with renewables accounting for 49 percent of all new electric power capacity added in the country in 2012.[9] Even conservative strongholds such as Texas now have large and rapidly growing renewable energy industries.

The United States saw record PV installations in 2013. More than 4 GW of new capacity was added, pushing the country's total solar capacity to about 12.2 GW, up from only 171 megawatts (MW) in 2005.[10] Added wind power capacity, however, fell from 13 GW in 2012 to less than 1 GW in 2013, in part because of a lack of long-term guarantees for supporting tax incentives.[11]

Energy Efficiency

Since 1990, the energy intensity of the two economies has declined by more than half. It fell by almost 59 percent in the United States and by 55 percent in Germany (although starting from a lower level), to an estimated 0.14 and 0.09 tons of oil equivalent, respectively, per USD 1,000 of gross domestic product (GDP).[12] (See Figure 2.)

Some of the improvement in energy intensity is due to the restructuring of the German and U.S. economies, which are dominated increasingly by the service sector and other less energy-intense sectors. But higher energy efficiency across the board, including in traditional sectors, has also occurred.

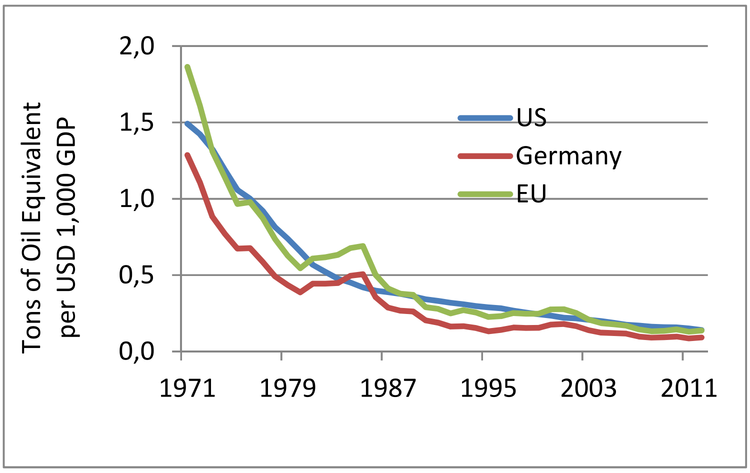

Figure 2.

Energy Intensity in the United States, Germany, and the EU, 1971–2011

Source: World Bank

In Germany, electricity prices were comparatively high long before the *Energiewende*. This has created a sustained economy-wide incentive to increase energy efficiency, leading to decreased costs and improved economic competitiveness. The reduction in local emissions of air pollutants has lowered related healthcare and pollution costs.

U.S. households pay electricity prices that are historically much lower than Germany's, ranging from 9 U.S. cents per kilowatt-hour (kWh) in North Dakota and Washington State to roughly 16 U.S. cents per kWh in California (the big outlier is Hawaii, where most electricity comes from oil and prices approach 37 U.S. cents per kWh).[13] But average household electricity consumption in the United States is more than three times that of Germany, effectively resulting in monthly bills that are comparable.[14]

New efficiency standards in the United States have reduced the energy use of appliances by 50–75 percent (depending on the appliance and model) between 1987 and 2010.[15] However, large potentials remain untapped. Nationwide energy consumption could be further reduced by 40–60 percent by 2050.[16] Large buildings in the United States, for example, can save on average 15–20 percent of their energy consumption without any major investments, just by using optimized building management.

Germany, to tap remaining potentials—and based on feasibility as well as cost/benefit studies—has set a target of reducing energy consumption 20 percent by 2020 (compared to 2008) and 50 percent by 2050 (including an 80 percent reduction in heating demand for buildings).[17] In the United States, no mandatory reduction goal exists at the federal level, but several states have set targets, and the Obama administration has called for doubling the country's energy efficiency by 2030.[18]

In both countries, environmental benefits are already apparent—and not at the expense of the economy. U.S. GDP, when adjusted for inflation, grew 69 percent between 1990 and 2012, but the country's carbon dioxide (CO_2) emissions increased by only about 10 percent during this period and actually have decreased since 2008.[19] Germany's adjusted GDP rose 37 percent over the same period, while its greenhouse gas emissions declined from 1,232 million tons of CO_2-equivalent to some 940 million tons of CO_2-equivalent.[20]

Investments

After many years of increases, global investment in clean energy shrank in recent years, falling 11 percent in 2013, on the heels of a 10 percent drop in 2012, according to Bloomberg New Energy Finance.[21] This was largely the result of weakness in two key markets: in the United States, investments declined some 8 percent to only USD 48 billion in 2013, and in Europe they fell 41 percent to USD 58 billion.[22] In Germany, in particular, investments dropped from USD 26.2 billion in 2012 to only USD 14.1 billion in 2013.[23] This marked decrease can be attributed in part to the falling cost of solar PV installations.

In other regions, however, renewable energy investments continued to rise. In Japan, investments, jumped 55 percent in 2013 to USD 35.4 billion.[24] Stock market shares in global clean energy further increased in 2013, following several years of decline.[25] Public markets apparently believe that the worst of the consolidation in the sector is now over.

The data indicate that in both Germany and the United States, the energy transition is at a crossroads. Germany remains on its long-term track for the expansion of renewables, but it needs to more rapidly improve its energy efficiency; it also has entered a phase of the transition that faces both technical and political challenges. The United States, meanwhile, has only begun to tap into its enormous renewable energy resources. it also faces the challenge of organizing its transition within the framework of a strongly federalist system with highly diverse energy matrices and political aspirations.

In both countries, it is time to renew efforts to support the *Energiewende*—and to keep reaping its benefits.

1.2 Achievements of the Energy Transition

Both Germany and the United States have taken important steps toward sustainable energy systems and higher energy efficiency. These have delivered not only environmental benefits, but also substantial social, economic, and security benefits. Renewables have become a competitive, affordable, and reliable source of energy, as well as a substantial creator of jobs.

Cost Competitiveness and Affordability of Sustainable Electricity

As renewable energy technologies mature in ever-larger markets, the cost of renewable power continues to decline. The average retail cost of new wind and solar PV energy in the United States has dropped to around 10 U.S. cents per kWh, or less.[26] Despite continued substantial direct and indirect subsidies for conventional power, renewable power—particularly solar and wind—has reached price parity or is starting to compete favorably with fossil fuels in many parts of Europe and the United States (for example, wind energy in Iowa).[27] (See Figure 3.)

The substantial growth of renewable energy in Europe has contributed to a sustained decline in electricity prices at the European Energy Exchange, to below 5 U.S. cents per kWh on average in 2013, a drop of 26 percent from 2011.[28] This is evidence that renewables can help lower energy prices.

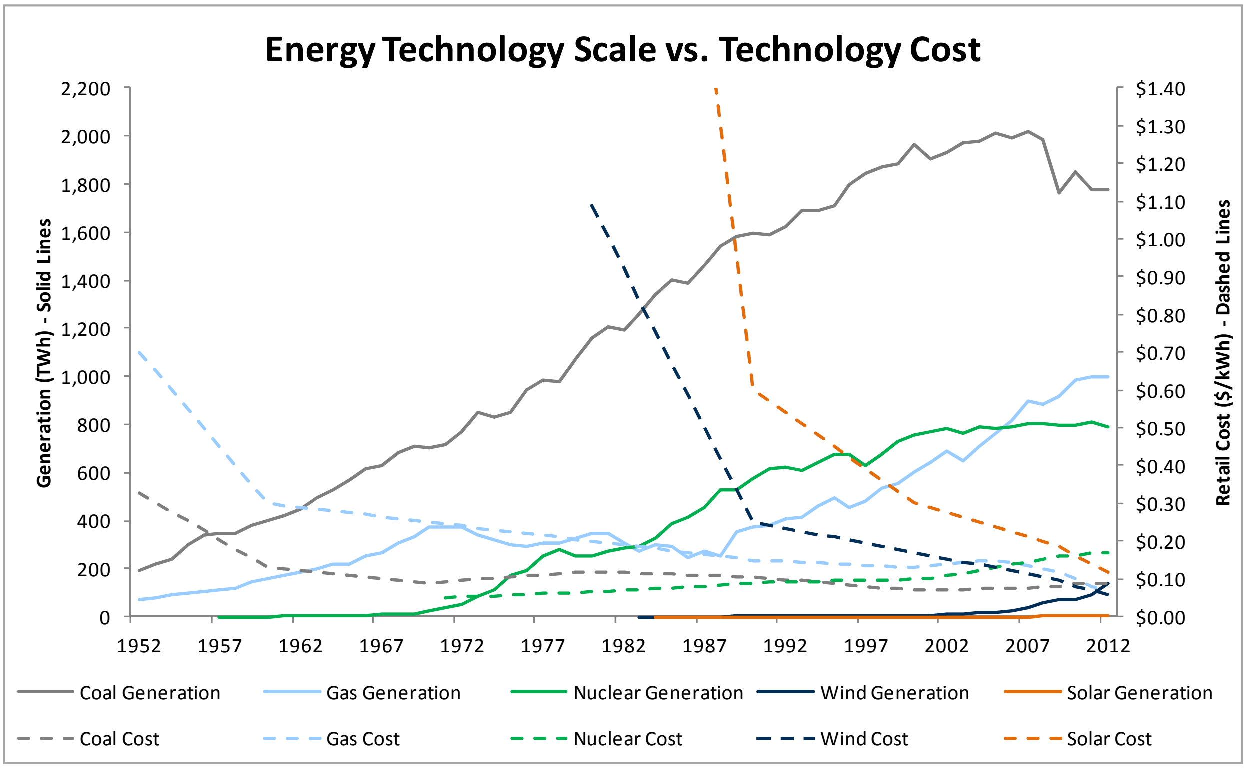

Figure 3.

Retail Cost and Generation of Renewable vs. Conventional Energy, 1952–2012

Source: ACORE

In the United States, the recent abundance of shale gas has lowered the price of natural gas to below USD 4.50 per cubic foot for electric power, or about 1.5 U.S. cents per kWh, causing a shift in domestic generation from coal to natural gas, and an increase in coal exports.[29] Even though the higher flexibility of gas plants and their lower carbon emissions make them suitable as a backup power source for renewables, U.S. and German observers have varying perspectives on the larger environmental and socioeconomic ramifications of the shale gas boom.

Although U.S. and global natural gas resources are large, they are still finite. As the cost of continued production gradually rises, recent analysis points to a continuous increase in gas prices—improving the competitiveness of renewables with natural gas and possibly creating parity in the not-too-distant future even in the United States.[30]

Job Creation

A key benefit of the energy transition, and of distributed generation in particular, is the creation of a vibrant and steadily growing industry that provides income for many. Jobs in Germany's newly created clean energy sector totaled some 380,000 in 2012—about half the number of jobs in the country's large

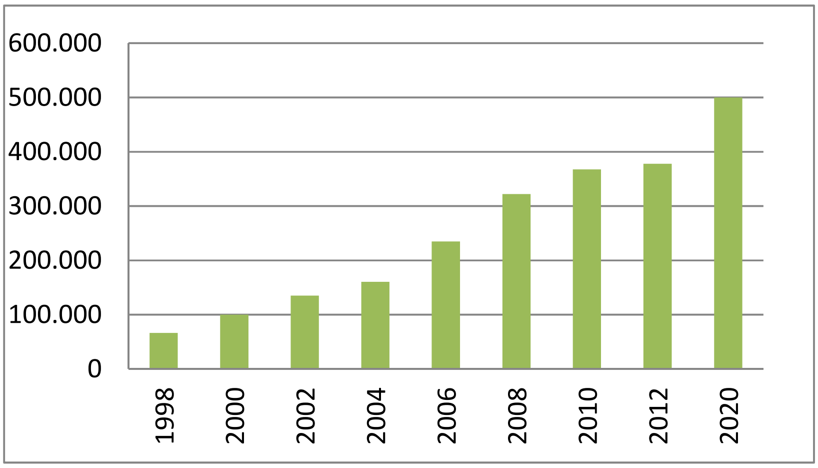

Figure 4.

Green Energy Jobs in Germany, 1998–2012, with Projection for 2020

Source: AEE

motor vehicle industry and more than twice the number in the fossil fuel industry.[31] (See Figure 4.) The United States, meanwhile, employs at least 450,000 people in the renewable energy industry (excluding hydropower).[32] Solar industry employment alone surpassed 140,000 in 2013, almost 20 percent more than in 2012.[33]

As an indication of further innovation to come, the United States issues more than 3,000 clean energy-related patents annually, and Germany issues more than 2,000; this is about as many as in the medical industry. About half of the green energy patents are in the solar sector.[34]

Sustainable and Secure Electricity

Despite the fact that 8 out of 17 German nuclear plants have been closed prematurely, and that intermittent wind and solar power now provide nearly a quarter of the nation's electricity over the year (and the bulk of electricity on some days of the year), Germany's electricity supply remains among the world's most reliable.[35] The country reported an average of less than 16 minutes of outages in 2012, compared to a reported 214 minutes in the United States.[36]

Overall, Germany has established itself as a net exporter of electricity, sending abroad 33 terawatt-hours (TWh) in 2013, up from 23 TWh in 2012—or the equivalent 5.6 percent of the country's total electricity generation.[37] In addition to still-sufficient conventional backup capacity, important factors behind this export capacity have included careful management of the grid, improved weather forecasting, and the ability to buy and sell power with nearby countries such as France and Poland. Regional trading increases flexibility and helps integrate rising shares of renewable energy.

Rising U.S. coal exports have contributed to a reduction in coal import prices in Europe. This price decline, combined with a collapse in the price of European emission allowances, has caused Germany's use of coal, after a period of steep decline, to rise almost 13 percent between 2009 and 2013.[38] Critics have noted that this is inconsistent with the nation's overall climate and energy strategy.

But this short-term development does not counter the achievements already made: despite its rise in coal use, Germany used 8 percent less coal power in 2013 than it did in 1990, and the share of coal in the country's electricity generation shrank from 60 percent in 1990 to some 45 percent in 2013, while nuclear power has been replaced by renewable energy.[39] (See Figure 5.) The current increase will likely be only temporary if policies can be adjusted to sustain support for the energy transition.

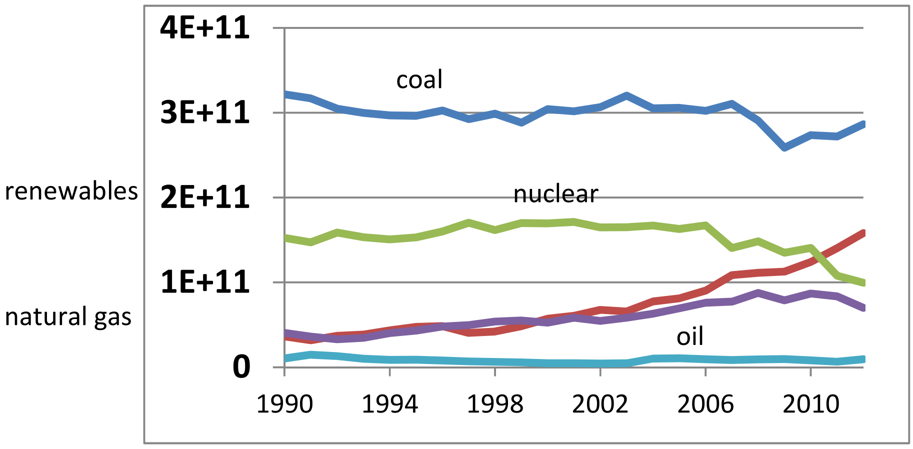

Figure 5.

Germany's Electricity Generation by Source, 1990–2012

Source: AG Energiebilanzen

2 | The Way Forward: Addressing Key Challenges to Advance the Transition

The current achievements of the energy transition on both sides of the Atlantic, while impressive, are not sufficient to prevent accelerating climate change and to unlock the full socioeconomic potential of clean energy.[40] The impediments to continuing the transition relate not to technology or cost, but to the inflexibility of the existing energy system, its legacy business models, and the resulting resistance to change. Studies (see, for example, the German "energy concept" below) indicate that the transition to renewable energy is, from an economic perspective, the most feasible way to achieve energy security and sustained economic growth.

On the technical side, the transition will require additional cost-efficient renewable energy generation, higher energy efficiency, and better-managed energy demand, as well as the adoption of intelligent technologies for transmission, distribution, and storage. Smart regulation and reliable support mechanisms need to create a market that creates incentives for developing and deploying sustainable energy technologies. The following sections discuss three particular challenges that will need to be addressed over the coming years:

- How to create effective incentives for the further expansion of renewables,
- How to best promote efficiency and demand-side management, and
- How to restructure the electric power industry.

2.1 Creating Reliable Support Mechanisms for Renewable Energy

Overarching political targets for renewable energy deployment, emission reduction, and energy efficiency exist in Germany, the European Union, and the United States. These need to be revised and strengthened regularly. As a means to reach these targets, governments have issued regulations and incentives that support the clean energy industry. As clean energy technologies grow in scale and become economically competitive, however, pressures to change these policies have increased.

Given the differences in political and regulatory structures, there is no simple solution for supporting renewables. A policy portfolio that both sets ambitious and continually rising goals and is lasting and reliable is key to reinforcing the market and creating a sound investment climate. Renewables have proven to be price competitive, but legacy support mechanisms for fossil fuels create a distorted market; consequently, policies need to offer an attractive investment climate and to guide renewables to be self-sustaining on the market.

To reach the goals for a sustainable energy system, a portfolio of policies is needed rather than a single silver bullet solution. This policy mix should include research and development (R&D) programs and loan and grant schemes, among other measures, and should be designed in close connection with other sectors such as buildings and transportation, as well as overarching climate policy. Continued detailed study of the experiences in Germany and U.S. states is important. Among the most promising measures are reliable policies that support steady, sustainable growth of renewables with the minimum amount of government support payments, and that avoid an imbalanced sharing of cost.

The sections below discuss the most prominent instruments available and the role that they can play in supporting the energy transition.

Implementing Strategies Toward (and Rethinking) Overarching Goals

Both the United States and Germany have committed to increased reliance on clean energy, although their policy approaches vary substantially.

Germany's policy is tied to EU legislation that commits the region to three main targets for 2020: obtaining 20 percent of energy from renewable sources; increasing energy efficiency by 20 percent; and reducing greenhouse gas emissions 20 percent below 1990 levels.[41] A proposal now under consideration would include a new target of a 27 percent renewables share by 2030.[42] To address efficiency, the EU Energy Efficiency Directive, enacted in December 2012, includes obligations for all member states to set national energy efficiency targets and to achieve savings in final energy consumption by 2020.[43]

As its specific contribution to EU policies, Germany has formulated national, binding targets for the *Energiewende*, with milestones to be reached by 2020 and 2050.[44] These include raising the share of renewables in total energy consumption to 18 percent and in electricity consumption to 35 percent by 2020, reducing primary energy consumption 20 percent by 2020 (and 50 percent by 2050), and reducing greenhouse gas emissions 40 percent by 2020 (from 1990 levels).[45] The new German government elected in 2013 has committed to continuing the energy transition. According to studies for the government-commissioned "energy concept," a share of 80 percent renewables in total electricity generation by 2050 is feasible, and was made a national target to be reached by that year.[46]

The United States does not have an official national target for renewables, in part because U.S. energy policy is more decentralized than that in Germany. Still, the Obama administration is committed to sustainable energy growth. In 2013, the White House called for a doubling of the economy's energy efficiency by 2030, along with increased use of renewables.[47] And some individual states have ambitious goals: California, for example, is aiming for 33 percent renewables in its electricity supply by 2020, up from 20 percent today.[48] Several states have introduced cap-and-trade schemes to reduce their economies´ emissions, and will use the proceeds for investments in clean energy or energy efficiency.

Regular assessments should be made to determine whether these goals—mandatory or not—are still ambitious enough to be on par with the technological possibilities, and how policy instruments can be improved to be more effective in helping to reach the set goals.

Making Tax Credits Reliable

In the United States, tax credits are the most important tool for supporting renewable energy at the national level, and they have contributed to the substantial growth in renewable capacity installations. But because these credits expire repeatedly, necessitating a renewal process, the U.S. renewable energy market remains hampered by uncertainty.

For example, the substantial setback in U.S. wind installations in 2013 stems from Congress hesitating until January of that year to extend the wind power tax credit. Once the tax credit was renewed, the industry revived, and by the end of 2013, 12 GW of new capacity was under construction.[49] However, the wind power tax credit has since expired again, and future federal and state policy support remains unclear. This indicates the importance of ensuring long-term reliability of this policy instrument, if it is intended to be part of a policy package to compensate for legacy fossil fuel subsidies.

Enacting and Updating Standards

Twenty-nine U.S. states have made the inclusion of renewable power a requirement for their utilities in the form of Renewable Portfolio Standards (RPS), and many utilities have started investing in renewables as a means to meet them. Renewable energy credits (RECs) are used to quantify and acknowledge the electricity generated from renewables. The RECs can be traded, but there is no national pricing for them, and the situation varies from state to state. In some states, RPS have already been met, but fierce battles are under way between renewable energy advocates who want the standards to be raised and extended, and electric utilities that would like to abolish them. So far, none of the RPS have yet been abolished or weakened, yet this instrument remains vulnerable.

National carbon pollution standards for new power plants, proposed by the U.S. Environmental Protection Agency and aimed at limiting emissions from these plants, could help the renewables industry. Even more powerful are the standards currently under development for existing plants, which give states broad latitude over how to meet them (for example, by using cap-and-trade schemes). In Germany, emission standards exist for non-CO_2 pollutants, whereas CO_2 emissions are regulated under the EU's emission trading scheme. Compliance with these standards needs to be closely monitored, and benchmarks need to be further tightened in the future, in order to achieve long-term sustainability goals.

Designing Feed-In Laws

Many experts have lauded the efficacy of feed-in tariffs (FITs) in promoting steady growth in the use of renewable energy and helping to greatly reduce the cost of the technologies. Germany's national FIT is widely perceived as instrumental for stimulating the country's renewable energy boom; it has successfully advanced technology development and reduced the per-kWh cost of solar PV and wind energy.[50] But the FiT's design of payment by consumers, with exemptions for many energy-intensive industries, has attracted criticism for contributing to rising household electricity prices. The measure is already being scaled back, with targets being set for each individual renewable source, and future reduction of the tariff scheduled in the event of overachievement (to avoid overcompensation). But this, together with ongoing redesign discussions, is weakening investment security and slowing sectors of the renewable market, as indicated by Germany's recent declines in solar installations.

One problem is that for private households in Germany, electricity prices have risen from around 20 U.S. cents per kWh in 1990 to 36 U.S. cents today.[51] But contrary to popular perceptions, Germany's electricity prices are driven by many factors including taxes, distribution charges, and the utilities' profit margins. The renewable energy surcharge—a fee on consumers to pay for the FIT—is currently at roughly 8 U.S. cents per kWh, and has become an additional cost factor.

Electricity prices for households should decline again once the investments amortize, as long as the lower cost of generation is passed on to private consumers and FiT payments from recent boom years expire. As a result of maturing technology, the FiT for roof-mounted solar PV in Germany is now down to around 17 U.S. cents per kWh and keeps declining.[52] Thus, self-consumption of privately owned generation has become a feasible and economic option to save on utility bills. Germany's energy-intensive industries, in order to ensure their international competitiveness, have been largely exempt from the renewable energy surcharge; in addition, they can purchase electricity directly at the energy exchange, rather than from utilities only.

FITs have proven to be a very effective incentive, but they need to be designed carefully. Reductions in FIT payments need to be planned in advance and in a reliable fashion in order to provide a stable investment climate. Negative side effects, such as the uneven sharing of cost, need to be prevented.

2.2 Enhancing Energy Efficiency and Demand-Side Management

Energy efficiency is a key element of an energy transition. It reduces overall energy demand, helping to match it with a clean energy supply and reducing generation costs. But substantial efficiency measures, despite reducing overall costs in the long term, are expensive in the short term and therefore difficult to incentivize; moreover, existing incentives are often split among different stakeholders. But the potentials of efficiency are significant. A portfolio of measures is needed that combines a "technology push" with public education and a "market pull" that provides incentives and certainty for the market, and thus helps to facilitate real structural change.

Demand-side management (DSM) helps match supply and demand. While efficiency lowers overall demand, DSM (also called load management) modifies demand time profiles to help match them with the intermittent generation from renewables. Since the cost-benefit ratio of options varies greatly, and in order to achieve maximum benefits, DSM should first be implemented in sectors with high potential, such as industry, and in regions that are affected by power plant or grid congestion.[53] Also needed are sufficient incentives as well as smart meters to assess consumption in real time, and Germany can learn from existing U.S. experience in this area. As with support for renewables, an encompassing policy portfolio is needed that allows for innovative business models and that includes, in addition to codes and standards, increased R&D, government procurement, rebates, and tax credits.

Designing Incentives for All Involved

A majority of U.S. states has adopted Energy Efficiency Resource Standards (EERS) or goals, requiring or urging utilities to help their consumers be more efficient. In recent years, some state legislatures have even mandated utilities to reduce customers' electricity usage, for example by 40 percent by 2030 (compared to 2005 levels).[54] Some utilities and advocacy groups actively oppose such policies, however, because improved efficiency can reduce electricity sales and undermine the traditional utility business model of boosting profits by selling greater volume.

The challenge lies in compensating utilities for their lost sales. Existing examples of incentives for utilities include financial bonuses for energy efficiency, rebates for products or services such as sealing of air ducts and windows, energy audits, or appliance replacements, as well as ratepayer programs.[55] Another option is separating or "decoupling" the sale of energy by volume from system management services entirely, for example by creating separate efficiency utilities such as "Efficiency Vermont."[56]

Energy efficiency measures provide varying returns on investment. But for most U.S. consumers, the economic benefits are not yet sufficient by themselves; current prices fail to provide the detail and incentive to spur substantial investment in energy efficiency—or, the incentives are split. U.S. homeowners, for example, often sell or move from their houses before they recoup any cost-effective (but longer-payback) investments in energy efficiency, such as heating system upgrades, improved windows, or building shell improvements. Instead, they tend to implement measures that offer shorter-term payback, such as improved lighting and appliances. If owners rent out property, they often avoid efficiency investments because landlords may not see the savings on utility bills; or, they may raise rents to recoup the investment cost, leaving tenants at risk of not being compensated for the higher monthly rental cost with lower utility bills over the year.

One way for utilities to recoup more-substantial efficiency investments in buildings could be to bill the building, rather than the consumer, provided that there is appropriate regulatory authorization or legislation. When occupancy changes, the new owners or tenants could continue to pay the utility for the efficiency measures taken, as they now profit from them.

Among the solutions for consumers is a public education campaign similar to that of the anti-smoking movement, promoting building efficiency as a healthy goal to pursue. Benchmarking of buildings, including disclosure, could provide market incentives. An example is the mandatory "*Energiepass*," or energy pass, introduced in Germany. Smart meters, now being installed in many parts of Europe and across the United States, are a tool to provide time-sensitive information on energy consumption, thereby creating awareness of immediate saving potentials. In addition, the meters establish collaborative one-on-one relationships between utilities and customers, and aid utilities with system operations.

Developing Effective Standards and Codes

In the United States, the Leadership in Energy and Environmental Design (LEED) rating system provides a standard for assessing the design, construction, operation, and maintenance of buildings and neighborhoods. Owners can voluntarily seek evaluation and certification of their buildings based on criteria such as energy efficiency and choice of materials. Meanwhile, building products such as seals and windows can qualify for the U.S. Energy Star label if they have sufficient insulation qualities.

Compliance with building codes is mostly on a voluntary basis in the United States, and is coupled with financial incentives. Minimum mandatory standards exist in U.S. states, but they vary in extent and strength and need to be extended and updated regularly in order to remain effective. To improve their effectiveness, they could be applied not only to new buildings, but also to existing ones, as well as undergo independent verification.

In Germany, strict mandatory standards were enacted in 2002 under the *Energieeinsparverordnung* (Energy Conservation Act), applying to new buildings as well as to existing buildings that are being remodeled (including to their heating systems). The building's annual primary energy consumption must remain below a certain threshold. The legislation is updated every few years to reflect developments in technology and cost, and energy consumption levels must be published in the *Energiepass*.

For appliances, the optional Energy Star label in the United States initially failed to incentivize efficiency gains, and the criteria and verification of compliance were criticized as being too weak. In 2010, a major overhaul tightened the standard-setting and mandated independent verification. Since then, each year the criteria for another kind of appliance, including parts of buildings, are revisited. The effects of the changes need to be monitored to determine the impact on energy efficiency.

In Germany and the EU as a whole, the mandatory EU energy label provides consumers with quantitative data about an appliance's energy consumption through a color-coded and easily understandable grading system. The underlying benchmarks are updated regularly. The system has proven effective in creating awareness of energy consumption and cost, thus incentivizing the purchase and development of more-efficient appliances.

Moving forward, an encompassing policy portfolio for energy efficiency should be developed. Besides strengthening the existing system of codes and standards, rebates and tax credits could be designed that create further incentives to reduce energy intensity in all sectors, including buildings and appliances but also sectors not yet directly regulated, such as manufacturing and the electricity system itself.

Deploying Demand-Side Management

Demand-side management bears huge potential to ease the energy transition, but it requires changes in energy consumption profiles. In both Germany and the United States, rising dependence on renewable energy is creating a growing need for DSM. Because DSM shifts energy demand, it helps to mitigate temporary regional electricity shortages or surpluses. Demand-side measures can be a cost-effective alternative to conventional or fossil peak-load capacity, helping to smooth the market, accommodate larger shares of renewables, and make the energy transition easier.

Figure 6 shows a German case study for securing supply in times of peak demand for a week in November 2022, when all nuclear plants will have been shut down.[57] Renewables, during their supply peaks, will reduce the need for fossil fuel generation. But at certain times, such as during windless winter days, wind and solar PV cannot sufficiently cover peak demand. For this reason, controllable resources will be required in the same order of magnitude as they are today. Almost a quarter of Germany's demand—approximately 15–25 GW—occurs during less than 200 hours of the year. Although open-cycle natural gas turbines can meet this demand at a cost of EUR 35–70 per GW, DSM could be even more cost effective.

In the U.S. state of California, peak summer electricity demand extends from the afternoon into the early evening, and after sunset. Thus, a combination of DSM and backup power supplies is needed to match demand with supply. In the United States as a whole, 29.5 GW of demand-side controls are already available to utilities and grid operators. Some utilities offer DSM services to customers as a means to protect the grid and ensure reliability. More than USD 2.6 billion per year in direct revenues could be generated using DSM, for example through bill savings. A similar source of revenue could be made available in Germany.[58]

To obtain a quantitative assessment of DSM's potential in Germany, Agora Energiewende performed, in collaboration with federal state governments and local experts, a first-of-its-kind study in southern Germany—where nuclear power plants are being shut down at the same time that industrial electricity demand is stable. It estimates the load management potential of industry in that region to exceed 1 GW

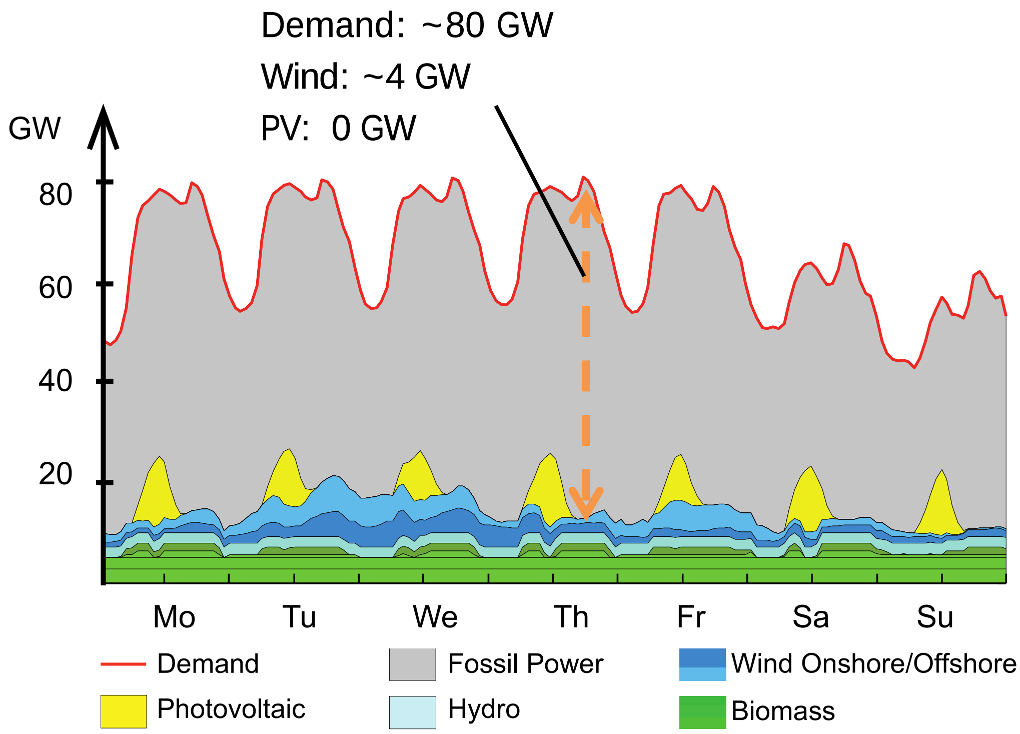

Figure 6.

Challenges of Securing Supply in Times of Peak Demand: A German Case Study, November 2022

Source: Agora Energiewende

for between 30 minutes and 2 hours.[59] As with efficiency, however, specific incentives are needed to deploy DSM and to enjoy the societal advantages. At least on the German electricity market, the current incentives are not yet sufficient. New market structures are required that allow for active participation and non-discriminatory access for consumers. It is still being investigated what economic incentives and market rules are necessary to do that. Already, German companies have started to study examples in the United States, and new tariff models are being discussed as a first possible approach. Initial studies indicate that electricity rates that vary with load or time of the day could create the needed incentives, provided that they offer tangible and transparent cost savings.[60]

2.3 Restructuring the Electric Power Industry

The emergence of new technologies for generating power, improving energy efficiency, and digitally controlling the electricity grid have made today's power industry appear antiquated. The legacy business model, based on the growth of electricity demand and the provision of baseload power in a centralized grid structure, no longer reflects today’s mandates of social, economic, fiscal, and environmental sustainability. This newer approach calls for the most efficient use of clean, renewable power production in a system that will have installations of varying scales (large, medium, and small) and will consist of distributed grids that can feed off and into the larger system. Utilities, some of them former monopolies, are losing market share and profits in many parts of the world, including Germany and the United States.

In turn, the energy transition has created opportunities for individuals as well as a new generation of companies to invest in sustainable technology solutions, from energy monitoring and management devices and the leasing of rooftop solar systems, to the management of micro- or off-grid systems. Businesses that want to be successful in the future must provide for a new societal goal—sustainability—and the future electricity market must create incentives for this.

For a transitional period, legacy utilities and the new players are operating in parallel. At the same time, supply and storage of clean energy are not yet developed enough to meet managed demand. Besides further investment in the grid, this situation requires intermediate backup capacity, the substantial cost of which needs to be shared among market participants. For the transition to continue efficiently and without disruption to power supplies, regulatory requirements and incentives will need to be modernized. The ultimate solutions have not yet been found.

Shifting Energy and Grid Markets

Currently in the United States, two different economic systems apply to electricity markets. Under the classic regulated system of vertically integrated monopoly utilities, consumers have to pay a price that is set by regulators in order to reward investments with a fair return. Meanwhile, a deregulated market has emerged that encompasses regional markets as well as retail markets with distributed energy. Here, customers can choose from independent suppliers (often using renewable energy sources), and the utilities' role is often limited to managing the transmission of the remaining electricity share that is not used locally at the point of production. The Federal Energy Regulatory Commission (FERC) helps de-monopolize access to the grid, for example by establishing Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs).

In Germany, various types of utilities exist as well, and most customers can choose between different electricity vendors. Under the *Energiewende* laws, producers of distributed energy have privileged access to the grid. The Federal Network Agency monitors distributed generation deployment and also supervises necessary grid extension activities.

On the consumer side, technologies such as increasingly affordable solar PV power have made consumer-owned generation manageable for many citizens. Private consumers and businesses can become "prosumers" and replace purchased grid electricity with renewable electricity they generate themselves. "Co-op" models, where several households own and share distributed installations, have also been tested. Changes in laws may be necessary to enable power providers other than regulated public utilities to sell electricity across public streets.

These developments are taking market shares away from traditional utilities in both the United States and Germany, and, during the transition, legacy utilities and the emerging new market players will exist side by side. At this crossroads, the question will arise of responsibility and revenues for funding generation capacity as well as maintenance and upgrades of the grid.

Securing Supply and Capacity

New large power installations, once depreciated, can generate electricity at very low marginal costs, particularly in the case of solar and wind power. Growing numbers of these installations have been lowering the wholesale price of electricity, but they are also reducing incentives for investments in additional installations. In Germany, for example, there are plans for 15 pumped hydropower plants, but currently no one is investing in them. New, efficient natural gas plants are under threat of being taken offline again because of competitiveness issues.

In addition, the shrinking profitability of existing conventional baseload power plants is leading utilities to consider retiring them, potentially leading to electricity shortages at times when solar and wind energy are unavailable. In response, policymakers are considering the need to create separate markets for generating capacity (in addition to the market for electricity itself). But utilities may not be ideally suited to secure long-term capacity contracts with third parties such as large energy providers, since their customer base and revenue stream is no longer equally stable everywhere.

The lack of incentives for large-scale generation and backup capacity are posing a potential threat to stability of supply, as there is not yet a match between renewable capacity and reduced, managed demand. As a result, legal struggles are afoot in Germany between utilities planning to shut down unprofitable plants, and regulators seeking to force them to remain online to secure supply.

Stimulating Sustainable Business Models

To avoid long-term reliance on government regulation, new business models need to be found for utilities while at the same time keeping the market open for new players. Moreover, as electricity begins to play a role in heating and transportation, and as renewables begin to be used in conjunction with natural gas, it will no longer be feasible to clearly separate business models and markets for electricity, heating, and transportation.

A range of new models is being tried. Consulting firms and nonprofit organizations such as the Regulatory Assistance Project in the United States are advising utilities and government officials on new approaches, including examples of new incentive structures, and how best to make the transition.[61] Today's electric utilities have profit margins of 5–10 percent, which are often set by government regulators. Decision makers will be willing to adopt new models only if the margins are similar to this or higher, or at least as high as the market and regulation allow for. In some cases, new institutional structures might be needed for utilities to implement new models.

One proposal for a capacity mechanism calls for electricity distributors (in places where utilities do not own the wires themselves) to secure capacity with cost-effective long-term contracts. The utility, in addition to selling energy, in turn can offer its customers efficiency improvement services that reduce peak capacity requirements, and then negotiate capacity charges with the distribution provider.[62]

The challenges outlined in this section are not yet fully solved, and robust new market structures have not yet been found. Increased efforts and research need to go into developing regulatory structures and business models that foster a competitive market that in turn promotes steady, reliable, and economical electricity, the entrance of new technologies, and the steady reduction of environmental impacts from conventional generation.

3 | Outlook

Despite tremendous progress over the last two decades, resulting in significant societal gains, Germany and the United States have just begun their transition to truly sustainable energy systems. This analysis has identified and discussed three closely interconnected priority areas for the way forward. Efficiency and demand-side management need to work in conjunction with flexible, decentralized renewable power generation, as well as its smart transmission, distribution, and possibly storage. Only combined will these elements make the continued transition to a sustainable energy system feasible.

New business models that guarantee the achievement of the overarching societal goal of social, economic, and environmental sustainability will depend on smart policy and regulation. It is important to create a market that advances these business models as well as a change in consumer demands and consumption patterns. As shown, a multitude of policies and measures already exists that have made substantial changes possible. But their effectiveness needs to be constantly monitored and evaluated as well as openly reported and deliberated. Where necessary, existing mechanisms need to be adjusted and enhanced or even complemented or replaced by new ones.

This paper, and the strategic dialogue on which it is based, have provided insights into both current and future challenges of the *Energiewende*, arguably one of the most important, difficult, and audacious projects on both sides of the Atlantic this century. It has also tried to provide some concrete ideas for how the early successes of the U.S. and German energy transitions can be carried forward. Perhaps the most important result of the discussion is the need to further intensify the dialogue among policymakers, regulators, grid operators, industry executives, academic experts, and representatives of media and civil society regarding the goals, ways and means of this historic transformation.

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