Germany's Energy Transition

A Comparative Perspective

CAROL HAGER *and* CHRISTOPH H. STEFES

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Editors

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To Mavie, Michael, and Stephanie
May your world be a world of hope

Foreword

Energiewende: Germany has coined a new word that the world is adopting into many languages. This book explains the origins of a fascinating idea and how it came to fruition: a developed country, known for incremental and not radical or disruptive innovation, commits to transform its energy infrastructure. To that end, it realigns its resources to research, develop, deploy, and commercialize clean energy technologies and thus changes the way it powers its homes, businesses, and automobiles. If Germany succeeds, and all the indications so far point to likely success, no one can deny anymore that the world is in the Age of Energy Transformation, a term in the agreed language of the US–EU Summit held in April 2007.

The original word, *Energiewende*, was made popular as the book title for a blueprint, published in 1980, on how to move beyond oil and uranium. Experts working with the Öko-Institut, the Institute for Applied Ecology, building on ideas first spelled out by Amory Lovins, defined a policy path for the country, first for West Germany, and later for the larger unified Germany, on which large majorities have agreed ever since.

Viewed in its entirety and evolution spanning large geopolitical changes as well as technological developments, the true nature of the *Energiewende* becomes plain to see: a slow transformation over decades. It is reasonably well monitored and managed as an adaptive policy process. Overall, it is an economically sound, low-risk strategy. With the benefit of hindsight, we can now say that it could, and should, have been accelerated. Even today, its ambition is held back by what might be called an overabundance of caution and organized interests vested in the old fossil and nuclear energy system.

The "green power shift," underway in Germany, already produces manifold and large economic-policy benefits in terms of innovation, business creation and growth, qualification and employment, additional tax revenue and social security contributions, import substitution, and strength in the balances of trade and payments. The renewable energy sector even acts as an automatic economic stabilizer in a general downturn of the business cycle. Further, the policy adds options in dealing with an aggressive and exploitative Russia, the importance of which became obvious when Russia invaded, occupied, and annexed Ukraine's Crimea and involved itself in a "civil war" in parts of the Donbas region in early 2014.

At least since the 1970s, when Germany was divided, frozen in conflict in the Cold War, nuclear technology and its ostensibly "civilian" use in the electricity sector was controversial in Germany. Controversy evolved into a *Gesellschaftlicher Grosskonflikt* (Grand Societal Conflict) that defines not just one but several generations. It called into question the four-sided relationship between citizens and ratepayers, municipalities as democratic local governments engaged in energy services, industry as operators of nuclear plants, and the central or federal government as regulator and promoter of energy policy choices. Pitched battles were fought in legislative chambers, before courts, and in the streets, until a phase-out of nuclear power was agreed on between operators and the federal government in 2000. The Grand Societal Conflict subsided. Some mistakenly saw it as resolved, while others knew it was dormant and ready to break out again if the phase-out were ever revoked.

Legislative ambush by government on parliament is the best way to describe the ill-fated 2010 decision to delay the closure of Germany's nuclear power plants. It was adopted after the law was presented and pushed through in a very short time and without normal scrutiny. As a consequence, it was challenged as being unconstitutional for several reasons, and may well have threatened the survival of the government of the day. It was ultimately defeated, for good reason, because it broke a longstanding cross-party consensus, formed after the tragedy in Chernobyl in 1986, to phase-out nuclear power.

What then drove the German parliament in the fall of 2010 to extend the allowed operating time for the country's nuclear power plants? Lobbying by the plant operators, the four big incumbent utilities, seeking to overturn the nuclear phase-out they agreed to in 2000, is the obvious answer. Extending required pretending the untenable, when the truth was already widely known that nuclear power is too expensive, polluting, wasteful, and dangerous even for a rich, technologically advanced country like Germany.

Germans saw through the false pretenses and took to the streets in ever-larger numbers to protest for a continuation and acceleration of the *Energiewende*, Germany's energy transition toward clean, safe, and increasingly cheap renewable energies. The 2010 extension made no sense in the larger framework of energy policy, economic policy, or technology policy. The vote on in the German parliament, the Bundestag, on October 28, 2010, is the most prominent, and in many ways surprising, outlier in an otherwise smooth process, explored in this book, of envisioning, preparing, planning, initiating, and managing a grand transformation of an industrial country away from costly, dirty, and dangerous fossil and nuclear power toward a future based on increasingly cheap, clean, and safe renewable energies.

Today, Germany has two issues that strengthen its soft power around the world: the "Dual System" of vocational training in the arts and crafts of technicians and managers, and the *Energiewende*. Both play well toward other perceived strengths of Germany and the Germans: technological prowess built on research as well as practical education, economic and fiscal solidity, and continuity in realizing long-term projects. It is not surprising, therefore, that a new *Energieaussenpolitik* (Energy Foreign Policy) is emerging, coupled with the external climate policy developed over the past 20–25 years. Both are strong on public diplomacy as a complement to more traditional foreign policy instruments.

The most important contribution Germany may be able to make for the success of international climate negotiations is to show that transforming the energy system, once begun in earnest, is much easier than it might appear at the outset. Many decision-makers around the world still cling to the belief that protecting the climate involves making sacrifices today for the benefit of future generations. The example of Germany's *Energiewende* shows that the energy transformation produces short-term benefits that outweigh its costs, that those costs are not higher than maintaining the old, non-sustainable energy system, and that the costs are coming down as experience accumulates. Saving the planet is getting cheaper by the day.

Driven by citizens across the country, the *Energiewende* is a contagious democratic happening. People all around the world are fascinated by the readiness of the Germans to engage and invest in the *Energiewende*, and their ability to do so as a consequence of changes in policy and regulation.

The experience is in sharp contrast to the experience in countries that are rich in fossil resources, where the "resource curse" tends to result in centralization, increasing corruption of elites and, ultimately, the emergence of autocratic, repressive governments. The experience with nuclear technology is no better, and the security policy price paid for the proliferation of nuclear technology through the energy sector is high and rising.

As you read the various chapters in this book that tell the story of *Energiewende* from different and comparative perspectives, you will find the battles between sustainable and unsustainable development, between distributed and centralized power, between citizens and technocracies in government, and between democracy and autocracy recurring themes.

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Introduction. Germany's Energy Transition in Context

Carol Hager

Introduction

When scientists at West Germany's fledgling Eco-Institute first proposed an *Energie-Wende* (energy transition) in 1980, virtually no one among the governing elite took them seriously. After all, they sought to eliminate both oil and nuclear power from the country's energy mix, a feat the scientific establishment thought impossible. They advocated for small producers to feed power from renewable sources into the grid, an idea the country's large, politically influential utilities opposed. They also made the revolutionary proposition that economic growth and energy use could be decoupled—that is, the economy could expand while energy demand shrank.[1] Few could have guessed then that, 35 years later, a now-unified Germany would be viewed as the global leader in the shift to renewable energy sources. With the world's fourth biggest economy, Germany is the largest industrial power to have committed to a full-scale transformation from a fossil fuel and nuclear-based energy system to a renewables-based one. The road has been long and the obstacles numerous. There is continuing pushback from opponents of change, both within and outside of the country. But Germany's path-breaking *Energiewende* is on track and is beginning to pay off in numerous ways.

Germany's energy transition defies conventional wisdom regarding the sources of political change. The *Energiewende* was a bottom-up movement

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in a country where political change tends to come from the top. It began not because of economic considerations, but out of moral conviction. It was a revolution of small producers in a country where large energy utilities have a history of monopoly and are politically entrenched. It retains overwhelming public support despite concerns about the distribution of its costs and benefits. It has overcome persistent opposition from some of the country's most powerful economic and political interests. As the threat of human-induced climate change looms over the planet, the success of Germany's energy transition sends a hugely important signal that the shift away from a fossil fuel economy, while difficult, is possible. The world is watching what Germany does.

This book is one of the first to offer a comprehensive analysis of the German energy transition, in both domestic and international context, for an English-speaking audience. We begin with the domestic context, locating the roots of the transition in West Germany's grassroots anti-nuclear movements of the 1970s and 1980s. We show how these movements fostered change, by making the long-term use of nuclear power politically infeasible on the one hand, and by creating networks of innovation and advocacy for renewable energy technologies on the other. We describe how Germany's federal structure, coupled with strong local leadership, has enabled municipalities and some federal states (*Länder*) to play an important role in the transition despite a tendency toward centralization in energy politics. We analyze critical junctures where policy entrepreneurs at the national level were able to change the direction of Germany's energy policy in the face of considerable opposition and inertia. We also show how traditional energy interests are reemerging to engineer national-level policy changes that shift the array of winners and losers. Finally, we examine how Germany's role in the European Union (EU) offers both opportunities and constraints for its energy transition domestically.

Germany's story is compelling in itself, but it is also instructive in a global context. Energy is a major political issue in many other countries, including the world's three largest economies, the USA, China, and Japan. With regard to climate change, as these countries go, so goes the world. By presenting comparative case studies of these three countries, we show how the German case may enhance our understanding of energy politics and policy changes worldwide. And conversely, each comparative case study highlights different features of the German energy transition. The USA, like Germany, has a federal system in which progress toward an energy transition has been uneven among different levels of government and different regions. The US pattern, however, differs from the German one in important ways. Significant innovation in renewable energy has occurred at the state and local levels in the USA. At the national level, on the other hand, American renewables advocates have had to negotiate a much less favorable political landscape. They have succeeded in fostering one of the largest renewables sectors of any country while being careful not to articulate a new energy system that would draw opposition from fossil fuel interests. In contrast to Germany, the USA has developed no coherent national vision for an energy transition despite a relatively high level of activity at lower levels of governance.

Japan's energy sector has traditionally had a structure similar to Germany's,... with large utilities enjoying regional monopolies of supply. Like Germany, Japan has seen growing citizen unrest over nuclear power, especially since the 2011 Fukushima catastrophe. Japanese utilities have more successfully resisted the transition to renewables, however. The structural power of business in Japan, along with the vertical integration of firms across the whole supply chain, has enabled them to slow political demands for change.

A resource-rich developing country with a one-party government, China faces some different challenges than the other countries included in our volume. The Chinese government maintains a tacit social contract with the population in which it delivers economic development and social benefits in exchange for continued political support. Whereas German policy has focused on generating electricity from renewables, Chinese policy has focused more on manufacturing renewable energy technologies, a "growth imperative" rather than a "green imperative."[2] Recently, there has been more pressure for a distributed energy system that includes an increasing share for renewables. This decentralizing push is reinforced by growing citizen mobilization around pollution-related public health issues. The Chinese government is thus beginning to face some of the same cross-pressures as the German government.

In sum, the American, Japanese, and Chinese cases raise instructive points of similarity and difference to the German case. Taken together, these case studies help us understand how the energy transition has worked, and can work, in a variety of political settings.

Political and Institutional Setting

This volume is intended for students of German politics, as well as for those whose interest is primarily in energy politics or in processes of political change more generally. Our contributions are united by a common focus on the ways political institutions change or resist change. In our view, this factor is key to understanding why energy transition happens, and how it unfolds differently across time and space. We also share a conception of political institutions as configurations of power, as evolving networks of inside and outside actors. How do different configurations of power facilitate or hinder the energy transition? Which coalitions of actors make lasting change happen? The following chapters offer several ways of addressing these central questions. Together, they reveal the rich complexity and global implications of Germany's experience.

The German political system offers a particular array of opportunities and constraints that I will describe briefly here. Germany has a corporatist policymaking style, in which policy decisions are reached consensually among elites from government ministries, industry, and labor in advance of national legislation.[3] Both industry and labor are organized in networks of associations, with peak associations negotiating on behalf of entire sectors. This setup was designed to minimize and depoliticize conflict.[4] It is a centralized, expert-oriented model that concentrates power in the hands of bureaucratic and economic elites. The national legislature, the *Bundestag*, is involved only after the major policy details are worked out between the relevant ministries and organized interests. As I explain in Chap. 1, this system provides few opportunities for citizen participation at the early stages of policymaking.

The *Bundestag* is elected by a two-ballot proportional representation system, with a five percent threshold for representation.[5] West Germany, and now united Germany, has had coalition governments for nearly the entire post-World War II period. The current government is a "grand coalition" of the two largest parties, the center-right Christian Democratic Union (CDU), along with its Bavarian sister party, the Christian Social Union (CSU) and the center-left Social Democratic Party (SPD). Smaller parties include Alliance 90/The Greens and the Left Party (a union of the left-wing party associated with the former East Germany and a breakaway faction of the SPD). The Free Democratic Party (FDP) has been a coalition partner in most postwar governments, but is not currently represented in the national legislature. The *Bundestag* has passed two flagship federal energy laws, the Feed-in Law (*Stromeinspeisungsgesetz*, 1990) and the Renewable Energy Act (*Erneuerbare-Energien-Gesetz*, 2000), described by Christoph Stefes in Chap. 3. The Chancellor is the head of government and is chosen by the largest coalition partner in the legislature. The current chancellor is Angela Merkel of the CDU (since 2005).

Germany has a federal structure in which the federal states (*Länder*) and municipalities possess some policymaking powers. The national government and the *Länder* both have the authority to pass laws in policy areas such as energy. Federal laws affecting the *Länder* must be approved by the upper house of the legislature, the *Bundesrat*. Before the federal government became involved in promoting renewables with the 1990 law, states and municipalities had been the major policy makers in this sector. As Philipp Schönberger and Danyel Reiche explain in Chap. 2, subnational governments continue to participate in energy policy making by various means, including formulating energy and climate action plans, providing support and information regarding renewables, influencing consumer behavior, collaborating with other *Länder* and municipalities, and investing in renewables themselves.

The EU has also provided a framework for energy policy making. Germany's large, quasi-private traditional utilities enjoyed territorial monopolies until EU market liberalization reforms abolished these in the 1990s.[6] EU policies such as the Emissions Trading Scheme, Renewable Energies Directive, and Energy Efficiency Directive have shaped the opportunities and constraints on the German *Energiewende*, as described by Miranda Schreurs in Chap. 4. The EU has also provided opportunities for opponents of the German energy transition, who have sought, since the 1990s, to have parts of its federal energy laws invalidated on grounds that they constitute unfair subsidies limiting market competition within Europe.[7]

It was in this institutional setting that the German energy transition took shape. Germany's political system offered an array of opportunities and constraints for both renewable energy advocates and traditional energy interests at various levels of governance. Each of our chapters on Germany highlights a different set of key actors in the energy transition. Major changes in the configuration of political power had to occur in order for the energy transition to take hold. The story of the *Energiewende* thus enables us to explore a question that reaches beyond the German case and the issue of energy policy: How does institutional change come about?

Theories of Institutional Continuity and Change

We take an eclectic approach to the study of institutional change, drawing from—and contributing to—several theoretical traditions in political science. We share the insight of historical institutionalism that political institutions and processes, once put into place, tend to persist.[8] Conventional energy advocates were deeply entrenched in Germany's political system.

They dominated the relevant ministries, the governing coalition in the *Bundestag*, the scientific establishment, and the energy utilities. These actors resisted the development of renewables from the beginning. The early advocates for renewable energy nearly all came from outside the centers of institutional power. Our study thus helps explore an important question for theories that rely on a path-dependency argument: under what circumstances does institutional change happen, especially when its advocates do not enjoy insider access?

Historical institutionalists have developed a theory of "punctuated equilibrium," which proposes that changes in a country's path are precipitated by occasional exogenous shocks or "critical junctures."[9] This is a good way to think about the initial conversations regarding changing the energy mix. The Oil Crisis of the early 1970s, as well as the Chernobyl and Fukushima nuclear accidents, undoubtedly advanced the cause of renewable energy worldwide. As many authors point out, however, it is difficult to demonstrate that exogenous shocks make all the difference in creating institutional change. In our cases, combinations of exogenous and endogenous factors, including subtle changes in the constellation of power and public opinion, are responsible for most turns in the paths of the energy transition. These are more aptly characterized as incremental processes, not shocks that lead to windows of opportunity for different actors to come to the fore.[10] In Japan, for example, the nuclear energy industry is closely connected to the Liberal Democratic Party (LDP), which controlled the Japanese government through nearly the entire post-World War II period. Llewelyn Hughes describes how a policy window opened for renewables when, as a result of a combination of factors, the opposition Democratic Party of Japan (DPJ) came to power briefly in 2009. Hughes argues that Japan's feed-in tariff (FIT) passed into law as a direct result of a shift in government that temporarily weakened the structural power of the conventional utilities.[11]

We view change as partly the result of the more or less concerted actions of networks of individuals. Stefes shows how policy entrepreneurs in the German federal government exploited opportunities for change that arose within their institutions to pass the landmark renewable energy laws of 1990 and 2000. In our two chapters on subnational politics, Schönberger, Reiche, and I describe the development of advocacy coalitions of committed individuals in business, politics, science, and education that promoted renewable energy at the local and *Länder* levels in Germany. They created their own opportunities to overcome the inertia of institutionally embedded players.

Our chapters also show how policy change happens without major institutional upheaval. Policy layering, for example, has worked to promote the energy transition in cases where powerful actors oppose it. It has also been used to shift power among the participants without challenging them in a more direct, politically risky way. In the US case, as Laird points out, layering is an approach to change when veto players loom large. Layering new policies on top of old, while avoiding an explicit policy of energy transition, has kept fossil fuel interests from crushing new renewable energy initiatives there. In Germany, on the other hand, conventional energy interests are using policy layering to try to reposition themselves. Stefes cites the example of the 2014 amendments to the Energy Sources Act. One of the changes will be to replace the fixed FIT rate through the introduction of competitive tendering for renewable energy projects. This change will likely favor the big players by making it more difficult for small producers to compete. In her chapter on China, Stephanie Ohshita describes how key players there have promoted policy layering in order to achieve a more distributed energy system, in contrast to the German case just described.

Opponents of energy transition may also try to slow or reverse the process through "policy drift," that is, failure to implement changes that would be necessary for the transition to progress. The German government and big utilities, writes Stefes, have not invested adequately in the development of new grid and storage technologies. Their neglect of these technologies has slowed the spread of decentralized renewable energy sources, such as small solar and wind. Drift is also a way for traditional utility advocates to reemerge without running afoul of public opinion. Hughes describes how in Japan, traditional utilities are refusing to connect FIT-approved renewables projects to the grid, citing capacity problems. Further, Japanese suppliers with regional monopolies have been slow to implement changes that would make it easier to move electricity between regions.

Our explanations also incorporate insights from different strands of ecological modernization theory. This theory views the ecological crisis as the inevitable product of modern industrial capitalist society. But just as the institutions of modern society can incentivize environmental destruction, they can be made to incentivize environmental protection. Political and economic elites will recognize that environmental protection lowers costs and creates efficiencies; in other words, "environmental protection pays."[12] Thus, the motivations already present in modern industrial society will be the force behind its ecological transformation. In terms of the energy transition, we see this happening in several of our cases. Schönberger and Reiche find that, contrary to expectations, German municipalities and federal states have been showing leadership in the energy transition not because they have surplus money and can afford to do so, but because they see investment in renewable energy as a way to lift local economies out of crises caused by deficits and high unemployment. Renewable energy is viewed as source of long-term local income and employment, the economically sound path going forward. Ohshita has a similar finding for China. The Chinese government recognizes that renewable energy sources will become more economical than coal, especially when the public health costs of the latter are taken into account. For this reason, they are willing to make the necessary shifts toward decentralization that will aid the transition.

We also incorporate insights from critical ecological modernization theory. These theorists place much more emphasis on citizen activism than those cited earlier. They claim that the pressure for institutional change arises not from the imperatives of modern industrial democracy, but from critical voices in society. Moreover, these critics—not the core industrial players—are often the direct sources of ecological innovation.[13] As my chapter points out, citizen protest against conventional energy projects, especially nuclear power, has resulted in political innovation. Germany is not undertaking the *Energiewende* simply in anticipation of efficiencies or profitability. There is a strong critique of political institutions in the citizen movements. Nuclear power became, and has remained, the focal point for a grassroots critique of corporatism as well as experiments in decentralized, participatory democracy that have gone hand in hand... with the local promotion of renewables. A similar dynamic can be observed in China. According to Ohshita, what is driving much of the innovation in China is the desire to remediate societal unrest over the pollution caused by energy extraction and consumption. The decentralizing reforms are made partly in response to this unrest, which officials fear would otherwise evolve into widespread critique of China's one-party system.

In Germany, furthermore, critical citizens were actually the source of new energy technologies. The traditional utilities resisted developing renewables and tried to keep them off the market. The networks of innovation that arose mostly among anti-nuclear and environmental activists helped transform southwestern Germany into the country's "solar region."

In sum, our cases contribute to theory building by uncovering the dynamics of institutional change. We begin with the path-breaking case of the German energy transition, devoting individual chapters to an analysis of the transition at different levels of society, from grassroots citizen movements to municipalities and *Länder,* to the national, and finally the European level. We also describe the ways in which players at these different levels interact to form networks for—and sometimes against—policy change. We then place the German case in comparative context, which helps further to highlight the relevant players and explanatory factors. The following section summarizes the arguments of the individual chapters and their relationship to the overall theme of the book.

Chapter Overviews

Germany's energy transition progressed from the grass roots upward, and this is also the progression of our volume. We locate the origins of the energy transition in the environmental and anti-nuclear citizen movements of 1970s West Germany. In Chap. 1, I take the reader to the epicenter of West Germany's anti-nuclear movement, the Upper Rhine region of Baden-Württemberg. I show how local activists built a self-reinforcing network of innovation that transformed Freiburg into Germany's "Solar Region" well in advance of federal policy to promote renewables. The grassroots network grew through the founding of institutions of "counter-expertise," local development of a solar energy industry, the establishment of solar energy research and development (R&D) and educational programs, and the infiltration of the political system by renewable energy advocates. Anti-nuclear activists themselves were an important source of technological and political innovation, and they still form the core of the regional renewables network.

Philipp Schönberger and Danyel Reiche analyze the role of German *Länder* and municipalities in the energy transition in Chap. 2. While in the 1980s, local and regional supply monopolies played a crucial role in most aspects of energy governance, EU-wide liberalization processes in the 1990s abolished these monopolies. Nevertheless, *Länder* and municipalities still possess far-reaching energy policy options, especially in the fields of spatial planning procedures, as well as electricity and heat generation by local and regional energy companies. They find that policy entrepreneurs and the anticipation of economic benefits are key to explaining why some localities are more receptive than others to adopting renewable energy technologies.

In Chap. 3, Christoph Stefes analyzes the ways in which Germany's federal government has promoted the energy transition, from the introduction of the FIT Law in 1990 to the 2014 revision of the Renewable Energy Act. Stefes shows how the FIT Law and subsequent reforms have unleashed a mutually reinforcing political and economic dynamic that allowed a small pro-renewable energy coalition to overcome resistance from the powerful coal and nuclear lobby. Yet it also demonstrates how opponents of the German energy transition have employed tools such as policy layering and policy drift to slow the energy transition, and more recently, to try to recentralize it by shifting control back to the traditional utilities.

Miranda Schreurs examines the European dimensions of the German energy transition in Chap. 4. As part of the EU, Germany must follow European directives and regulations. Because it is Europe's largest economy and largest producer and consumer of energy, Germany also exerts significant pressure on others through its domestic energy choices. Other EU members expect Germany to take a leading role in the energy transition. There are, however, very different energy endowments among European countries and varying approaches toward the transition. Germany's *Energiewende* is viewed by some as a model, and by others as a threat to key industries (especially nuclear power and coal). As Schreurs explains, Germany's energy transition is being watched closely by its neighbors. Success in fulfilling its goals could pull other countries along, while failure could slow similar efforts in other countries.

In Chap. 5, Stephanie Ohshita notes that China's political leaders face a doubly daunting task in moving toward an energy transition: to lessen energy demand from their industry-dominated economy, and to move away from their coal-dominated energy supply.

They also walk a fine line politically, working to achieve more distributed energy generation while maintaining centralized political and economic control. Some of the decentralizing efforts, such as the introduction of a fixed FIT rate, contrast with recent German moves to recentralize energy generation. China has maintained social peace by providing economic development and a rising quality of life. As in Germany, the threat of citizen protest around energy issues motivates the Chinese government to accelerate its efforts to reduce industrial pollution and transition to renewable energy sources.

Frank Laird addresses American energy policy in Chap. 6. During the Oil Crisis of the 1970s, American policy makers sought to engineer a transition away from oil without agreement on what would come next. In the 1980s, a resurgent conservative movement rejected government planning for the energy system. Since 1992, policies have aimed to change some parts of the system while avoiding articulating the shape and content of a new energy system. The process has been one of incremental change, achieved by layering new institutional rules on top of existing institutions, resulting in the growth of one of the largest renewable energy industries in the world. In contrast to the German approach, however, American policy still seeks to expand all energy sources, including fossil fuels. Laird explains the US's much less ambitious renewable energy program by highlighting veto points and veto players in the political system.

Llewelyn Hughes argues in Chap. 7 that Germany and Japan are taking divergent paths toward the energy transition. The two countries share a corporatist political style, with traditional utilities enjoying privileged access to the Japanese government. Their goals are roughly similar with regard to reducing the share of nuclear power and increasing the share of renewable energy in the mix, especially since the Fukushima accident in 2011. In contrast to the German case, however, the structural power of Japan's utilities has enabled them and their political allies to slow the spread of renewable energies, and has thus placed limits on Japan's energy transition.

Christoph Stefes draws lessons from the case studies in Chap. 8. Using the German case as a springboard, these chapters highlight the multifaceted challenges, and the enormous potential, in different paths to energy transition. Taken together, they tell the story of what is undoubtedly one of the most important political, economic, and social undertakings of our time.

Notes

1. Florentin Krause, Hartmut Bossel, and Karl-Friedrich Müller-Reißmann, *Energie-Wende: Wachstum und Wohlstand ohne Erdöl und Uran* (Frankfurt/Maine: Fischer Verlag, 1980).
2. Stephanie Ohshita, Chap. 6 of this volume.
3. Susan Rose-Ackerman, *Controlling Environmental Policy: The Limits of Public Law in Germany and the United States* (New Haven, CT: Yale University Press, 1995).

4. Claus Offe, "The Attribution of Public Status to Interest Groups: Observations on the West German Case," in *Organizing Interests in Western Europe*, ed. Suzanne Berger (Cambridge: Cambridge University Press, 1981), 123–158.
5. In this system, half the representatives are elected directly and half by party vote. Each voter casts one vote for a constituency candidate. The candidate who receives the most votes wins the seat. The voter casts a second vote for a political party. This second vote determines the overall proportion won by each party in the Bundestag. If the party wins more seats than it has successful constituency candidates, its remaining seats are filled from a party list. A party must win at least five percent of the vote, or three direct constituency seats, in order to be represented in the Bundestag. See Deutscher Bundestag, "Elections," (2015), www.bundestag.de/htdocs_e/bundestag/elections/elections/.
6. The reforms resulted ultimately (and ironically) in a wave of mergers that consolidated the industry into four mega-companies in Germany, with operations on a wider scale in Europe (RWE, EnBW, E.On, and Vattenfall). See Rüdiger Mautz, "The Expansion of Renewable Energies in Germany between Niche Dynamics and System Integration—Opportunities and Restraints," *Science, Technology and Innovation Studies* 3, no. 2 (2007): 114. Mautz notes that just two of the four remaining suppliers were responsible for 70 percent of supply by 2007.
7. David Toke and Volkmar Lauber, "Anglo-Saxon and German Approaches to Neoliberalism and Environmental Policy: The Case of Financing Renewable Energy," *Geoforum* 38 (2007): 684.
8. Sven Steinmo, "What is Historical Institutionalism?", in *Approaches and Methodologies in the Social Sciences: A Pluralist Perspective*, ed. Donatella Della Porta and Michael Keating (Cambridge: Cambridge University Press, 2008), 118–138.
9. Giovanni Capoccia and R. Daniel Keleman, "The Study of Critical Junctures: Theory, Narrative, and Counterfactuals in Historical Institutionalism," *World Politics* 59, no. 3 (2007): 341–369; also Kathleen Thelen, "How Institutions Evolve: Insights from Comparative Historical Analysis" in *Comparative Historical Analysis in the Social Sciences*, ed., James Mahoney and Dietrich Rueschemeyer (Cambridge: Cambridge University Press, 2003), 208–209.
10. John Kingdon, *Agendas, Alternatives, and Public Policies*, 2nd ed. (New York: Harper Collins, 1995). See also James Mahoney and Kathleen Thelen, *Explaining Institutional Change: Ambiguity, Agency, and Power* (Cambridge, 2010); Frank Laird and Christoph Stefes, "Putting the Brakes on the *Energiewende*: Actors and Strategies in Opposition to Renewable Energy in Germany and the United States," paper presented at the 37th Annual Meeting of the German Studies Association, Denver, CO, October 3–6, 2013, 12–13; Christoph Stefes, "Bypassing Germany's *Reformstau*: The Remarkable Rise of Renewable Energy," *German Politics* 19, no. 2 (2010), 148–163.

11. FIT laws permit individual producers to feed electricity into the grid at a guaranteed price, thus lowering the perceived risk to investors and encouraging distributed energy generation through renewable sources.
12. Maarten Hajer, *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process* (Oxford, 1995), 3. The term "ecological modernization" is generally credited to Joseph Huber and Martin Jänicke. See Joseph Huber, *Die verlorene Unschuld der Ökologie* (Frankfurt/Main: Fischer, 1982); Joseph Huber, *Die Regenbogengesellschaft: Ökologie und Sozialpolitik* (Frankfurt/Main: Fischer, 1985); Joseph Huber, *Unternehmen Umwelt: Weichenstellungen für eine ökologische Marktwirtschaft* (Frankfurt/Main: Fischer, 1991); Martin Jänicke, "Preventive Environmental Policy as Ecological Modernisation and Structural Policy," (Berlin: WZB, 1985); and Martin Jänicke, "Ökologische Modernisierung—Optionen und Restriktionen präventiver Umweltpolitik," in *Präventive Umweltpolitik*, ed., Udo E. Simonis (Frankfurt/Main,1988),13–26. Hajer calls this the "techno-corporatist" version of EM theory.
13. John S. Dryzek, David Downes, Christian Hunold, and David Schlosberg with Hans-Kristian Hernes, *Green States and Social Movements: Environmentalism in the United States, United Kingdom, Germany, & Norway* (Oxford: Oxford University Press, 2003), 37. Dryzek's insight is that passive exclusion of environmental groups by the German central state "helped fashion a strong oppositional counter-culture which went beyond specific policy goals to include issues of identity and alternative forms of action and behaviour." In *The Politics of Environmental Discourse*, Maarten Hajer presents a "reflexive ecological modernization" theory in which EM is more dependent on practices of social learning, and the reform of institutions in a more discursive direction, than in the techno-corporatist version. P. Arthur, J. Mol and Gert Spaargaren, "Ecological Modernisation Theory in Debate: A Review," *Environmental Politics* 9, no. 1 (2000), 17–49, here 20). David Toke proposes that the grass roots has been the source of technological innovation in renewable energy in David Toke, "Ecological Modernisation, Social Movements, and Renewable Energy," *Environmental Politics* 20, no. 1 (2011), 60–77.

The Grassroots Origins of the German Energy Transition

Carol Hager

Introduction

Germany is an acknowledged world leader in renewable energy development and implementation. Its landmark federal energy law, the Renewable Energy Sources Act of 2000 (EEG), is considered a model for others. Germany has also set the standard with its accelerated timetable for transitioning from fossil fuels to renewables.[1] Impressive as these actions are, Germany's energy transition cannot be credited to the top levels of government alone. The impetus for renewables predated the federal legal infrastructure. The transition was pushed by a network of supporters that formed outside of, and largely in opposition to, the mainstream political, bureaucratic, and industrial centers of power.

The *Energiewende* (energy transition) represents an about-face in policy in a system where fossil fuel and nuclear interests are quite powerful. Energy planning has traditionally involved closed-door negotiations between federal and state economics bureaucracies and large energy utilities.[2] The major utilities were uninterested in developing renewables, and there was no big push from the federal government, either. The transition was prompted by "not in my backyard (NIMBY)" protests against conventional energy

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sources, particularly nuclear power. At critical junctures, nuclear accidents and other environmental harms bolstered the case for renewable energies and weakened the arguments of their more established competitors.[3] Renewable energy development was a bottom-up phenomenon in a country where policy change normally comes from the top.

The critical role of grassroots mobilization in turning Germany away from nuclear power is documented elsewhere.[4] Less well researched is the connection between protest politics and technological innovation. Grassroots opposition is sometimes credited with making established technologies less politically viable, and that is certainly the case here, too. But, in Germany, the impact of mass mobilization transcended the rejection of particular technologies or facilities. The innovation in new, renewable energy technologies sprang, in part, from the protest movement itself and was pushed along by it at critical points. The German case may lead us to reassess the role of grassroots protest in technological change.

In this chapter, I analyze the evolution from citizen protest to networks of innovation for the iconic case of Wyhl in the Freiburg/Breisgau region of Baden-Württemberg. The successful site occupations at Wyhl and neighboring facilities in the mid-1970s popularized new forms of citizen activism in Germany. They also gave rise to a regional movement for solar energy that ultimately helped revolutionize German energy policy.

Linking Protest and Innovation in NIMBY Theory

Community opposition to local environmental harms has often been characterized as NIMBY. The term has negative connotations; local protests against government-supported facilities, most notably hazardous waste-disposal sites and nuclear power plants, have often resulted in siting failures.[5] Partly for this reason, these local movements are criticized as parochial and detrimental to the public good. Social scientists, too, have commonly referred to NIMBY as a "syndrome."[6]

Some scholarship on NIMBY since the 1990s has taken a more differentiated view, viewing local protest as a rational reaction to a flawed siting process.[7] Other studies focus on motivations of the protesters, such as risk perception and attitudes toward government, or demographic factors such as age, education, and income, as well as variations in support based on incentives offered by industry.[8] The literature on social movements has critiqued the concentration on latent community characteristics, focusing instead on active framing processes through which movement leaders mobilize community members to participate in grassroots protest.[9] Taken together, this scholarship gives us a more complex picture of citizen protest that treats all participants as rational, strategic actors. Still, most analyses of NIMBY treat the conflict itself as a negative to be avoided or minimized where possible.

Moreover, the results of NIMBY protest beyond the particular siting controversy are seldom analyzed. This is true even of studies that focus on NIMBY groups as social movements. These may try to account for the expansion or transformation of movement goals during the course of a conflict or demonstrate how protest may expand geographically over time. But even those that acknowledge that local resistance can evolve into a broader *Systemkritik* (critique of a political system) tend to treat the resistance as pathological, and its effects as limited to the immediate controversy.[10] Only a few focus on what David Hess calls the "generative" side of social movement action, the link to longer-term, positive societal change.[11] Such change may be difficult to measure. Nevertheless, the generative effects of NIMBY are an important part of the explanation for Germany's successful energy transition.

There are several ways in which NIMBY protest can lead to innovations in both technology and decision-making processes. For one, NIMBY protest often prevents the construction of projects that appear in retrospect to have been ill-advised. The delays caused by ongoing protest force industrial and political elites to rethink the scientific, economic, and demographic assumptions upon which the projects were originally based. In the case of hazardous waste disposal, changes in the production process may reduce the amount of waste, and thus eliminate the need for large offsite repositories.[12] In the German case analyzed here, cross-border protest mobilization prevented the construction of massive overcapacity in nuclear power.

Second, NIMBY protest may weaken the gatekeeping function of technical expertise in policymaking.[13] In the 1970s, local citizens throughout Germany began to challenge large industrial projects on technical and scientific grounds through the development of what they called "counter-expertise." Counter-expertise is knowledge generated in order to offer an alternative to an inaccurate or incomplete, but popularly accepted, scientific view. At Wyhl, anti-nuclear protesters organized informal presentations at the occupation site that raised questions about the safety and economic viability of nuclear power. A small group of Wyhl veterans later founded a non-profit institute dedicated to helping citizen groups muster the technical expertise to challenge similar projects in court. NIMBY groups throughout Germany built their own enduring network of counter-expertise, embedded in, and informed by, their own local cultures and resulting in a broader public discussion of alternatives.

NIMBY actors may also pose a deeper challenge to technocratic policymaking by asserting that the decision to pursue a particular project is fundamentally political, not technical, and, as such, should be decided not by elites but by the broader society.[14] At Wyhl, protesters recast energy policy choices as moral decisions over the direction of the whole society, a choice between a linear model of economic growth and an emerging alternative model that took into account effects on the environment and on future generations. Reformulating technological decisions as political ones may contribute to the democratization of decision processes and the empowerment of local citizens.

In addition to changing attitudes toward particular technologies, challenging non-participatory policymaking processes, and generating technical expertise, grassroots protest movements can engage in “creative reconstruction” by fostering a regional milieu conducive to innovation.[15] Werner Krauss shows how opposition to government-imposed regional planning combined with local wind power initiatives to create new “wind energy landscapes” in northern Germany.[16] Ion Bogdan Vasi notes that social movements can help create an atmosphere conducive to investment in renewables in that they “shape entrepreneurs’ perceptions of social and economic opportunities, as well as their motivation to take risks to exploit these opportunities.”[17]

This creative reconstruction took the form of technological and political innovation in the Freiburg case. There are several dimensions to technological innovation. First, NIMBY protests at Wyhl led directly to the founding of an institution of counter-expertise dedicated to helping citizens challenge the dominant energy paradigm. Second, it helped foster the bottom-up development of a renewable energy industry, particularly in solar power. Participants in the Wyhl protests incorporated their activism into a wide variety of professions, which supported one another partly because of those old ties. Third, Wyhl veterans were also behind the establishment of strong public elementary, vocational, and continuing education programs to support a solar economy. Finally, the massive antinuclear protests in the Freiburg region, along with emerging grassroots experiments in solar energy design and implementation in a variety of fields, created a regional milieu in which key actors decided it was worthwhile to take the risk of advocating for solar research and development (R&D). The Fraunhofer Institute for Solar Energy Systems got its start this way.

Political innovation can also be part of the creative reconstruction fostered by NIMBY movements. Anti-nuclear protest throughout Germany led to the development of advocacy networks to push for renewable energy and to prevent any rollback in government support. In the Freiburg region, anti-nuclear protest was connected to the development of the nascent environmental organization *Bund für Umwelt und Naturschutz Deutschland* (BUND; Friends of the Earth), which became a fixture among non-governmental organizations (NGOs) and a strong advocate of renewable energy technologies. The protest was also connected to the founding of local green voting lists and to the greening of the established political parties. Activists worked from outside and inside government to push for the adoption of renewables.

A Note on Research Design

This study uses a process-tracing method for a single case, as described by Alexander George and Andrew Bennett. The in-depth analysis of a single case can identify factors important to the outcome that may not be obvious when the issue is viewed from greater distance. It also aids in identifying the mechanisms by which an identified change occurs.[18] Anti-nuclear activism in Germany is correlated with the development of renewable energy technologies; the process by which the one led to the other is a topic of great importance for theorizing about the broader impact of grassroots mobilization. I have reconstructed the process through which the Wyhl protest catalyzed the creation of the Freiburg "solar region" by assembling information from a variety of sources. These include political and legal correspondences, court transcripts, newspaper and journal articles, documentary films and books, informational brochures, personal communications, and written memoirs. These are supplemented by 42 semi-structured, open-ended interviews with participants in the Wyhl conflict and others involved in the regional renewable energy economy. I conducted the interviews between November 2012 and August 2014. Together, these data help uncover the path from anti-nuclear protest to technological and political change.

"We Said No": The Successful Site Occupation at Wyhl

The story of Germany's energy transformation began in the early 1970s in the southwestern corner of the Federal Republic where Germany, France, and Switzerland intersect. It is a landscape of farms, vineyards, and villages, where gentle pasturelands near the Rhine give way to the steep mountains and giant conifers of the Black Forest. The center of this region is Freiburg, a university town with a population of 226,000.

Baden-Württemberg, the federal state in which Freiburg is located, is predominantly Catholic and was a stronghold of the Christian Democratic Union (CDU) throughout the postwar period. The CDU was a particularly vocal proponent of nuclear energy. In the 1970s, the state government planned an industrial build out of the whole Upper Rhine region between the Swiss border and Mannheim.[19] The French and Swiss governments were also targeting this region for heavy industry. All three countries planned to construct multiple nuclear power plants here. In the 90-mile stretch from Gösgen (Switzerland) to Wyhl (Germany), there would be no less than eight nuclear parks with a total of up to 17 reactors. The newspaper *Die Welt* called it "the most colossal energy concentration on earth."[20]

Local residents in all three countries began mobilizing against the plans, and multiple demonstrations and site occupations occurred. But it was the 1973 announcement of a nuclear plant near the village of Wyhl that crystallized the opposition into a lasting force. The center of the Wyhl protest organization was in the neighboring village of Weisweil, where a "citizen initiative" group was founded immediately upon announcement of the site. Citizen initiatives had started out in Germany in the late 1960s and early 1970s mostly as self-help groups to provide community services like day care. In the course of the 1970s, they increasingly formed to protest large, state-sponsored industrial projects, especially power plants. Energy protest in the Wyhl area, as in Germany as a whole, was embedded in a larger array of citizen movements concerned with environmental quality of life and critical of the economic growth mentality of government and industry.[21] In the case of the anti-nuclear movements, their rhetoric, too, evolved from stopping the project in their own town to questioning the safety and benefits of nuclear energy in general.[22]

After a successful, but controversial, referendum on the sale of the land, the utility began clearing the site for construction.[23] A short-lived site occupation was followed by ever-larger demonstrations in the Wyhl forest until, on February 23, 1975, the crowd broke through the barriers and set up camp. Among the early leaders of the Wyhl protest was a group of mostly chemistry students from Freiburg University. They coalesced around several active and retired science professors who had been raising questions about the appropriateness of nuclear energy for electricity generation. There was a general feeling among the protesters that it was not enough to object to nuclear power; they had to both ground their objections in science and offer plausible alternatives. They also needed a way to keep people at the site in order to discourage the authorities from trying to retake it. Both of these goals were accomplished with the founding of a "Community College of the Wyhl Forest" in March 1975 at a makeshift "friendship house" on the construction site.[24]

In addition to the more technical discussions, the Community College offered presentations on local customs, crafts, flora and fauna, and even travel. While the Baden-Württemberg state government denounced the protesters as left-wing radicals, in reality the movement was infused with technical experts and embedded in the traditional culture and wine-growing economy of the region. The Community College was one way the movement maintained its breadth. Its programs, which at first took place almost daily, also kept a lively crowd at the site through the evening hours.

The German government and the energy industry had not reckoned with the deep objections to nuclear power. This form of energy promised to be cheap and plentiful, and thus to foster rapid economic growth, which political elites unquestioningly associated with the public good.[25] Officials were slow to take seriously the reservations of local citizens, and their repressive reactions seemed only to confirm the broader concerns of the citizen initiative groups. Dieter Rucht writes:

> From about 1974 the protest against nuclear power plants developed beyond local impacts. It was no longer limited to the effects of nuclear facilities in the "classical" sense of environmental pollution. The resistance against a concrete project became understood as resistance against the whole nuclear program. Questions of energy planning, of economic growth, of understanding of democracy entered the picture.[26]

The slogan of the Wyhl resistance was a phrase of Baden dialect, "*Nai hämmer gsait*" ("No, we said"), encapsulating popular frustration with a government/industry complex that refused to listen to the public.

The site occupation at Wyhl lasted for eight months. After a peaceful end was negotiated, the conflict moved to the Freiburg Administrative Court. In March 1977, the administrative court vacated the construction permit, primarily out of concern about the safety of the containment structure in case of explosion. This was the end of any serious attempts to place a reactor at Wyhl.[27]

The Wyhl conflict resonated throughout Germany. The methods of mobilization and site occupation developed in the region were copied nationwide as the nuclear fight expanded to recycling and storage facilities as well as other plant sites. Locally, the connections forged at Wyhl held beyond the site occupation. The cross-border network of citizen activists grew over time. The Community College continued to host informational events for eight years, pairing scientific experts with local farmers and rotating its presentations among the surrounding villages.[28] But Wyhl's influence extended beyond the issue of anti-nuclear protest. For many, the Wyhl resistance was the inspiration for a new path in life.

From Anti-Nuclear Capital to Solar Region

Institutions of Counter-Expertise: The Eco-Institute Freiburg

Presenting accurate information to the public about nuclear power and its consequences was a priority for the Wyhl resistance. The Community College was one forum for discussion. What was lacking, though, was critical dialogue with government and industry. The administrative court hearings, where the fate of the Wyhl plant and others was ultimately decided, were an imperfect platform for such a dialogue. These were technical proceedings; their only task was to determine whether this specific facility was permissible as proposed. Lay citizens were at a distinct disadvantage here.

In order to help citizens compete on this new playing field, 27 scientifically trained anti-nuclear activists founded the Institute for Applied Ecology ("Eco-Institute") in Freiburg in November 1977. Their founding declaration made direct reference to their experiences at Wyhl. It explained, "With the institute we want to help citizens gain scientific support for their proceedings, whereby we deliver expert reports and arrange for technical experts [to testify]."[29] The courts had given them an opening, but this new venue was also problematic:

> In court proceedings and hearings the critical citizen encounters a phalanx of experts who advise the bureaucracy and industry. More and more citizens recognize that science is not free of [special] interests. Only a few scientists have been prepared up to now to support the citizens. In the long run, however, the citizen initiatives will only succeed in achieving their demands in planning and in court if they themselves deliver the necessary scientific foundation.[30]

The anti-nuclear movement had seen that prevailing scientific opinion fell on the side of the utilities, and that mainstream scientists were largely dependent on the industry whose plans they were assigned to evaluate. From the beginning, part of the Eco-Institute's purpose was to cultivate counter-expertise. It was explicitly committed to reevaluating scientific evidence and assessments that had been widely portrayed as truths.

Importantly, the Eco-Institute gave a home to critical scientists. At the time it was founded, there was no real place at universities or established research institutions for experts who did not share the government and industry elite's enthusiasm for nuclear and fossil fuel energy.[31] Most of the Eco-Institute's scientists were young and idealistic, not part of the scientific establishment. But they got support from more established scientists and other concerned citizens, sometimes clandestinely. Longtime employee and current Executive Board member Rainer Griesshammer recalls that at the beginning they would receive anonymous tips in unmarked envelopes.[32] The Institute's critiques of federal energy policy made it a target of nuclear proponents in industry, government, and scientific institutes. However, others trusted the young scientists to get to the bottom of things. As the Institute produced more studies, and as its findings were borne out with time, its reputation grew.

Mustering counter-expertise in the fight against unwanted facilities was only part of what the Eco-Institute's founders had in mind. "The fight for a humane future," they declared, "demands more than just the avoidance of potential damages. It demands of us a positive response to the question of how we want to live."[33] One of the Institute's first studies, which eventually appeared as a book entitled *Energie-Wende*, made the then-revolutionary proposal that Germany withdraw completely from nuclear energy. Its authors also broke with convention and, instead of assuming steadily increasing energy demand, proposed that flat demand would not only be more desirable, but could also realistically be achieved through more efficient energy use.[34] This was one of the first scientifically grounded challenges to the government/industry growth paradigm.

Renewable Energy Businesses

Many who had experienced the site occupation tried to find ways to contribute to the development of renewable energy in their careers. They formed a diverse and expanding network connected at base by a strong antipathy to nuclear power and an equally strong sense of responsibility for the turn toward a different energy future. This section shows how the Wyhl experience sparked creative experimentation in a sampling of businesses and services.

Solar Collectors

Promontion of solar energy, say opposition leaders, went hand in hand with the anti-Wyhl protest from 1974 onward. Scientists, engineers, and craftsmen met during the site occupation to discuss their mutual experiments with solar energy devices in an "honest-to-goodness transfer of knowledge."[35] Together with members of the newly founded environmental organization BUND, some activists from the Baden-Alsace group sponsored Germany's first exhibition of solar energy technology in the village of Sasbach, near Wyhl, in summer 1976. Although the "Sasbach Sun Days" featured only 12 exhibitors of solar devices, this combination of technical exhibit, trade show, and public festival attracted more than 12,000 visitors.[36] Most importantly, the Sun Days showcased local inventions.

Werner Mildebrath, an electrician from Sasbach, exhibited his homemade solar collector at the Sun Days. He was already well known among the protesters for installing sound equipment and lighting for events at the occupied sites. He had become fascinated by the potential for solar energy. In 1975, he built a solar system with a garden hose and a dark painted panel to heat water for his own house. His crude collector was a hit at the exhibition. "People couldn't believe," he says, "that you could heat water that much with just solar energy." Mildebrath says he originally intended to build the collectors only for his family's use, but so many people wanted them that he founded a small solar energy firm that eventually won contracts from as far away as Egypt. His devices are estimated to have been some of the first functioning solar panels in Germany. The people who bought the early models, he says, were opponents of nuclear power above all else. They supported solar energy "out of conviction." He was eventually driven out of business by the arrival of mass producers, but many of the systems he installed locally are still in use.[37]

Small-scale experimentation was in keeping with the region's reputation as the "land of tinkerers and craftsmen." The Sasbach Sun Days outgrew its venue after three years and was replaced by a more broad-ranging annual Eco-Trade Fair in Freiburg, sponsored by the environmental NGO BUND. Local trade fairs have continued to be an important venue for small developers of renewable energy technologies.[38]

Solar Architecture and Construction

On the website of Rolf Disch's renowned solar architecture firm is a photo of a young Disch at the occupation site, with the caption, "And so it all began—in Wyhl." What began for him in Wyhl, he says, was the idea that the public could be inspired, not just to oppose something, but also to make a positive change in the society. Disch's main focus in the 1980s was solar-powered automobiles. But he decided that he could have the most impact with his architecture business. Half the battle, he says, was convincing large investors that solar buildings were a good investment. More than once, he had to sell his possessions to continue with a project after a wary investor pulled out. The same went for local government support—everyone needed repeated convincing, he says, that solar housing ought to be funded.[39]

Disch became adept at inviting the public to take part in his experiments. He displayed his inventions at local exhibitions. His firm held open houses. He initiated a successful campaign for a community-funded solar installation on the roof of Freiburg's soccer stadium, using a raffle for free season tickets as an enticement. In 1994, he completed the Heliotrope, described as the first private home worldwide with a positive energy balance.[40] The house is a popular destination on eco-tours of Freiburg. It serves as a demonstration project and also as the Disch family residence.

Disch's crowning achievement was the completion of a "solar development" of 59 colorful, positive-energy houses in 2004. Two years later, a solar-powered commercial addition, known as the "Sun Ship," was completed. The Sun Ship now houses not only Disch's firm but also the Eco-Institute and several other environmentally related businesses. Disch's award-winning solar design projects have brought international visibility to Freiburg.

Tourism

Freiburg and the Black Forest are fabled tourist destinations. Recently, eco-tourism has become an additional calling card for the region. Wyhl veterans have been instrumental in the development of this new branch. Alongside Disch's showpiece solar buildings, another attraction is the Victoria Hotel in Freiburg. This award-winning "green hotel" employs renewable energies and energy-saving technologies, including wood pellet combustion heating with a flue gas cleaning system, solar roof panels and mini-wind turbines, and a pumped water heat exchange cooling system. Many of these initiatives came from Astrid Späth, who owns the hotel with her husband, also a Wyhl veteran. As a young teenager, Späth was inspired by the way such a "joyous resistance" succeeded in stopping the plant. It struck her, she says, that "with a certain stubbornness you can change the world." When she and her husband took over the family-owned hotel, she looked for ways to make a difference there. As a member of the Freiburg Sustainability Board, she now gives presentations on ecological hotel management.[41] The Victoria is a founding member of the Green City Cluster Freiburg, and of Sleep Green Hotels, a group of especially environmentally engaged European hotels.

Eco-tourism has become a big draw in the Black Forest as well. Matthäus Weber owns an organic "vacation on the farm" business that has been voted one of Germany's best. It sits high above the village of St. Peter, with a view of Weber's own wind turbine, along with solar-paneled roofs, and a heat exchanger that cools milk from his dairy cows while heating household water. Wyhl, he says, was a key experience for him. It taught him that the citizens "were lied to" about energy, and it gave him a sense of responsibility to make change happen peacefully, the way the Wyhl protest did. The Chernobyl nuclear accident in 1986 strengthened his resolve to do things differently, when he saw Ukrainian and Belorussian farmers forced to abandon their lands and livelihoods. He went his own way in building his wind turbine over the objection of some local authorities. Eco-farmers, he says, see support for renewable energy as a part of their conservative culture, as fulfilling their obligation to "protect [God's] Creation."[42] He enthusiastically demonstrates his wind- and solar-powered operation to his guests, and he advocates for expanded renewable energy production in this area.

Small Trades and Crafts Businesses

The development of solar energy and other renewables encouraged supporting businesses dedicated to delivery and maintenance of systems. Prominent among these is Schwörer Carpentry in Wyhl. This family business, which was founded in 1902 by the current owners' grandfather, has installed over 1,000 solar roofs. According to Reinhard Schwörer, they began installing solar panels "out of curiosity."[43] Demand was high in this area after the site occupation; Schwörer concurs with Mildebrath that people wanted solar panels out of conviction, not to make money.[44]

It was an investment in the future, he says, both for the customers and for the business. His firm went from installers to inventors by developing a patented solar panel mounting for tile roofs. Solar roofs have become a second business pillar for the firm.

"Plus-Energy Villages"

Antipathy to nuclear power inspired whole villages to become renewable energy innovators. After the Chernobyl accident in 1986, several families in the South Baden village of Schönau came together to take local action against nuclear power. They decided to try to buy the local grid in order not to have to purchase electricity from a utility that owned nuclear plants.[45] The "Schönau Electricity Rebels" weathered a determined campaign by the utility and eventually won the right to form their own company. They were one of the first grid operators in Germany to offer power exclusively from renewable energy sources. Their battle attracted international attention and inspired other German villages to follow in their footsteps. New federal laws eventually enabled them to sell clean energy nationwide. "Plus-energy villages," which produce and sell electricity from renewable sources, have become a growing trend throughout Germany.[46]

Vocational Education: The Richard Fehrenbach Trade School

Olaf Srowig took part in the Community College of the Wyhl Forest. Wyhl, he says, was not just about resistance; it pointed out a need to develop alternatives to nuclear power. Srowig sees three facets to the energy transition. The first is research, the second is production, and the third is a skilled workforce. During the Wyhl protests, he was employed at the Richard Fehrenbach Trade School in Freiburg, and he decided that the best way for him to carry forward the lessons of Wyhl was to train skilled craftsmen for a new, renewable energy economy. He got his chance when he was appointed director of the school in 1982.[47]

Srowig found creative people to educate the students. One of these is senior teacher Gottfried Wetzel, another participant in the Community College, whose specialty is heating technologies. They began to construct demonstration projects on the grounds, including a "solar tower" that teaches students about the workings and maintenance of solar energy systems. Someone has to be able to put things together on the ground and keep them running, says Srowig, but their contribution is greater than that. Important innovations have come from craftspeople. They know how the technology works in practice, and they have creative ideas to move it forward. Wetzel's lab displays projects developed at the Fehrenbach School that are close to the cutting edge of research. He and his students are working on latent heat storage technologies, for example. They are also learning about solar cooling—there are only five solar-powered cooling systems in Freiburg, he says, and two of them are on his campus.[48] They collaborate with research institutions in the city, particularly the Fraunhofer Institute, but their focus is on practical applications and educating students to develop their ideas independently.

Another important function they fulfill is to provide an ongoing workforce for the many small family craft businesses in the region. According to Srowig, there are some 350 of these (including Schwörer Carpentry, described earlier), and 80 percent have renewable energy work as part of their operations. A small firm needs to be able to offer something new to stay in business, and renewables give them that edge. Wetzel says he gets three or four calls per week from people looking for skilled employees. With the region's changing demography, mom-and-pop businesses often have no one to take over the family shop. The school helps by supplying people who have not just basic skills, but also the creativity to innovate.[49]

Renewable Energy R&D: The Fraunhofer Institute for Solar Energy Systems

Another facet of the regional transition from protest to innovation was the establishment of an R&D institute devoted to solar energy. Neither the German federal government nor the traditional utilities had shown much interest in this; as Christoph Stefes points out in this volume, few believed there would be a large market for renewable energy technologies.

The pioneer in solar energy systems was Professor Adolf Goetzberger. At the time of the Wyhl protests, he was an esteemed physicist who had worked in the USA with the pioneers of semiconductor technology. He had been wooed back to Germany in 1968 as head of the Fraunhofer Institute for Solid State Physics in Freiburg. The Fraunhofer Society is a non-profit organization that runs a prestigious chain of R&D institutes, each of which is required to back up its commitment to applied research by winning a proportion of its funding through contracts with industry.[50] Goetzberger had become interested in the possibilities of solar energy, and after reading the Club of Rome's report, *The Limits to Growth*, he began to develop a vision for a separate institute devoted solely to this new line of research.[51]

He found little support among his colleagues; he says it was considered “ridiculous” to work on solar in the late 1970s. Based upon his sterling reputation, he was finally able to convince the president of the Fraunhofer Society to approve the project, and the Fraunhofer Institute for Solar Energy Systems (Fraunhofer ISE) opened its doors with about 20 employees in 1981.[52]

Goetzberger was encouraged by Freiburg’s favorable atmosphere toward renewable energy. Although he had not been directly involved in the anti-nuclear movement, he says he realized the local enthusiasm for renewables was related to that experience. What he and the veterans of Wyhl had in common was a desire to create something positive for the environment. He met and encouraged solar architectural pioneer Rolf Disch. He was aware of local citizens like Werner Mildebrath who were building solar collectors in their garages. These people ignored the experts who warned them against investing in solar energy. The reason the early solar market took off, he says, is that people pursued solar technologies as a hobby, and their customers cared more about developing the new energy source than they did about cost.[53]

Fraunhofer developed solar cell technology, and eventually thermal conversion, smart grids, and storage technologies. The institute had several “cliff-hangers,” where the Fraunhofer Society and the federal government threatened to shut it down due to the technology’s failure to find large private investors in Germany. But Goetzberger was involved in a growing international solar research network, and he had the support of the Freiburg mayor, who saw this field as a possible selling point for the region. In addition to supporting local experiments with solar technologies, Goetzberger helped draw the International Solar Energy Society to Freiburg in the late 1980s. His successors built strong ties with Freiburg University and the Richard Fehrenbach School in the 1990s and beyond. At present, the Fraunhofer Institute for Solar Energy Systems is the largest solar energy research institution in Europe, with some 1,200 employees. It educates hundreds of students for careers in solar energy.[54]

Political Support Organizations: BUND and the Greens

Politics was another key part of the network built by veterans of the Wyhl protests. Erhard Schulz studied chemistry at Freiburg University during the early 1970s. He belonged to the group of professors and students who helped organize the Community College at the occupation site.[55] Schulz gave presentations there, outlining the hazards of nuclear power and raising alternatives for power generation.

Schulz helped found a regional organization of the environmental group BUND in Freiburg in 1975. BUND was a new kind of group that combined the political mobilization of a citizen initiative with the nature protection emphasis of traditional environmental organizations. Schulz became the first managing director of the Baden-Württemberg organization, a position he held until 2000. He recruited volunteers from among forestry and chemistry department faculty at Freiburg University. Through his diverse contacts, he was able to wed the expertise of the university group to the nature protection and anti-nuclear activities of BUND. This gave them what he calls "a good scientific backbone."[56]

For Schulz, as for many of his contemporaries, making headway against nuclear power was only one side of the coin; the other was bringing alternative energy technologies to fruition. Under Schulz's leadership, BUND sponsored the Sasbach Sun Days, as well as the Eco-Fairs from 1979 to 1998. By that time, the fair had grown to 540 exhibitors and 56,000 visitors. Schulz's proudest achievement is the Eco-Station in Freiburg, which was erected as part of the State Garden Show in 1986. Maintained by the City of Freiburg and run by BUND, it serves as an environmental education center and demonstration project in ecological living.[57] It includes a "nature house" that showcases both natural, traditional construction techniques and state-of-the-art solar and cogeneration technologies. It is surrounded by organic gardens that illustrate various ecotopes. Built to inspire ideas about living in harmony with nature, the Eco-Station hosts educational events for the general public and for schoolchildren, including a summer camp.

The grassroots activism around energy projects also contributed to the founding of green and alternative voting lists throughout West Germany and eventually the national-level Greens in 1980. While anti-nuclear activists and renewables advocates were found across the party spectrum, the party organizations had been slow to take up the cause. Veterans of the Wyhl protest felt ill-served by the existing regional party constellation, particularly the CDU. They decided to try for direct representation by running one of their members for the state legislature. His convincing win signaled to the group that they could gain local office with candidates connected directly to the anti-nuclear movement. This was one impetus for the founding of the local Greens.[58]

The Greens entered the national parliament, the *Bundestag*, in 1983. They earned their best result nationwide in the region around Freiburg, with 12.3 percent.[59] In the Bundestag, they worked to bring the concerns of the citizen initiatives into government. One of their early actions was to force the formation of two special parliamentary commissions on energy issues.

Networking Organizations

United by their anti-nuclear activist origins and their commitment to a renewable energy future, individuals in many different branches built an interconnected network that began to attract other pioneers to the Freiburg region. Georg Salvamoser was born in Bavaria. He did not think of himself as an "eco-freak," but he was interested in solar energy. In 1983, he had solar panels installed on his house. "Nothing banged or crashed, and we got free electricity," he recalled. His interest in solar energy became a passion, but he was frustrated that there were so few providers in Germany. In 1991, he quit his job, sold the family house, and moved with his wife to Freiburg, which already had a reputation as one of the solar capitals of Germany. There he opened a firm, Solar Energy Systems, to install photovoltaic (PV) systems. He became acquainted with other solar pioneers in the area. As soon as his firm began to turn a profit, he invested in a new enterprise, bringing the large-scale production of solar modules to Freiburg in the first zero-emissions plant in Europe, the Solar Factory.[60] With the opening of the Solar Factory, Freiburg had all three of Fehrenbach School director Olaf Srowig's preconditions for energy transformation: cutting-edge research, a skilled workforce, and manufacturing.

One of the lessons he learned at Wyhl, says architect Rolf Disch, is that, when it comes to finding support for innovative ideas, "it works best with people one knows." Disch, Salvamoser, Schulz, and other local entrepreneurs decided they needed an energy agency to promote their products and services. Finding no support at higher levels, they cooperated in founding a registered association, Association for the Promotion of Energy and Solar in the Freiburg Region (FESA e.V.), locally.[61] FESA promotes renewable energy through public relations work and community education. It also conducts educational programs in many local schools. FESA's goal is "decentralized and democratic energy provision on the basis of renewable energies, from which municipalities and local citizens enjoy the profits."[62]

FESA later founded a limited liability company, FESA GmbH, to help area residents invest in renewables projects and navigate the permitting and construction processes. It has enabled hundreds of small investors to participate in the regional renewables boom. FESA was also a partner in founding the Energy Agency Regio Freiburg, along with the City of Freiburg and some members of the Chamber of Commerce, in 1999. The regional agency acts as a consultant and liaison for renewable energy projects. Everyone from municipalities to individuals can come here for advice. The agency partners with the nearby Fraunhofer Institute and multiple universities on projects, and roughly half of its 30 employees are students doing internships with the agency.[63] Together, these institutions have been critical for expanding the regional renewables network (depicted in Fig. 1.1) and keeping local projects alive when more conventionally minded investors and public officials balked at supporting new ideas.

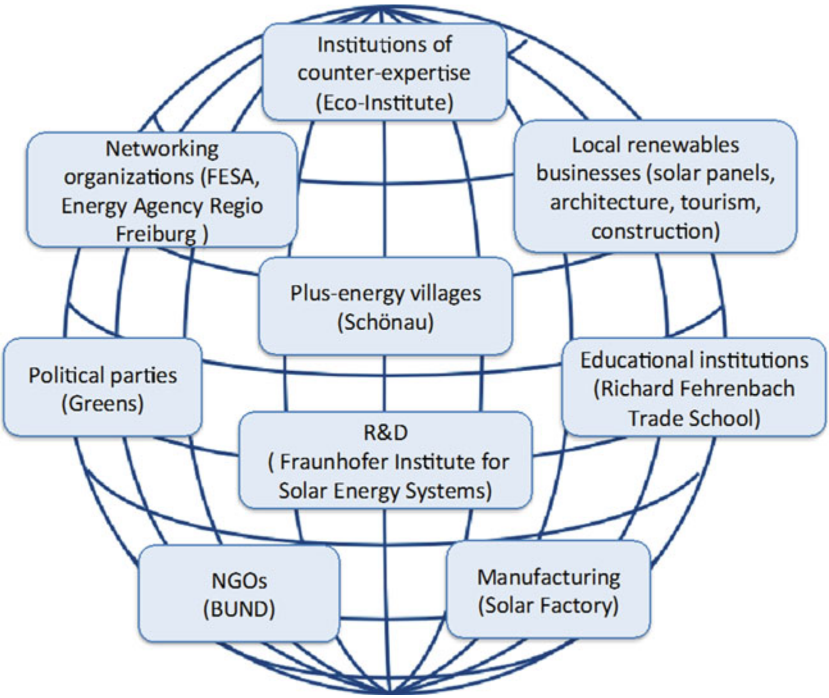

Fig. 1.1 Network of innovation in the Freiburg region (*Source*: Created by the author)

Political Support and the Expansion of the Freiburg Solar Region

As important as the actors involved in this story are those who were not involved. Political and economic elites played a negligible role in the early development of a renewables industry. Federal ministries were not uniformly supportive, and there was no substantial federal legislative help until 1990. Locally, too, the city government and the university administration were inconsistent in their support during the early phase of renewables development. Partly because of the visibility of the anti-nuclear movement, the region began to attract *Querdenker* (nonconformists) before the established institutions got in the game. The diverse network described here provided a foundation for Freiburg's transition to a "solar region" despite the absence of a legal infrastructure to support renewable energy development. This is consistent with the pattern elsewhere in Germany.[64]

The advocacy network from this region also influenced the development of federal renewable energy policy. The Chernobyl disaster raised the profile and the legitimacy of the Eco-Institute, and the Fraunhofer Solar Institute saw its fortunes rise, at least temporarily. The growing scientific awareness of climate change also helped. This had not been a factor in the initial arguments for solar energy, but it soon overtook the others in immediacy. What had once seemed utopian ideas were now taken seriously as alternatives to fossil fuels and nuclear energy. When the Bundestag formed a special commission on climate change in 1989, an Eco-Institute board member was included in the group.

The concept of a feed-in tariff, which has roots in Denmark, was developed into a policy proposal in Germany not by the established players, but rather in the "counter-expert" institutes that had arisen from the energy protest of the previous decades.[65] The 1990 Feed-in Law granted access to the grid to small energy producers at a guaranteed price, lowering the perceived risk to investors. After the federal Social Democratic Party (SPD)/Greens coalition government took office in 1998, renewables advocates saw more of their ideas put into place. The coalition pressured the Economics Ministry into forming a "100,000 Roof Program" to promote solar power and passed a revised Feed-in Law (EEG 2000), which guaranteed prices for feeding alternative energy into the grid for a 20-year period.[66]

The EEG accelerated the already flourishing solar network in the Freiburg region. Farmers, city residents, public works departments, and whole villages invested in renewables. The research network in the Freiburg region was growing as well. Several faculties of Freiburg University founded a Center for Renewable Energies (ZEE) in the 1990s, which affiliated with, among others, the Fraunhofer ISE and the Eco-Institute.[67] In 2000, Freiburg became home to the Intersolar Exhibition, billed as the world's largest exhibition for the solar industry. The Intersolar outgrew its Freiburg site and was moved to Munich in 2008.[68]

This development took on a life of its own as the Freiburg region's green reputation grew. Freiburg won numerous "green city" designations. It elected one of Germany's first Green mayors. People interested in renewable energies moved there to study or to open environmentally friendly businesses. The bottom-up model of energy investment and innovation is firmly anchored in the population of the Freiburg region. A 2012 survey showed that respondents from this region support the energy transition more strongly than elsewhere in Germany and even elsewhere in Baden-Württemberg. They also express more willingness to invest personally in renewable energy technologies.[69] Freiburg has been recognized nationally and internationally for its environmental orientation. The "solar region" designation has become a marketing factor for the whole region and a professional advantage for those who have trained there.[70]

Conclusion

This case study of the Freiburg region has shown how a regional renewable energy sector emerged from NIMBY protest. The grassroots opposition to nuclear power, and the informed desire to find alternatives to it, were the catalysts for the bottom-up development of renewable technologies in a country where top-down policymaking is the norm and in a region whose political leadership was tied particularly strongly to the conventional energy industry. The advocacy network for renewables grew through the founding of institutions of counter-expertise, the local development of a solar energy industry, the establishment of solar energy R&D and educational programs, and the infiltration of the political system by renewable energy advocates. Anti-nuclear activists themselves were an important source of technological and political innovation, and they form the core of the renewables network that developed here. As former physics student and Wyhl activist Georg Löser puts it, "every pioneering activity here leads back to Wyhl."[71]

Counter to the NIMBY stereotype, the Wyhl protest was scientifically and technologically forward-looking. Activists engaged in "creative reconstruction" in several ways. They prevented what in retrospect appears as a massive overcapacity in electricity. They helped debunk the myth of neutral expertise and expose the economic and political interests behind the pro-nuclear coalition. They empowered local residents to participate in technological innovation and in energy policymaking. Finally, they created a self-perpetuating regional milieu in which innovation in renewable energy technologies, especially solar, could flourish. The grassroots rejection of nuclear power is thus intimately tied to Germany's impressive energy transformation.

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    The survey was carried out by the organization Upper Rhine Climate Partner (*Klimapartner Oberrhein*). Approximately 500 people were surveyed in each of three areas: Germany as a whole, the state of Baden-Württemberg, and the Upper Rhine region (around Freiburg).
70. Bernward Janzing (freelance journalist), interview with the author, Freiburg, Germany, November 14, 2012.
71. Löser, interview with the author.

Why Subnational Actors Matter: The Role of *Länder* and Municipalities in the German Energy Transition

Philipp Schönberger and Danyel Reiche

Introduction

Findings from climate science have been indicating dangerous effects of global warming for decades, with an increasing clarity.[1] Moreover, the resources of natural gas and oil as well as uranium are declining and could be depleted by the end of the twenty-first century.[2] At the same time, many observers perceive the concentration of remaining fossil resources in politically unstable regions such as the Middle East and Russia as a severe risk to the security of energy supply in Europe. According to many actors involved, these developments make it necessary to initiate a major technological change toward energy saving, energy efficiency, and renewable energy.[3]

From a technology perspective, this kind of change is possible. Respective concepts and action plans have been proposed time and again.[4] However, none of these ideas has been implemented on a larger scale so far. Taking

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the multi-level system of governance into account, two of the most important questions in this policy field are as follows: What are the policy options to promote the energy transition at each level of governance? What factors can influence the furthering of the transition to renewable energy through these options? In this chapter, these questions are analyzed for the *Länder* and municipal levels of governance in Germany.

This chapter refers to several theoretical approaches. In particular, concepts of ecological modernization, capacity building, and conditions for environmental policy success are applied to the *Länder* and municipal levels of governance.[5] Moreover, the chapter follows certain foundations of policy research such as the policy cycle and Paul Sabatier's advocacy-coalition approach.[6] Finally, path dependence concepts as well as more recent research on multi-level and local governance are included.[7]

We will begin by outlining the history of the term *Energiewende* (energy transition) in the German energy policy context. We will also look at the status quo of the energy transition from the perspective of German *Länder* and municipalities. We will then describe the changing political framework conditions for *Länder* and municipalities before presenting the opportunities and instruments that German *Länder* and municipalities can use to promote the energy transition. A number of practical examples illustrate these policy options. The section is based on an extensive review and analysis of scientific literature as well as other documents.

In the last section, we analyze the conditions that influence the degree to which the *Länder* and municipalities promote the furthering of the renewable transition comparative to national averages. Based on Jänicke's categorization, potential conditions are divided into problem-related, political-institutional, economic, informational-cognitive, and actor-related factors. The empirical basis for the *Länder* level consists in a secondary analysis of case studies undertaken by Mez et al.[8] For the municipal level, data from Philipp Schönberger's dissertation project are included.[9] We conclude with an assessment of the future role of *Länder* and municipalities in the German energy transition.

German "Energiewende" at the *Länder* and Municipal Levels

German states have significantly contributed to Germany's energy transition. However, the *Länder* have not fared equally well. For example, as Fig. 2.1 shows, the shares of primary energy consumption accounted for by renewable energy range from 9 percent (Berlin) to 26.5 percent (Mecklenburg-Vorpommern).

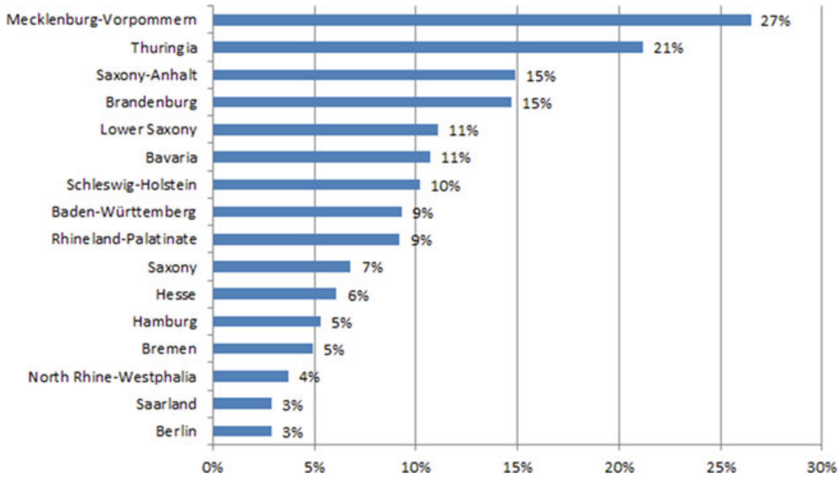

Fig. 2.1 Shares of primary energy consumption accounted for by renewable energy – German Länder. *Source*: Agentur für Erneuerbare Energien (AEE), BundesLänder in der Übersicht, (2014), accessed October 10, 2014, http://www.foederal- erneuerbar.de.

Comparing municipalities instead of *Länder*, the differences are even bigger. There are front-runner districts that—at least in the electricity sector—have already achieved calculated renewable energy shares of more than 100 percent, compared with local renewable electricity production and local consumption (Fig. 2.2).

When interpreting these data, we should recall that the geographical potential for renewable energy use differs considerably between German *Länder*, and even more between municipalities. For example, it is a lot easier to achieve a high share of wind energy for the *Länder* in the coastal regions. Thus, explaining the degree to which various *Länder* and municipalities have achieved a transition to renewables in relation to national averages and in relation to one another requires a more in-depth analysis.

Changing Framework Conditions for *Länder* and Municipal Energy Politics

For the past 30 years, the role of German *Länder* and municipalities in the country's energy politics has been significant. As explained in article 74 of the German *Grundgesetz* (constitution), energy supply is a field with

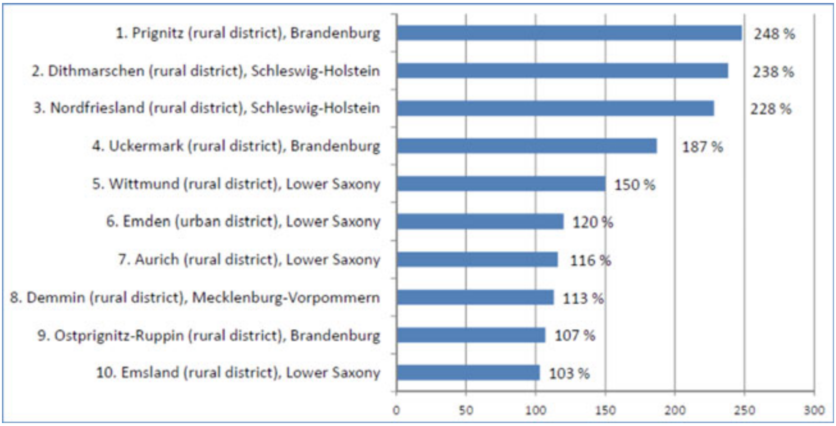

Fig. 2.2 Ratio between local renewable electricity production and local electricity consumption—top ten German districts (*Source*: Agentur für Erneuerbare Energien, DGS = Deutsche Gesellschaft für Sonnenenergie.

competing legislation. Both federal and *Länder* parliaments are entitled to pass laws in this area. For a long time, the federal level did not make full use of this option, which is why the *Länder* and municipalities played a crucial role in the promotion of renewable energy in the 1980s.[10] Some *Länder* and municipalities even set up financial promotion schemes for renewable energy and energy-saving measures, for example, feed-in tariffs for solar and wind.[11] Moreover, local and regional energy companies had supply monopolies in their respective territories, enabling their municipal owners to set energy prices.

Liberalization processes in the 1990s, induced by the European Union (EU) and put into national law by the *Energiewirtschaftsgesetz* (Energy Industry Act), abolished these monopolies. More recently, the EU created further important framework conditions, such as the introduction of the Emissions Trading Scheme, the Renewable Energy Directive, and the Energy Efficiency Directive. Altogether, the influence of the EU on the energy sector has rapidly increased within the past 20 years (see Chapter 5 on EU in this volume). At the same time, federal policies to promote renewable energy in all energy sectors (i.e. electricity, heat, fuels) were implemented in Germany (see Chapter 4 by Stefes in this volume). However, the increasing importance of the federal and EU levels of governance did not erase the influence of *Länder* and municipalities. Subnational actors still maintain a number of decisive energy policy options.

Opportunities for *Länder* and Municipal Energy Transition Governance

The opportunities and instruments of *Länder* and municipal renewable energy policy (not only, but also, in Germany) can be divided into five distinct governance modes: (1) overarching measures, (2) consumer behavior of the *Länder* and municipal administrations, (3) regulation and planning, (4) provision of energy, public transport, and housing, and (5) support and information.[12] These five categories refer to different levels of action (Fig. 2.3). First, overarching measures (e.g. target-setting and *Länder*/local energy concepts) can be distinguished from individual, concrete instruments to promote renewable energy. The latter can be divided into instruments concerning the *Länder*/municipal administration itself

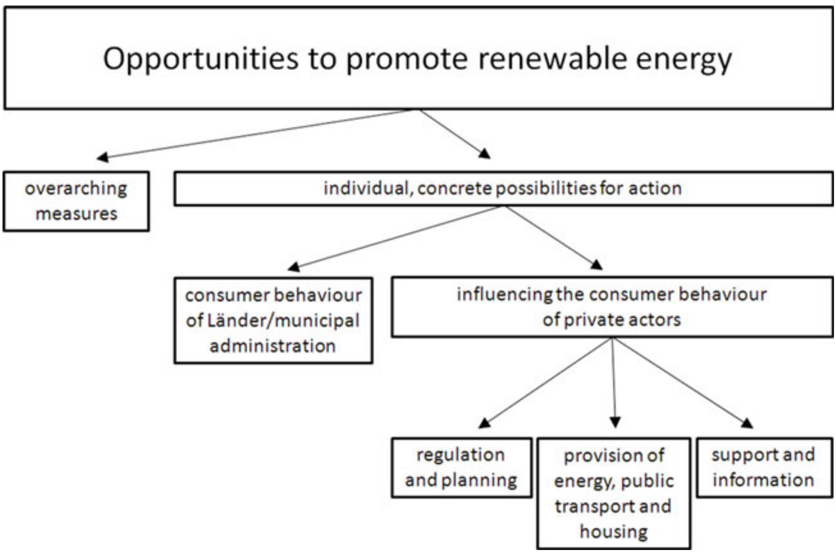

Fig. 2.3 Overview of *Länder* and municipal opportunities to promote renewable energy (*Source*: Adapted from Schönberger (2013), Alber and Kern (2008), Kern et al. (2005), and IEA (2009))

as an energy consumer, and instruments aiming to influence the consumer behavior of private actors. Finally, there are three ways for *Länder* and municipalities to influence private actors: regulation and planning; provision of energy, transport, and housing; and support and information.

Overarching Measures

This section deals with three overarching measures to promote renewable energy: (1) energy and climate action plans, including targets concerning the share of renewable energy or the reduction of greenhouse gas emissions, (2) cooperation with other *Länder* and municipalities, and (3) the institutionalization of renewable energy and climate protection within the administration.

The development of *energy and climate protection action plans* is a widely used measure in *Länder* and municipalities. According to the German Advisory Council on the Environment, targets can improve long-term orientation and help to create a reliable environment for investors.[13] Today, all *Länder* have established action plans or comparable strategies, including quantitative targets.[14] In some *Länder*, there are comprehensive, long-term, and binding targets. For example, the state government of Baden-Württemberg aims for a 50 percent reduction of the energy consumption and an 80 percent renewable energy share until 2050. This way, greenhouse gas emissions are to be reduced by 90 percent.[15] In other cases, the targets only cover certain aspects, such as renewable energy expansion or the electricity sector. Moreover, some targets have been given up or replaced rather soon. In the state of Hesse, for instance, the government set a target in 2005 to achieve 15 percent coverage of final energy consumption through renewable energy until 2015. Four years later, this was replaced by a 20 percent target for 2020.[16]

Also at the municipal level, energy and climate action plans have become increasingly popular in recent years. The main driver of this process has been a networking project called “100% Renewable Energy Regions,” funded by the Federal Ministry of the Environment. So far, there are more than 130 German municipalities and regions striving for an entirely renewable energy supply.[17] These action plans usually contain a CO_2 balance sheet, an estimate of local renewable energy and energy-saving potential, and concrete policy recommendations. The popularity of these action plans has been increased not only by greater local willingness to mitigate climate change, but also by a federal support scheme that also includes the financing of additional administrative personnel for the municipalities.[18]

At the *Länder* level, *cooperation with other Länder* is an obvious way to influence national framework conditions for the energy transition via the *Bundesrat* (Federal Council). In particular, some laws at national level require the approval of the *Bundesrat*, for example, the *Bundesregierung* (government) and *Bundestag* (parliament) cannot put through certain legislation against the *Länders*' vote. Furthermore, the Federal Council itself can initiate legislation. In the past decades, according to Mez et al., the *Länder* have asserted their energy policy interests successfully in many cases.[19] This could also be observed during the decision-making process for the revision of the Renewable Energy Act in 2014.[20]

At the municipal level, the importance of cooperation with other municipalities is increasing. Cooperation with neighboring municipalities is often well advised, such as for establishing energy-related advisory agencies or defining priority areas for wind power.[21] Furthermore, transnational climate-protection networks have gained importance since the 1990s.

The *institutionalization of renewable energy and climate protection* within the administration is important to make sure that agreed-upon measures are implemented properly. At the *Länder* level, competence for energy issues is organized very differently within the respective governments. In many cases, both the ministry for economic affairs and the ministry for the environment are involved. Recently, some *Länder* also created ministries for climate protection or energy transition.[22] Likewise, at the municipal level, the competence for energy issues is often split between the department for the environment, the building authority, and the mayor's office. Kern et al. recommend establishing both a central, coordinating climate-protection unit and decentralized responsibilities within individual departments.[23]

Consumer Behavior of Länder *and Municipal Administration*

Like every consumer, *Länder* and municipal administrations can take measures to reduce their energy use and to meet their energy needs with renewable energy. By doing so, *Länder* and municipalities can take climate-protection measures without consideration of, and influence from, private actors (for possibilities to influence the energy consumption of private actors, see sections below). Especially, municipal administrations are among the largest consumers within their territories.[24] Additionally, acting as a model in these areas, they can serve to legitimize climate-protection measures concerning other actors.[25] For example, in North Rhine-Westphalia, the minister for construction initiated the use of renewable energy in state-owned properties in as early as 1996.[26]

In order to cover their *electricity* demand with renewable energy, *Länder* and municipalities can purchase green power for public buildings. In the case of Hamburg, municipal buildings have been supplied with a ten percent share of green power since 2002. At present, green power covers 100 percent of the electricity demand of municipal buildings, local public transport, and several municipal companies. The required electricity is produced in German hydropower plants and Danish wind parks. Nevertheless, the measure is contentious, since *Rheinisch-Westfälisches Elektrizitätswerk* (Rhine-Westphalia Electricity; RWE) supplies hydropower. RWE is one of Germany's biggest energy companies, which also operates nuclear and coal power plants.[27]

Furthermore, electricity demand can be covered directly by using cogeneration units or photovoltaic (PV) systems on administration buildings. However, given the current legislative framework of the Renewable Energy Act, the more profitable option is feeding at least a certain share of the PV-generated power into the electricity grid. Using 100 percent of PV electricity in the building where it is produced is no economic solution because storage costs are too high.[28]

In order to cover the administration's heat demand with renewable energy, solar thermal, biomass, and near-surface geothermal plants are possibilities. Each of these technologies can be used either as individual plants or in combination with a local heating network. Today, individual heat plants supply heat to the majority of buildings in Germany. Nevertheless, the expansion of local heating networks can be an opportunity to realize an efficient use of renewable heat.[29]

As far as motorized *transport* can neither be avoided nor replaced by walking or cycling, biofuels and renewable power can be utilized. This applies to cars, trucks, and motor-supported bicycles.[30] Since switching to renewable transport will not challenge motorized individual transport, popular support might emerge rather quickly.[31]

Further to the direct energy demand, which finds expression in the administrations of the *Länder* and municipalities electricity, heat, and fuel costs, so-called *gray energy* plays an important role. Gray energy is the amount of energy needed for the manufacturing and disposal of products and the delivery of services.[32] *Länder* and municipalities can commit themselves to favor products and services on the basis of renewable energy (e.g. products from companies that use green power for their manufacturing processes). Cities that have committed themselves to ecological procurement include Bremen, Heidelberg, Frankfurt/Main, and Stuttgart.[33]

Regulation and Planning

Länder and municipalities can implement regulatory and planning measures especially in relation to buildings and the designation of areas for renewable energy plants. With regard to buildings, the federal *Erneuerbare-Energien-Wärmegesetz* (Renewable Heat Act) prescribes that new buildings have to cover a certain percentage of their heating and hot water demand with renewable energy via a number of technological options. For example, in the case of a solar heating system, 15 percent of the total heat demand has to be covered. However, the federal law delegates the decision of whether comprehensively renovated buildings also have to use renewable energy to the *Länder* level. Until now, Baden-Württemberg is the only regional state that has put such a law into force. Others have enabled their municipalities to implement their own policies. The solar ordinance of the Hessian city of Marburg is the most prominent example of a municipality hindered in its efforts to prescribe the use of renewable heat also for renovated buildings by the *Länder* government and parliament.[34] Moreover, municipal building codes can also be based on binding land-use plans or urban development contracts. However, the opportunities, defined by the Federal Building Code *Baugesetzbuch* (Federal Building Code), are limited, and there is a need for legal clarification on some crucial points.[35] Additionally, municipalities can oblige building owners to connect to and use district heating networks, which can be fed with renewable heat (e.g. from combined heat and power plants). All regional (*Länder*) Municipal Codes include this option.

In general, municipalities are allowed *to designate areas for renewable energy plants* within their territory. This is especially relevant for wind turbines, since these are regarded as relevant for spatial development.[36] On the level of urban land-use planning, areas for renewable energy plants can be depicted in the preparatory land-use plan.[37] However, according to the *Raumordnungsgesetz* (Federal Building Code and the Regional Planning Act), all urban land-use plans have to be compatible with the regional plan, which is, therefore, the decisive level for designation proceedings.[38] In turn, municipalities participate in the development of the regional plan.[39] Until now, most municipalities have argued against the designation of wind energy areas within their territory. However, it is also possible to request more wind energy areas, as some examples show.[40]

At the *Länder* level, the restrictiveness of guidelines for wind energy areas varies significantly. For example, Bavaria recently introduced a restrictive minimum distance of 2000 meters from residential buildings for modern wind turbines with a height of 200 meters.[41] This will probably stop most wind energy projects planned in the state. The other *Länder* are less restrictive. In Baden-Württemberg, for instance, the required minimum distance is only 700 meters.[42]

Provision of Energy, Public Transport, and Housing

Another possibility to influence the energy use by citizens and companies includes the provision of energy, public transport, and housing. German municipalities have been engaged in these areas since the nineteenth century, while *Länder* seldom assume responsibility for these provisions.[43] In this respect, Baden-Württemberg is an exceptional case, since the state bought a 45 percent share of *Energie Baden-Württemberg* (EnBW), Germany's third largest energy company, in 2010.[44] Furthermore, the *Länder* own woodland and therefore are involved in the use of forest wood for energy purposes.[45] Finally, *Länder* laws set important rules for the economic activities of municipal energy companies.

On the basis of the regional (*Länder*) Municipal Codes, municipalities can establish *Stadtwerke* (energy companies) and carry out energy-related economic activities. Thus, municipalities are generally authorized to produce energy from renewable sources.[46] Provisions of the Municipal Codes, however, differ significantly regarding the limits of municipal economic activities.[47]

Additionally, framework conditions for the electricity and gas market were substantially altered in the 1990s by the amendment of the *Energiewirtschaftsgesetz* (Energy Economy Act) and underlying EU provisions. Striving for liberalized energy markets, local supply monopolies – including the ones of municipal energy companies – have been eliminated. They now have to compete with private energy suppliers, resulting in considerably lower profits, which affect municipal budgets and possibilities (e.g. to subsidize public transport).[48]

At the start of the new millennium, shortly after the liberalization of energy markets, numerous observers identified a trend that many municipal energy companies were sold or at least refrained from energy production. By 2005, the shareholding structure of more than 100 municipal energy companies had changed. In many cases, large private energy companies had acquired shares in order to ensure sales and to further strengthen their position.[49]

However, this empirical evidence from a certain period does not support the conclusion drawn by some scholars that the role of municipalities as providers will continue to become less important in the future.[50] On the contrary, a number of indications point toward a possible rollback, a renaissance of municipal energy companies. In the past few years, municipalities have tended to repurchase their energy companies and grids or to found new companies, thereby becoming more independent from the big energy companies again.[51] Moreover, an increasing number of good-practice examples show the opportunities for municipal companies to contribute to the expansion of renewable electricity and renewable heat as well as to energy efficiency.

In the *electricity sector*, municipal energy companies can support the expansion of renewable energy in at least two ways. First, they can purchase green power on the electricity market and then sell it to consumers. Second, municipal energy companies can, where compatible with the respective Municipal Code, install and operate renewable electricity plants or participate in such plants. In order to finance the higher costs (compared to conventional power plants), the cities of Munich and Heidelberg have set up funds that are fed by revenues from green power tariffs.[52] However, the most important framework condition to realize ecological and economic targets at the same time is the *Erneuerbare-Energien-Gesetz* (Renewable Energy Act; EEG). Through the cost-covering remuneration guaranteed by the EEG, investments in renewable power plants become economically feasible.[53] In 2009, the municipal energy company of Munich announced a broad extension of renewable electricity production, aiming to cover the complete demand of the city by 2025. This renewable energy expansion program requires a planned investment volume of nine billion euros by 2025, and is regarded to be one of the most ambitious renewable energy projects in the world.[54]

In the *heat sector*, municipal energy companies can produce or purchase natural gas from biomass and then sell it to consumers.[55] Moreover, local or district heating networks can be fed with renewable heat. In general, municipal energy companies in Germany show a comparatively high share of combined heat and power (CHP) companies, such as Schwäbisch Hall, Oerlinghausen, and Lemgo, all of which operate CHP plants on the basis of biomass and/or natural gas.[56] Additionally, in Crailsheim (Baden-Württemberg), the municipal energy company is currently constructing a solar thermal local heating system for a new development area. With a size of 10,000 square meters, it will be the biggest solar thermal plant in Germany and will cover about 50 percent of the heat demand of 2000 inhabitants. A seasonal reservoir will also be able to store the solar heat for the cold season. The solar local heating system is supposed to avoid 1000 tons of CO_2 emissions per year.[57]

Regarding *energy efficiency technologies*, the short distance to their customers is a high comparative advantage of municipal energy companies. A variety of options exist to promote these technologies. For example, the municipal energy company of Emden offers a so-called heat direct service. Instead of natural gas or another energy source, customers can purchase useful heat. The energy company takes care of all necessary investments and the maintenance of the heating system.[58] Additionally, the city of Kassel (Hesse) and its municipal energy company introduced an *Abwrackprämie* ("scrap bonus") in March and April of 2012. Individuals received 100 euros for disposing their old refrigerator and buying an especially energy-efficient new one.[59]

Overall, it can be stated that there are tendencies toward a rollback, a remunicipalization, and a stronger role of municipal energy companies.[60] Compared to competitors, municipal companies have several advantages. They can exploit synergies between their different business segments, such as energy, waste, water, sewage, and mobility. They are comparatively close to their customers and are in contact with them in the different segments. Furthermore, a strong role of municipal energy companies can lead to effects that might be regarded as politically desirable. They can (1) be helpful to achieve the primacy of politics, (2) contribute to public value (e.g. by improving the situation of municipal budgets), and (3) limit oligopolistic structures and the market power of big energy companies.[61]

With regard to public transport, many German municipalities founded mobility companies, running electric trams, subways, and/or buses. This portfolio can be supplemented by car sharing. As described earlier, the societal acceptance of measures restricting motorized individual transport is rather weak. Thus, it is essential to develop attractive alternatives such as a high-quality public transport system.[62] Operating public transport by renewable energy, biofuels, and renewable electricity are options to be considered. Similar to the energy sector, public transport was also liberalized in the 1990s by EU and federal provisions that aimed to improve market access chances for private companies. In reality, however, running public transport is hardly economically feasible without public subsidies, which are still allowed and only have to be made transparent.[63]

Finally, by founding *housing companies*, municipalities can construct energy-saving passive houses, refurbish buildings to comply with passive house standards, and use renewable energy as well as combined heat and power technology for the energy supply of buildings. Municipalities can influence such decisions via the members of the housing companies' supervisory boards. The *Länder's* main role in housing policy is to organize financial support schemes.

Support and Information

Support and information includes energy consulting services, public relations and educational work, financial incentive programs, and support and attraction of investment in renewable energy.

Offering *energy consulting services* is an obvious possibility for municipalities because of their closeness to citizens, companies, and disseminators (e.g. private energy consultants, chimney sweepers, construction industry). For example, the city of Frankfurt/Main puts emphasis on energy concepts for buildings, especially the use of combined heat and power technology. Another option is to offer individual mobility concepts without motorized individual transport.[64] Some municipalities cooperate with the energy consulting services of the consumer protection organization *Verbraucherzentrale*.[65] Some *Länder* support these developments by establishing regional energy agencies.[66]

Another important task for *Länder* and municipalities is energy-related *public relations and educational work*. Environmental departments, municipal energy companies, energy agencies, or adult education centers can perform this task. This way, municipalities can reach people who do not explicitly ask for energy consulting services. Examples for information campaigns are the federally coordinated *Woche der Sonne* (Week of the Sun) and the locally initiated *Münchener Solartage* (Munich Solar Days). At the *Länder* level, there are ministerial campaigns aiming to promote the energy-efficient refurbishment of buildings and to increase the societal acceptance of renewable energy plants.[67] Moreover, in Germany, framework curricula for schools are adopted at the *Länder* level and can focus on energy and climate-protection issues in various ways.

Moreover, *Länder* and municipalities can establish their own financial incentive and support programs. Such programs exist in all *Länder;* however, there are considerable differences with regard to the promoted technologies as well as to the actors that can apply for the funding.[68] For example, in North Rhine-Westphalia, the "progress.nrw" program and its antecessor "REN program" have promoted the use of renewable energy and energy-saving measures for several decades. Between 1988 and 2006, altogether 640 million euros were granted to private households, companies, municipalities, and public institutions.[69] A more recent example for the promotion of solar thermal systems is the municipality of Nalbach.[70] Taking into account the grave situation of many municipal budgets, one solution for the financing of incentive programs can be funds that are financed by a surcharge on the energy prices of municipal energy companies.[71]

Finally, many municipalities work with their citizens and businesses as well as with businesses from outside to *attract investment in renewable energy*, using the frameworks that exist at higher levels of government (such as the Renewable Energy Act; EEG). One possibility is to support citizen-owned renewable energy plants, which have become popular during the past years. Wind energy and solar plants are financed by a high number of citizens, each of whom contributes a relatively small share of the investment (usually between 100 and 20,000 euros).[72] Another positive effect of this model is the inclusion of many citizens in ecological projects. If solar panels are installed on the roofs of school buildings, the projects can also serve educational aims.[73] In the case of solar energy, an important prerequisite for the realization of citizen-owned plants is the availability of data about suitable roofs.[74] By publishing these data the municipality can trigger private investments.

Conditions for Furthering the Renewable Transition

In this section, we will examine the question of which factors influence the degree to which federal states and municipalities are able to introduce strategies to further the transition to renewables relative to the national average. A catalogue of potential factors has been compiled in Table 2.1.

Länder *Level*

The following analysis of the factors that influence the furthering of renewable energy policies at a federal state level makes use of the empirical investigations by Mez et al.—in terms of a secondary analysis—and is partially complemented by more recent developments. The study carried out by Mez et al. looks at the renewable energy policies of the three states,

Table 2.1 Independent variables: factors that can influence the ability of *Länder* and municipalities to implement/further renewable energy policy

Problem-related factors		Renewable energy potential and economic structure Pressure applied by promoters and antagonists of the energy transition/winner–loser balance and regional economic effects
Structural and situative conditions	Political-institutional factors	Party-political majorities in parliament and executive offices/new parties und majority changes Policy mix, path dependence, and environmental policy integration Inclusiveness of the political decision-making process Political framework conditions at higher political levels
	Economic factors	Financial situation of citizens and public budgets/unemployment as a potential competitor for environmental issues in the struggle for political attention, especially in times of recession
	Informational-cognitive factors	Knowledge about public attitude toward renewable energy/long-term experience with renewable energy/recent media headlines Awareness of the actors with regard to their policy options
Actor-related factors		Committed individual persons/advocacy coalitions

Source: Created by the author, based on Schönberger (2014)

namely, Lower Saxony, North Rhine-Westphalia (NRW), and Saxony-Anhalt.[75] The three states have very different basic conditions in terms of their significance for national energy policy, their primary sources of energy, and their party-political outlook. They, therefore, constitute a broad spectrum of case configurations.

As depicted in Fig. 2.1, Lower Saxony and Saxony-Anhalt can be seen as farther along in implementing renewables, with renewable energy shares of primary energy consumption at 11 and 15 percent, respectively, both exceeding the national percentage of renewable energy sources of nine percent in the year of reference. In contrast, with a renewable energy share of four percent, North Rhine-Westphalia is below the national average and can therefore be classified as comparatively less far along in the energy transition.

The empirical material from these three case studies is presented systematically using the described categorization of the factors in Fig. 2.4. Unless stated otherwise, the source of all empirical data is the study by Mez et al.[76]

Problem-Related Factors
The case studies confirm the significance of geographic factors. For example, Lower Saxony has a geographic advantage for the use of wind energy (on- and off-shore) and biomass, thanks to characteristic features such as

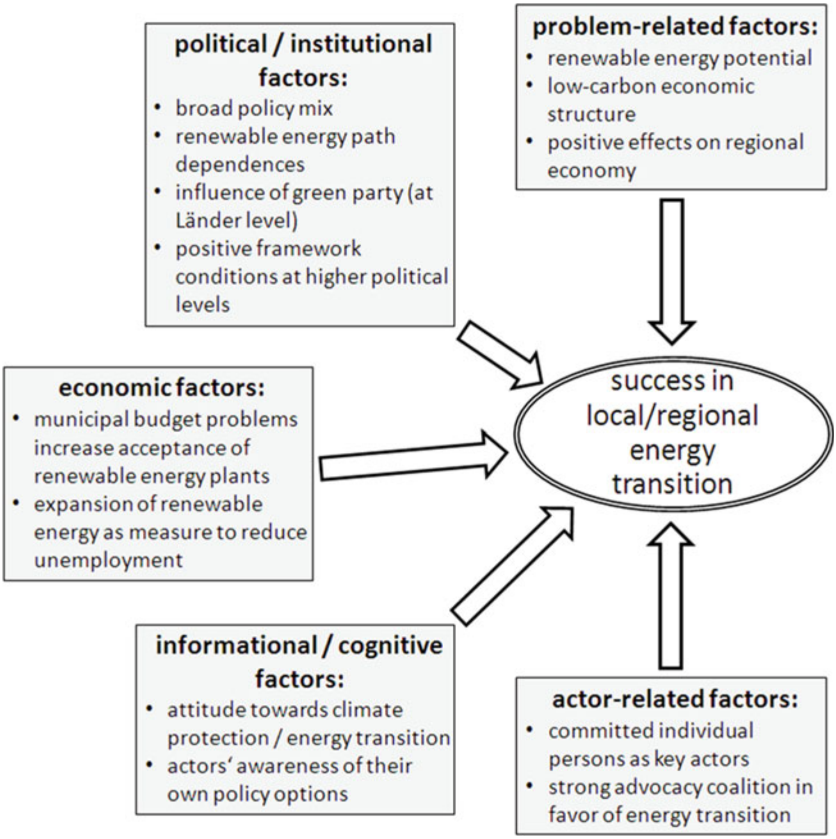

Fig. 2.4 Explanatory factors for furthering the energy transition governance at *Länder* and municipal level (*Source*: Adapted from Schönberger (2014))

coastal regions and flat lands. In terms of wind energy, Saxony-Anhalt has the benefit of medium-range wind conditions, low population density, and a low proportion of protected landscape and areas of conservation. On the other hand, solar radiation levels are comparatively low. In contrast, the example of North Rhine-Westphalia clearly highlights the significance of economic structure for the implementation of renewable energy policies. Thus, the state displays above-average levels of energy consumption, heavily influenced by the industrial facilities, making it difficult to achieve a high share of energy from renewable sources.

Pressure to act from both supporters and opponents can also be recognized in the *Länder*-level case studies. Particularly in Lower Saxony, many people are employed in the renewable energy sector, especially in economically underdeveloped areas. In contrast, in North Rhine-Westphalia, although there are indeed many people employed in the renewable energy industry, the same is also true of the fossil fuel sector. In addition, there are 86 municipal shareholders, primarily from North Rhine-Westphalia, with shares in RWE, an energy company chiefly concerned with fossil fuels and nuclear energy.[77] This explains why representatives from the state government in North Rhine-Westphalia repeatedly reveal themselves as champions of the interests of the fossil fuel industry, while also exerting influence over national politics.[78] This lobbying counteracts efforts to establish commitment to the *Energiewende*.[79]

Political-Institutional Factors

The importance of political-institutional factors can also be seen within the case studies. With regard to party-political influences, the social-democratic/green *Länder* governments in North Rhine-Westphalia and Lower Saxony both demonstrate a considerably more positive attitude toward wind power than the conservative-liberal governments during the time period observed (the 1980s onward).[80] In all three states, the renewable energy policy mix is comprised of a range of different tools, including energy concepts, state planning, and development programs. However, sometimes measures counteractive to the turnaround in German energy policy are implemented, such as the support of brown coal open face mining (NRW, Saxony-Anhalt), subsidies for coal mines (NRW), and planning-related obstacles for the expansion of wind energy (NRW, Lower Saxony). Furthermore, the state energy agency was abolished in Lower Saxony, thus weakening the state's capacity to act in terms of information and consulting.

All three federal states are also characterized by specific fossil-nuclear policies. In Lower Saxony, this is seen in its four atomic power stations alongside the oil and gas production in the North Sea, which have a major impact on the state budget. In contrast, in both North Rhine-Westphalia and Saxony-Anhalt, coal usage and production play a very influential role.[81] As for policy integration, all states are striving, above all, to unite their policy on renewable energy with economic development and business relocation.

Economic Factors

In all three case studies, the situation of the state budget is a matter of concern. Monstadt and Scheiner point out that, in recent decades, it was repeatedly observed that the economic interests of a state had more of an influence over voting behavior regarding energy- and climate-protection laws in the *Bundesrat* than the respective party-political government configurations.[82] Economic development and the prosperity of the population are at very different levels in each of the three federal states. As with most other former German Democratic Republic (GDR; East Germany) states, Saxony-Anhalt, in particular, is characterized by a low GDP per capita and a high rate of unemployment. The latter is also true for certain regions in North Rhine-Westphalia. Overall, hope can be seen, on the one hand, that many new jobs will be created in the renewable energy sector in the future, but, on the other hand, there is also the fear that many jobs in the fossil fuel and atomic energy industries will be lost, particularly in NRW. Nevertheless, the EEG, in particular, offers an incentive to all states to support investments in renewable energy sources in their own region because if they do not do so, net financial resources will be allocated to the other federal states within the scope of the EEG reallocation charge. Similar incentives apply for taxpayer-funded subsidies from the federal government.

Informational-Cognitive Factors

The case studies show that criticism of individual renewable energy projects can be found in many different places, especially with regard to projects that are particularly visible, such as wind power facilities. Here, the engagement of citizens' initiatives often converges with critical statements of individual politicians. However, more recent investigations into the public acceptance of energy facilities show a more widespread approval for expanding renewable energy facilities, even in the local area. Even in coal-dependent North Rhine-Westphalia, a survey in 2012 concerning the construction of wind power facilities in the local region received 63 percent approval from the respondents, significantly higher than that for a new coal-fired power station, which was merely nine percent.[83]

Actor-Related Factors

The case studies show that at the *Länder* level, individual persons can play a very important role. In Lower Saxony, for example, during the period in question, the State Premier (Christian Democratic Union; CDU) spoke out in favor of wind energy while the environment minister (Free Democratic Party; FDP) spoke out against it; this was detrimental to the investment climate in the state. However, overall, in Lower Saxony, there exists a widespread and dominating advocacy coalition in favor of renewable energy expansion, which can also be explained by looking at the positive effect on the regional economy.

In NRW and Saxony-Anhalt, however, although renewable energy expansion is advocated, this is only done to a limited extent as, at the same time, the continued support and use of coal has been given a higher priority. Although the Green Party and environmental organizations are acting to change this situation, a large coalition composed of individuals representing the Social Democratic Party (SPD), CDU, FDP, energy companies, and trade unions dominate the energy policymaking process. Since the accession of the red-green state government in 2010 in North Rhine-Westphalia, the situation has now shifted in favor of climate protection. With this in mind, the state parliament passed a climate-protection law with ambitious targets for the reductions of greenhouse gas emissions in 2013.[84] The extent to which this change of position will deliver long-term effects, however, remains to be seen.

Municipal Level

Up-to-date empirical data compiled by one of the authors of this chapter can be used for the analysis of the factors and their influence on municipal renewable energy policies. The empirical data for the municipal level is based on 33 interviews with local experts, non-participant observation of council meetings, as well as the analysis of council documents, scientific literature, media reports, and further documents.[85]

Due to the high number of differences between the three good-practice municipalities chosen, it is therefore possible to analyze a relatively broad spectrum of possible circumstances despite the low number of actual cases studied. The municipalities differ in terms of federal state, party-political character, unemployment rates, and population density. In addition, completely different regions of Germany are represented in the case selection with Lower Saxony (northwest), Brandenburg (northeast), and Rhineland-Palatinate (southwest).

In all three municipalities, an entire bundle of measures are being implemented. At least one measure from each mode of governance is in operation in every municipality. All three sample municipalities demonstrate a higher proportion of energy from renewable sources than the national average in at least one energy sector (power, heat, and/or fuel).

Problem-Related Factors

In each of the three municipalities investigated, there is considerable potential for the use of renewable energy. The potential of wind power plays by far the most important role in terms of quantity. With regard to local energy requirements, comparable data is only available for the electricity sector. Here, per capita consumption is very different in comparison with the national average. The three municipalities, therefore, have very different conditions for achieving a higher share of energy generated from local renewable energy sources. It can be seen that the local potential for using regenerative energy sources, as well as the energy intensity of the local economic structure, clearly plays a relevant role in the question of how a municipality can achieve a higher proportion of local renewable energy sources in its power balance.

In the three sample municipalities, the local expansion of renewable energy infrastructure is accompanied by significant benefits for the regional economy. As the affected shareholders also wish to capitalize on their potential profit and find a way to express this, pressure on local policymakers to act has intensified. In the sample municipalities, a broad spectrum of shareholders profit from an ambitious municipal policy of expanding renewable energy. These actors include facility operators (companies, utilities, and households), manufacturers, installation companies, and employees; farmers who lease their land; and broader sections of the population (incentivized via direct investment or price reductions).

In contrast, generally no one within the municipality loses out financially, since the costs for the local expansion of renewable energy is predominantly covered by national contributions and tax money. Municipal budgets also benefit from lower unemployment levels, income from leases, and charging for route usage and cable routing. Critics and opponents of individual renewable energy projects in the three sample municipalities have, instead, focused to a greater degree on the conservation of species and the preservation of the landscape. However, they are not usually able to stand up against the strong regional economic arguments within the political process.

Political-Institutional Factors

Party-political changes within municipal councils or in the mayor's office have not led to any changes in renewable energy policy in any of the three sample municipalities. On the contrary, almost universal consensus was seen among local policymakers; as a rule, all decisions were made with a large majority. While this consensus supported the expansion of renewable energy in Emden and Prenzlau without any discernible disruptions, three phases with very different levels of commitment to renewable energy policy can be identified in Alzey-Land. At the same time, these transitions or changes between these phases cannot be linked to changes in majority party, mayor, or the emergence of a new party. In Prenzlau, the consensus regarding the expansion of renewable energy was even supported by three different mayors with three different party-political backgrounds (SPD, Die Linke, and independent).

A renewable energy policy mix that covers all five modes of governance can be found in each of the three sample municipalities, albeit to different extents. Local funding programs for renewable energy projects in Emden and Prenzlau can be classified as economic instruments. However, such economic instruments tend to take a more complementary role. In the three municipalities investigated, the federal policy of economic incentives, in particular the German Renewable Energy Act, was decisive for the quantitative expansion of the renewable energy infrastructure. It can, therefore, be concluded that not every political level necessarily requires its own economic incentives in order to implement its environmental policy.

An integration of renewable energy policy with other political fields can be seen within the sample municipalities to varying degrees, although, in general, this is not very far advanced. In Emden and Prenzlau in particular, strong links can be seen between the expansion of renewable energy on the one hand, and the promotion of trade and industry and job creation caused by the relocation of renewable energy-related business on the other.

An institutionalization of local renewable energy policies is likewise only evident in Emden and Prenzlau. Emden has been particularly successful at integrating various administrative units within the framework of ongoing internal administrative processes for the European Energy Award. Civil servants who are involved with making decisions relevant to changes in local energy policy now regularly meet to discuss and exchange ideas.

Socio-technical path dependencies are a strong factor of influence in all three cases. The local expansion of renewable energy has led to renewable energy paths being opened in the sample municipalities that have developed a large amount of intrinsic logic and momentum far beyond formal institutional structures. It can, therefore, also be seen that path dependencies are by no means beneficial only for established fossil fuels or nuclear energy (as in North Rhine-Westphalia, France, or Poland), but can also have positive effects in terms of renewable energy expansion.[86] These socio-technical path dependencies comprise three different dimensions:

- *Technical-economical dimension*: It is clearly economically viable to continue to use previously constructed technical facilities and the corresponding infrastructure, and also to modernize facilities after operations have ceased (repowering). Additionally, powerful economic stakeholders emerge around these facilities and infrastructure, and these continue to defend their interests.
- *Social dimension*: According to the experiences of all three sample municipalities, the population becomes accustomed to the sight of renewable energy facilities, even large wind power stations.
- *Political dimension*: The political stakeholders likewise become accustomed to the once tried and tested procedures and tools, such as land-use planning for wind energy plants or establishing local renewable energy development programs.

Openness regarding local processes to shape public opinion can be considered as another key factor for stimulating responses from opponents, administrative bodies, associations, businesses, and civic participation schemes. A collegial sense of cooperation and a constructive atmosphere were evident in the local councils of all three sample municipalities. The political, administrative, civic, and commercial stakeholders all consistently report transparent information and open procedures in current local municipal politics in which opinions, other than merely those of the majority, are also heard.

Ultimately, the framework conditions at higher political levels are of crucial importance for the implementation of municipal renewable energy policies. In particular, the German Renewable Energy Act, enacted in 2000, constitutes an immensely important foundation for numerous investments from municipal utilities, associations, other enterprises, and private individuals. As is made clear in Emden, the national allocation of finances for energy injection allowances also has a beneficial effect on local renewable energy expansion. In contrast, the *Stromeinspeisungsgesetz* (feed-in tariff; StrEG), which was effective prior to the EEG, placed the Emden municipal utility companies under obligation to pay the feed-in allowances themselves as the local network operator; this inhibited the commitment of city officials. Furthermore, the legislative framework for renewable energy policy in the states of each of the respective sample municipalities can be classified as comparatively positive overall. As early as the 1990s, *Länder*-level spatial planning in Lower Saxony and Rhineland-Palatinate contained specifications for the development of renewable energy sources. Moreover, state-level guidelines for municipal economic activity relating to the energy sector tend to have rather broad-ranging definitions in all three sample municipalities; this is advantageous for the expansion of renewable energy plants operated by municipal companies.

Economic Factors

In terms of economic framework conditions, literature on environmental policy assumes, on the one hand, that a dedicated policy of climate protection requires a positive municipal budgetary situation.[87] On the other hand, high levels of unemployment are seen as a hindrance to making environmental improvements, and tend to lead to less attention being given to environmental concerns.[88] Based on the three case studies presented here, these two literature-based hypotheses must be rejected, at least with regard to the issue of local renewable energy expansion:

1. A positive municipal budgetary situation does not appear to be a necessary condition for a dedicated policy of renewable energy expansion. In this manner, the municipal development program for renewable energy, which is still in operation today, was initiated in Emden in the 1990s despite the presence of a budgetary crisis. Furthermore, the municipal energy company established a series of wind energy plants in the municipal area; these facilities generated

negative results until the implementation of the German Renewable Energy Act in 2000. Inversely, in Alzey-Land, it is the less wealthy boroughs that are particularly keen to generate additional income from wind energy. In this case, a more positive municipal budgetary situation could potentially hinder the continued expansion of renewable energy sources.

2. In comparison with national averages, both Emden and Prenzlau consistently have significantly higher levels of unemployment. However, the expansion of renewable energy infrastructure is seen in conjunction with the relocation of renewable energy businesses to the local area, thus being a key pillar of support for the local economy and a means to reduce unemployment levels.

Informational-Cognitive Factors

It is very difficult to measure the long-term collective experience of populations and individual local politicians in matters of energy policy. Admittedly, many of the interviewees stated that they perceived the local population to have a generally positive attitude toward the expansion of renewable energy. The nuclear catastrophes in Chernobyl and Fukushima, as well as the 1992 United Nations Conference in Rio de Janeiro, were all cited in the interviews as factors that consciously affected ways of thinking. In Emden, the assumption of a comparatively high environmental awareness is also supported by the numerous demonstrations held against the use of fossil fuels and nuclear energy (against the transport of nuclear waste, the construction of coal-fired power stations, and the Fukushima disaster). Current media headlines were influential in swaying policy in only one of the three case studies. This was when, shortly after the Fukushima catastrophe in 2011, the Emden town council agreed upon a previously controversial proposal to only use green electricity for all municipal buildings, traffic lights, and businesses.

Furthermore, a necessary condition for the implementation and integration of environmental policy is the awareness of local stakeholders regarding their own room to maneuver.[89] The broad spectrum of measures being implemented in both Emden and Prenzlau demonstrate a high level of awareness for their scope of action. In addition, the interviews also reveal that there is extensive knowledge of the remaining possible courses of action. However, alongside some other measures in Alzey-Land, there is a strong focus placed on the designation of land for wind energy use, such that other possible courses of action are barely given any attention.

Actor-Related Factors

The constellation of actors differs vastly between the three municipalities investigated. In both Emden and Prenzlau, the respective mayors, municipal utilities, and local renewable energy companies were driving forces behind the turnaround in energy policy, while political parties and the administration both played a predominantly supportive role. There stakeholders all share the deep core belief that (1) climate change represents a threat renewable energy can mitigate, and (2) the development of the local economy and the creation of jobs is to be a main priority. At most, differences between the stakeholders emerge in response to individual questions (secondary aspects)—an example of this is the variety of ways in which different stakeholders assessed specific wind energy projects in Emden. Opponents of expanding renewable energy use cannot be identified in Emden or Prenzlau.

However, in Alzey-Land, there are two distinct advocacy coalitions that are diametrically opposed in terms of their stance on wind energy. Here, the pro-wind energy coalition is firmly established and indicates a similar belief system to the pro-renewable energy coalitions in Emden and Prenzlau. However, secondary aspects splinter the coalition internally. The dominating trend within the coalition advocates a concentration of wind farms governed by regional planning, while the environmental associations *Bund für Umwelt and Naturschutz Deutschland* (BUND; Friends of the Earth) and *Naturschutzbund Deutschland* (Nature and Biodiversity Conservation Union; NABU) want to give bird protection a higher priority. Although these do certainly view certain wind power projects as critical due to their effects on bird protection, they are not against the expansion of wind power in general. Other individual stakeholders place heavy emphasis on the local autonomy of individual communities with respect to location decisions. The anti-wind energy coalition comprises only a few stakeholders, and the core belief of this coalition questions the reality of climate change, and holds that interested parties are heavily exaggerating its potential risks. This inability of opposition coalition groups to form an alliance contributes to the domination of the pro-wind energy coalition in Alzey-Land.

In an overall look at the three case studies, it can also be seen that the local groups of various environmental associations are often seen to be more skeptical opponents of specific local renewable energy projects than would be expected, based on the proactive behavior of the same associations with respect to renewable energy policy at the national level.

This apparent contradiction can be explained by the fact that, at the municipal level, it becomes an issue of a specific location, where, for example, wind energy use may conflict with protection of birds. In this respect, the case studies confirm the conclusions drawn by Reiche regarding this matter.[90]

Conclusion

The turnaround on German energy policy to accommodate more renewable energy sources (*Energiewende*) is one of the most important topics on the political agenda in Germany. The potential of *Länder* and municipalities to act in support of this policy turnaround is, to a great extent, dependent on the framework conditions established at national and EU levels. On the other hand, five modes of governance remain available to both *Länder* and municipalities: overarching measures, energy consumption of the public administration, regulation and planning, supply of services, and support and information. The use of each of these modes can act to address blind spots in the energy and climate policies of higher political levels, and to add increased momentum to these policies.[91]

By utilizing their existing possible courses of action, state governments and municipal councils can also capitalize on their comparative advantages over other political levels. For example, they are approachable to local citizens, businesses, and other regional organizations. Furthermore, they are also able to integrate different energy-related aspects with other fields of politics, such as the use of energy from renewable sources, energy efficiency, climate protection, transport, land use, and economic development.[92]

When looking at the relationship between *Länder* and municipalities and private stakeholders, it would seem that—in spite of the increasing importance of non-corporate stakeholders in the last 20 years—the former continue to be assigned the more important function in terms of renewable energy policy. Two points can demonstrate this. First, municipalities in particular—just like private actors—are able to participate in market action, both as environmentally conscious energy consumers and as energy producers and suppliers who place an emphasis on the expansion of renewable energy sources. Second, *Länder* governments and municipal councils fulfill multiple tasks that could scarcely be delegated to private actors, such as regional and urban land-use planning and regulatory appointments, as well as the setting of targets for renewable energy expansion. However, they do not always make full use of their potential to take action.[93] Additionally, problem-related, political, economic, cognitive, and actor-related factors influence the promotion of the transition to renewables.

It can be assumed that both *Länder* and municipalities will continue to play a key role in terms of the future organization of the *Energiewende*. In particular, the construction of further renewable energy facilities and the expansion of energy grids will be necessary as part of the turnaround in German energy policy. In so doing, it is important that *Länder* and municipalities promote acceptance throughout the necessary site-specific planning procedures within the context of state, regional, and urban land use planning. Sub-national stakeholders also play a central role in the renovation of existing buildings. The achievement of these enormous possible energy savings is dependent upon the willingness of millions of decision-makers to invest in renewable energy. As has been shown here, *Länder* and municipalities can boost this willingness to invest by using a number of measures including acting as a model with their own administrative buildings, implementing their own development programs, and providing consultancy services.

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3

Critical Junctures and the German *Energiewende*

Christoph H. Stefes

Introduction

In June 2011, the *Bundestag* and *Bundesrat* (the lower and upper houses of parliament, respectively) passed a comprehensive legislative package, including 120 individual measures, to wean Germany's energy system from its heavy reliance on fossil and nuclear fuels. This energy package implemented a strategic plan to promote renewable energy and energy efficiency that the federal government had published a year earlier. The energy package sets one primary goal and includes related measures to achieve this goal. Germany intends to reduce its greenhouse gas emissions by 40 percent by 2020 and 80–95 percent by 2050 (compared to 1990). It attempts to do so by rapidly increasing the use of renewable energy, which is supposed to cover 80 percent of electricity consumption and 60 percent of total energy consumption by 2050, reducing primary energy consumption by half by 2050 or earlier (compared to 2008) through increased energy efficiency, eliminating the need for heating in homes by modernizing the insulation of old buildings and imposing stricter insulation standards on new homes, and reducing the final energy consumption in the transport sector by 40 percent by 2050 or earlier (compared to

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2005).[1] To achieve these goals, Germany will have to overhaul its energy system with far-reaching consequences for many related policy areas, such as social policy, agriculture, transportation, education, and even foreign and defense policy. It is a formidable challenge that is easily comparable to the introduction of the German welfare system under Chancellor Otto von Bismarck in the nineteenth century. Then, and now, Germany embarked on a journey into uncharted territory, while the world watched closely (and imitated later).

Since its enactment, the energy package has been labeled Germany's *Energiewende* (energy transition), a term first mentioned in a 1980 study commissioned by the Eco-Institute.[2] Looking at the pace at which *Energiewende* has become a staple name not only in German-speaking countries but also abroad, one might conclude that the German government had undertaken a revolutionary step with the passing of the 2011 energy package. Yet this would be an erroneous conclusion, ignoring the many steps that had already been taken since the 1970s. The massive extension of renewable energy, combined with a more efficient use of energy, is at the heart of the *Energiewende;* as the previous two chapters in this volume have shown, renewable energy and energy efficiency had already been promoted at the municipal and state level in the 1970s. At the federal level, the 1990 *Stromeinspeisungsgesetz* (StrEG; Feed-in Law) paved the way for the commercial introduction of renewable energy in the power sector. Through subsequent reforms of this law, and the introduction of supporting policies such as a tax on carbon fuels, renewable energy has increasingly gained a competitive edge in Germany's energy system, and the economic use of energy has been encouraged. Even the phase-out of nuclear energy that was included in the energy package of 2011 was not new, but was the return to a deal that was struck in 2000 between a previous government and the operators of Germany's nuclear power stations.

This chapter analyzes the steps that Germany's federal governments have undertaken to accomplish the *Energiewende*. It thereby focuses on the promotion of renewable energy. For German policymakers, renewable energy is central to the energy transition. It serves as a "pathway to achieve the environmental objectives of addressing climate change and phasing out nuclear power, as well as to bolster economic goals (promoting a new industry, creating jobs, and stimulating exports and trade) while enhancing security (reducing energy imports and diversifying supply)."[3] Adopting an analytical framework that is grounded in historical institutionalism and the work of John Kingdon, this chapter argues that the energy transition has proceeded in leaps and bounds, identifying three critical junctures that resulted in institutional changes, which have significantly shaped the German *Energiewende* since 1990: the passage of the StrEG, the passage of the *Erneuerbare-Energien-Gesetz* (EEG; Renewable Energy Act) in 2000, and the amendment to the EEG in 2014.[4] Whereas the StrEG and the EEG accelerated the decarbonization and decentralization of energy production in substantial ways, the recent EEG amendment is poised to slow down the *Energiewende*. It will also return control over the pace and direction of this transition back to the large utilities, the initial losers of the *Energiewende*.

The chapter is structured along these three critical junctures and subsequent institutional changes. After outlining the analytical framework, I proceed by explaining the emergence of the federal government as a key driver of the German *Energiewende* with the passing of the StrEG in 1990. I will then focus on the consolidation of the *Energiewende* through the enactment of the EEG ten years later and continue with an analysis of the recent reforms of the EEG in 2014. The chapter concludes with an assessment of the current state of Germany's energy transition in the wake of the 2014 EEG amendment. I thereby emphasize the achievements in the power sector, without ignoring the possibility that the amendment might roll back some of these accomplishments. Moreover, the chapter highlights the shortcomings in promoting renewable energy and energy efficiency in the transport and heating sectors.

Analytical Framework

One of the key tenets of historical institutionalism is the assumption that fundamental decisions taken in politics are rarely altered or reversed on a regular basis. Societies only infrequently diverge from paths that they have once chosen to take. For instance, countries rarely change back and forth between democratic and autocratic regimes, types of welfare systems do not change overnight, and electoral rules are rarely, if ever, altered in fundamental ways. The reason for this inertia is that political decisions are commonly embedded in sets of institutions. Douglass North defines institutions as "the rules of the game in a society or, more formally … the humanly devised constraints that shape human interaction. In consequence, they structure incentives in human exchange, whether political, social, or economic."[5] Institutions enable otherwise self-interested and opportunistic individuals to cooperate for mutual gains, by supplying "information relevant to the behavior of others, enforcement mechanisms for agreement, penalties for defection, and the like … [thereby] altering the expectations an actor has about the actions that others are likely to take in response to or simultaneously with his own actions."[6] Yet, some scholars argue that they not only reduce transaction costs that allow for collective action but also help individuals to interpret new situations and provide templates for appropriate responses to these situations. As rules and norms "sink in," they shape actors' identities and interests. Human behavior becomes a more or less automatic response to outside stimuli, which are filtered through dominant rules and norms that are specific to the settings.[7]

Historical institutionalism eclectically draws from both approaches to institutions. However, seeing "institutions as the developing products of struggle among unequal actors," it has a less sanguine perception of institutions.[8] Historical institutionalism does not assume power away, and by studying the historical evolution of institutions, it emphasizes the asymmetric distribution of power. Power begets power, and institutions thereby serve as catalysts. Winners impose their institutions, benefit from them, and use their newly gained resources to block later changes. In contrast, losers have to suffer the consequences—whether they grudgingly cooperate or doggedly boycott. Historical institutionalism, therefore, rejects the idea that losers slavishly follow rules and norms. Instead, losers are keenly aware of the detrimental consequences of institutions, bide their time, and eventually attempt to change the institutions whenever the opportunity arises. In response, winners are aware that they need to shore up "their" institutions.

Public policies are such institutions. Although the inclusion of policies seems unorthodox, as they appear easily alterable, Paul Pierson rightly points out that many policies are "remarkably durable." Moreover, "extensive policy arrangements fundamentally shape the incentives and resources of political actors."[9] Yet, as we all know, public policies change on occasion—and sometimes even fundamentally. How can we then explain rapid policy changes? While institutions often display considerable resilience, they are not immutable. Historical institutionalism offers an explanation for swift institutional alterations or even institutional collapse that is followed by the creation of new institutions from scratch. These rapid institutional transformations occur in times of crises, and are caused by exogenous shocks. The theory locates the genesis of new institutions, or at least the fundamental reshaping of existing institutions, in the wake of a "critical juncture," defined as follows:

> A situation in which the structural (…) influences on political action are significantly relaxed for a relatively short period, with two main consequences: the range of plausible choices open to powerful actors expands substantially and the consequences of their decisions for the outcome of interest are potentially much more momentous.[10]

These developments and shocks must change the interests, beliefs, and/or power resources of actors. Economic crises, wars, natural catastrophes, and so forth serve as examples of such monumental events.

The focus on critical junctures leaves us with "a discontinuous model of change in which enduring historical pathways are periodically punctuated by moments of agency and choice."[11] Yet most political analysts will point out that institutional breakdown and replacement are rare occurrences in Western industrialized countries, if not in most countries around the world. Moreover, linking diffuse exogenous shocks and developments to very concrete policy changes is unlikely to generate convincing explanations. By introducing insights from policy analysis, which focuses on policy windows and entrepreneurs, we might be able to arrive at a better understanding of the nature and effects of critical junctures in the policymaking process.

Policy windows are in many ways conceptual equivalents of critical junctures, as they are short and infrequent moments during which institutional and policy changes become feasible. They become feasible due to the emergence of pressing problems and political changes, such as the arrival of a new government or shifts in public opinion, which make policies attractive that had once been politically infeasible. It is therefore the coming together of problems and challenges, alternative and acceptable solutions, and political circumstances that generate the opportunity for institutional change. Yet, as Kingdon argues, these factors do not just come together by themselves: "Policy entrepreneurs play a major part in the coupling at the open policy windows, attaching solutions to problems, overcoming the constraints by redrafting proposals, and taking advantage of politically propitious events."[12]

These entrepreneurs are crucial in designing new institutions and building majorities for them. Moreover, policy entrepreneurs provide political support for institutions by fomenting positive feedback as well as building new institutions and linking them to existing institutions in mutually supportive ways. Yet, policy entrepreneurs also stand on the opposite side of the fence. Political losers do not just wither away, but will use any opportunity to reverse the outcome of the last political struggle. In doing so, they might use gaps between the institutional rules and their enforcement. They encourage the reinterpretation of existing rules, layer new rules on top of existing institutions, and prevent the adjustment of existing institutions to changing circumstances, leading to institutional drift. Their action might be able to undermine the effectiveness of institutions and policies in ways that enable new majorities to emerge that demand the abolition or at least fundamental reform of existing institutions and policies. In other words, institutional change is caused by exogenous shocks, but also by more incremental changes that are endogenous to institutions. These incremental changes might create an opportunity for path-breaking institutional changes. In reality, exogenous shocks and incremental endogenous changes often work hand in hand.[13]

The remainder of this chapter will show how and why critical junctures emerged and policy windows opened in ways that allowed for fundamental institutional changes that have transfigured the German energy system. The initial focus is thereby on those circumstances and policy entrepreneurs that made the passing of the StrEG and the EEG possible and thereby put Germany on the path of *Energiewende*. The focus switches later to the skeptics of the *Energiewende*, who, in more recent years, have skillfully used inherent and manufactured shortcomings of existing institutions to build momentum against the speed and direction of Germany's energy transition. This momentum led to the passing of the EEG amendment in 2014.

1990: Birth of the Energiewende at the Federal Level

For more than half a century, a powerful coalition of utilities, the *Bundesministerium für Wirtschaft* (BMWi, Federal Ministry for the Economy), Germany's energy-intensive industries (e.g., aluminum and chemical industry), and a phalanx of politicians controlled the German energy system. Formal and informal institutions sharply curtailed the entry for new players; new ideas were therefore unlikely to emerge. Germany's energy sector was on a seemingly unchangeable path that emphasized centralized energy production, using fossil and nuclear fuels.

The *Energiewirtschaftsgesetz* (Energy Sector Law) of 1935 entrusted private utilities to provide Germany's consumers with electricity and gas and granted the utilities the right to form regional monopolies. Following

World War II, (West) Germany upheld this privilege. Since the utilities also controlled the grid, the large utilities were effectively able to block the entry of potential competitors. Regulatory agencies regularly turned a blind eye toward the utilities' attempts to exploit their privileged market positions, allowing the utilities to harvest significant windfall profits. The utilities reinvested these profits by acquiring stakes in nuclear, coal, and gas companies, causing a vertical integration of fuel, generation, distribution, and commercialization in the energy sector.[14] By the 1960s, the utilities had conquered a commanding height in (West) Germany's economy.

Policymakers and state officials honored the utilities' strategic position by being sympathetic to their interests. The Ministry for the Economy was especially supportive of the utilities, irrespective of the political party that headed the ministry. To defend their interests on the political stage, the utilities coordinated their lobby efforts through their peak association, the *Verband der Elektrizitätswirtschaft* (VDEW, Association of the Electricity Industry).[15] Furthermore, they built strong networks with politicians and public officials at the municipal, state, and federal levels, sponsoring sports clubs and cultural centers, offering lucrative positions for these officials after their departure from public positions, and placing their own managers in influential government positions.[16] For instance, the Ministry for the Economy's revolving door for representatives of the utilities was notorious for the weak boundaries between economic interests and government organizations.

Given their powerful position in Germany's political and economic system, the utilities were able to prevent the passage of any bills that would have been detrimental to their interests. Until the 1980s, the utilities also had no serious political adversaries. This situation changed only with the rise of the Green Party and various environmental and anti-nuclear groups and movements. For obvious reasons, the utilities only played lip service to the promotion of renewable energy. They had heavily invested in nuclear and fossil fuel power stations, which allowed them to dominate the energy system. Renewable energy threatened to undermine their dominance. The utilities' political allies widely shared this attitude. For instance, during the 1980s, the Ministry for the Economy blocked proposals by the *Bundesministerium für Bildung und Forschung* (BMBF, Federal Ministry for Education and Research) to expand the research and development (R&D) budget for renewable energy technologies, which paled in comparison to the enormous subsidies that the nuclear and coal industries received. Moreover, the opponents adamantly refused the promotion of renewable energy through Feed-in Tariffs (FITs), fearing a loss of their regional monopolies through the growth of smaller and independent electricity producers. At that point, Denmark had already successfully experimented with FITs.

Against this backdrop, the calls for a transition to a decentralized, decarbonized, and denuclearized energy system seemed futile despite the fact these calls grew increasingly louder during the 1980s in the wake of the positive experiences that some municipalities had made with renewable energy (see Chap. 2 in this volume). Yet, against all odds, the StrEG was passed in the German federal parliament in 1990, enacted a year later, and defended against strong political and legal counter-attacks throughout the decade. To explain the introduction and survival of the StrEG, several long-term developments, shock events, skillful entrepreneurship of backbenchers in the German *Bundestag* and officials in the *Bundesministerium für Umwelt und Reaktorsicherheit* (BMU, Federal Ministry for the Environment and Nuclear Safety), and the availability of feasible policy alternatives should be considered.

Developments during the 1970s and 1980s put significant pressure on traditional energy sources. The oil crises severely hurt the economies of industrialized countries. Legal cases against subsidies for German coal production challenged another fossil fuel. In April 1986, the nuclear reactor in Chernobyl (USSR) exploded, providing a political boost to Germany's anti-nuclear movement. In addition, a strong environmental movement and the Green Party, which entered the *Bundestag* for the first time in 1983, placed global warming on the political agenda. In the late 1980s, the first proposals for FITs circulated in the federal parliament, sharply opposed by the Ministry for the Economy and the center-right parties of the Kohl government, the Christian Democrats (CDU/CSU) and the Free Democrats (FDP). Meanwhile, an unlikely coalition of parliamentary backbenchers in the *Bundestag* emerged. This coalition consisted of a handful of parliamentarians from the ruling CDU/CSU and from the two opposition parties, the Greens and the Social Democrats (SPD), who advocated for supporting smaller wind and hydro-power plants, taking the FIT system of Denmark as a blueprint. These policy entrepreneurs realized that they could not count on the Ministry for the Economy to support their cause. They, therefore, drafted the StrEG on their own and shored up political support for the bill among their fellow party members.[17]

Yet, without wanting to downplay the political skills of the parliamentarian backbenchers, the legal and political pressure that was placed on the conventional energy sources (and with it on the utilities and their allies) and the credible availability of an alternative energy source that had been put to the test at home and abroad were necessary conditions for the StrEG to pass. Moreover, contingency played a considerable role. As it turned out, the opponents of renewable energy were unprepared to put up a fight, as the utilities were preoccupied with taking over the East German energy system after the fall of the Berlin Wall. As a representative of one of the large utilities conceded in an interview with the author: "The StrEG was an accident. We simply did not see it coming."[18] Moreover, everyone involved on both sides of the aisle seemed to underestimate the impact that the StrEG might have. As the SPD parliamentarian Dietrich Sperling scoffed during the debate in the *Bundestag*: "We cannot assume that this little law which moves just about 50 million DM will contribute to environmental protection and unfold a noteworthy effect."[19] The law, therefore, encountered much less resistance than it would have just a few years prior to German reunification.

In fact, as Fig. 3.1 demonstrates, the StrEG had an appreciable, but nevertheless limited, effect on the expansion of renewable energy in Germany's energy system.

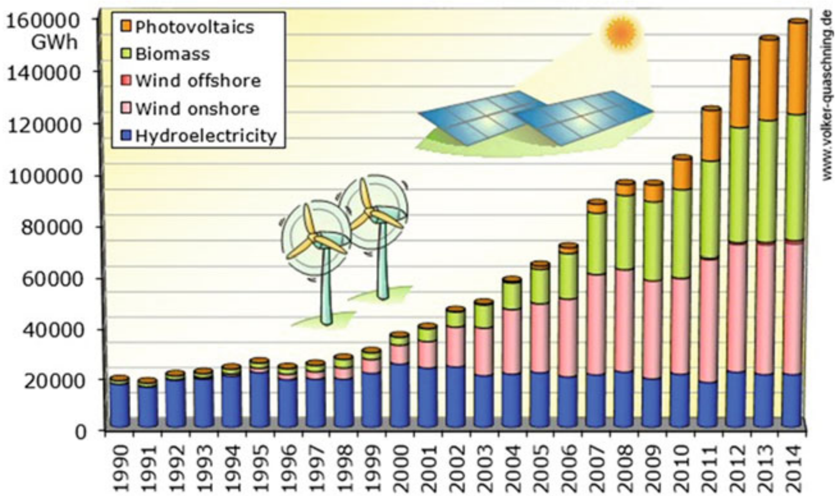

Fig. 3.1 Renewable electricity generation in Germany, Graphic 1 (*Source*: Quaschning 2015)

While the share of renewable energy in Germany's power sector doubled between 1990 and 2000, this expansion was almost exclusively a wind energy boom. Other renewable energy sources did not benefit enough from the rates set by the StrEG. Here, the states and municipalities were often lifesavers (see Chap. 3). Nevertheless, the growth of the wind sector led to falling prices for turbines due to technological learning and economies of scale. The profits were partially invested in R&D, and also in boosting the lobbying activities of the renewable energy sector.[20] The StrEG's biggest contribution to Germany's *Energiewende* was indeed the political momentum it created. The rapid growth of wind energy served as a bridgehead for other renewables. Renewable energy suddenly appeared to be a feasible alternative not only to some environmental activists in the Freiburg region (see Chap. 2), but also to the wider public. The StrEG thereby served as a rallying point for numerous previously unconnected groups that supported renewable energy for a wide variety of reasons: farmers who profited from wind and biogas installations, German engineering companies that invested in renewable technologies, church and environmental groups which fought against air pollution and greenhouse gas emissions, progressive labor unions, and politicians who had long blamed the utilities for abusing their privileges to undermine market mechanisms and democratic control.[21] BMU officials and parliamentarians encouraged these various groups to work together and coordinate their actions. They also nudged the various renewable energy associations toward a more unified stance, which early on resulted in the formation of the German Renewable Energy Federation, the peak association of the renewable energy sector.[22]

By the mid-1990s, the opponents of renewable energy realized their failure and pushed back. Speaking for energy-intensive industries such as aluminum and chemicals, the powerful Federation of German Industries warned that the StrEG could contribute to rising energy prices, undercutting the competiveness of German export industries. The Association of the Electricity Industry openly questioned whether the StrEG was a hidden state subsidy, and therefore in violation of EU treaties—an argument that convinced the European Commission's Directorate General for Competition to initiate proceedings against the StrEG. Utilities sponsored local citizen initiatives against wind turbines and supplied journalists with ammunition, leading to the appearance of numerous articles critical of renewable energy.[23] Finally, the Ministry for the Economy started to demand a thorough revision of the StrEG, with significant rate cuts. As Germany was heading toward a deep economic recession, these efforts could have well succeeded, taking into account that environmental concerns took a backseat in political debates at the time.

In response, policy entrepreneurs employed their arsenal in defense of the StrEG. For instance, the Ministry for the Environment financed a public campaign in defense of renewable energy, and it used its allies in the European Commission to counter DG Competition.[24] In 1996, the ministry had already succeeded in amending the Federal Building Law, limiting the power of local opposition groups to block new renewable energy installations. The following year, large demonstrations were organized in support of renewable energy across Germany. Renewable energy associations also hired lawyers to defend the StrEG in ensuing cases in German and European courts. In the end, renewable energy's policy entrepreneurs successfully protected the StrEG. In the 1997 Act on the Reform of the Energy Sector, the Ministry for the Economy was only able to introduce a 10 ten percent cap on the amount of renewable energy that an individual utility had to feed into the grid. Any proposals for tariff cuts were taken back. Moreover, all legal suits failed, as national courts and the European Court of Justice struck down the argument that the StrEG presented an illegal state subsidy.[25]

Yet, despite these political victories, the StrEG had reached an impasse by the late 1990s. The liberalization of Europe's energy markets led to cutthroat competition and a wave of hostile takeovers in the energy sector, causing a steep decline in energy prices. Since the remuneration for renewable energy under the StrEG was tied to consumer prices, owners of renewable energy installations saw a decline in their profit margins. Moreover, the ten percent cap artificially stopped a further expansion of affordable wind energy in the northern parts of Germany that benefitted from strong winds. Finally, the StrEG had failed to give a boost to the more expensive renewable energy technologies that more or less teetered on the brink of extinction.[26] It therefore needed a second critical juncture to reform the German FIT system, cement the path toward a sustainable energy system, and accelerate the pace of the *Energiewende*.

2000: Accelerating and Consolidating the Energiewende

On September 27, 1998, the center-right government of Chancellor Helmut Kohl, which had governed Germany for 16 years, lost the parliamentary elections to an SPD–Green alliance, led by Gerhard Schröder. In the coalition treaty, the new government made the expansion of renewable energy a priority. It set clear and, at the time, ambitious targets for increasing the share of renewable energy in the power sector (50 percent by 2050). To implement the coalition agreement, it needed the government to draft a bill. In Germany, the ministries draft the vast majority of bills, as they have the staff and expertise to do so. Yet, as in 1990, the Ministry for the Economy, now controlled by the SPD (previously by the FDP), dragged its feet and refused to work on reforming the StrEG. In response, as in 1990, a handful of parliamentarians of the governing coalition single-handedly rewrote the StrEG and garnered the political support to pass the EEG in 2000. Policy entrepreneurs, once again, exploited a window of opportunity that the first entry of the Green Party as a coalition partner in the German government had opened.

The EEG built on the StrEG, but it also considerably improved the investment climate for renewable energy. For instance, it removed all caps and set guaranteed rates for renewable energy sources for 20 years that were considerably higher for non-wind technologies, such as solar and biogas, in order to promote the development of these more expensive energy sources. It also ensured that the costs would be evenly spread across all utilities. The EEG was thereby able to jumpstart the expansion of renewable energy, which had suffered during the late 1990s due to ongoing legal battles in European and German courts (see Fig. 3.1). The EEG also included periodic adjustments of the rates to account for technological advancements that reduce production costs. Reducing the rates periodically has in turn encouraged these technological developments.[27]

Since 2002, electricity has been directly marketed and traded on the European Energy Exchange, with consequences for the compensation scheme under the EEG. The initial investment funds for renewable energy are relatively high, but the maintenance costs are very low (no fuel costs and carbon taxes). Moreover, utilities are required to give priority to the buying and selling of renewable energy. Renewable energy has, therefore, pushed down the costs of electricity on the spot market of the European Energy Exchange, thereby driving out the more expensive fossil and nuclear fuels. In 2000, the *EEG Umlage* (EEG surcharge) was introduced. The surcharge is added to the electricity bill, and its proceeds go to the producers of renewable energy to compensate for the difference between the rates that the EEG guarantees and the much lower revenues achieved at the European Energy Exchange.

As several interviewees emphasized, prior experiences with the FIT regime through the StrEG proved crucial in getting the EEG on paper and in winning the support of the ruling coalition. Without the StrEG, the EEG would have been much less ambitious, and probably less successful.[28] The EEG cemented the already chosen path, but it also accelerated the pace of the energy transition. In addition to the EEG, the new government raised taxes on energy consumption (*Ökologische Steuerreform*), further leveling the playing field in the energy market. Moreover, by negotiating a nuclear phase-out with the utilities, the government increased the importance of renewable energy as a key alternative. In fact, the unexpected pace at which renewable energy had entered the energy market made the nuclear phase-out feasible in the first place. It was clear that Germany would have had to violate its obligations under the Kyoto Treaty had it decided to replace nuclear energy with fossil fuels instead of renewable energy. Kyoto enjoyed widespread support among German voters. Violating Kyoto would have therefore come with significant political costs.

The new government also got serious about the other side of the coin of the German *Energiewende*. It was clear from the start that Germany could only achieve its ambitious renewable energy goals if consumers were using less energy despite a growing economy. It therefore needed massive investments to promote energy efficiency. The government launched several new programs to increase energy efficiency in the heating and transport sectors. For instance, in 2003, massive subsidies for biofuels were passed.[29]

By the time the SPD–Green government was replaced by a CDU/CSU–SPD coalition in 2005, it appeared that Germany's energy transition was well consolidated. Even the return to a government of the fiercest critic of the FIT system, the FDP, in 2009 did not trigger any greater concerns about the direction and path of the *Energiewende*. Several reasons provided confidence that Germany would continue on its path. First, the renewable energy sector had become a major growth and job engine in Germany. Between 2004 and 2013, employment in the renewable energy sector nearly doubled. In 2013, the renewable energy sector employed close to 380,000 workers, and German renewable energy companies had a turnover of almost 23 billion euros.[30] Since most renewable energy plants are installed in rural areas, the sector is often the biggest source of taxes and employment in impoverished regions of East Germany. East German states as well as states in Northern Germany with large wind energy potentials have, therefore, been staunch supporters of the *Energiewende*. Even the conservative states of the South (Bavaria and Baden-Württemberg) have supported renewable energy as they disproportionately benefit from the EEG surcharge. Renewable energy is also a major player in Germany's export sector, and through the creation of the *Deutsche Energie-Agentur* (DENA, German Energy Agency), the government has actively promoted the export of renewable energy technologies.

Second, the economic importance of the renewable energy sector has spilled over into the political arena, shifting the balance of power toward renewable energy advocates. Today, the trade associations of the renewable energy sector employ dozens of well-trained lobbyists. Tight networks between these trade associations, green think tanks, state officials, and members of various parties have been established. These connections have helped renewable energy advocates make political inroads. Third, in 2002, the political authority over the renewable energy sector switched from the Ministry for the Economy to the Ministry for the Environment, and thereby from a ministry that had been a lukewarm supporter of the *Energiewende* to a staunch advocate of Germany's energy transition. The Green-led Ministry for the Environment used this opportunity to expand its expertise and hire numerous renewable energy specialists. It was thereby able to decisively shape the periodic revisions of the EEG. The ministry also forced its way into the energy summits that are irregularly convened by the Chancellery and brought with it representatives of the renewable energy sector. It thus opened the last bastion of the traditional energy sector.[31]

Fourth, while the proponents of renewable energy grew in number and strength, the skeptics of the *Energiewende* weakened, losing important allies. While the FDP and the Ministry for the Economy as well as the utilities and the energy-intensive industries remained highly critical, many industries (and banks) had become heavily invested in the renewable energy sector. In turn, trade associations had become more sympathetic to the energy transition. For instance, the powerful Federation of German Industries took a neutral position on renewable energy.[32] Moreover, the liberalization of the European energy market undermined the privileged position of the utilities, which were forced to disentangle their various areas of operations.

Finally, the same veto points that had once shielded the traditional energy sector seemed to protect the *Energiewende*, at least since the 2000s. For instance, at the energy summit of March 2013, the FDP-led Ministry for the Economy pushed for drastic and even retroactive cuts of the FITs laid down in the EEG. Yet, several German states loudly opposed and defeated the ministry's plans. Retroactive cuts were also unlikely to withstand legal scrutiny.

When the center-right government under Chancellor Angela Merkel decided in 2010 to delay the negotiated phase-out of nuclear power plants by 12 years on average, few analysts feared that this decision would derail the *Energiewende*. In any event, less than a year later, the Fukushima disaster and the subsequent political fallout forced the government to reverse its decision. Given an earlier than in 2010-envisioned nuclear phase-out, renewable energy and energy efficiency should have received considerable government support, taking into account that only renewables could have filled the void that nuclear power left without a massive increase in CO_2 emissions. In fact, for about a year, renewable energy enjoyed widespread support. Yet, the skeptics of Germany's energy transition soon gained the upper hand, pointing toward unresolved issues, including rising energy costs, that appeared in the wake of renewables' rapidly increasing share in Germany's energy portfolio.

2014: Putting the Brakes on the Energiewende

Twenty years after its initiation at the federal level, the massive opposition against the *Energiewende* has surprised many analysts, including this author.[33] It has become clear that its biggest losers—namely, the utilities and political allies—continue to mobilize against the energy transition and find support among those companies and citizens who are fearful that the energy transition might cause power outages, raise electricity prices, lead to a loss of competitiveness of German energy-intensive products (e.g., chemicals and aluminum), and stir local resistance against the installation of even bigger wind turbines and high-voltage power lines.

The 2014 amendment to the EEG will probably slow down the *Energiewende* and recentralize energy production. Already in 2012, the government set a cap for the total amount of solar energy it would eventually subsidize through the EEG (52 gigawatts [GW], almost double as that of the solar energy capacity in 2012). It thereby reintroduced limits that had been added to the StrEG in the 1990s, but were removed by the EEG in 2000. Moreover, it set a "soft" corridor for yearly solar energy growth by adjusting the rates—the faster the growth of newly installed solar energy constructions beyond a certain point, the lower the tariffs paid for the energy produced by these new constructions. In 2014, it introduced a similar measure for wind energy. The installation of new wind turbines is further put into jeopardy by returning the right to set the minimum distance between turbines and human settlements to the

German states. In 1996, the federal government had passed amendments to the Federal Building Law, prioritizing the installation of wind turbines over concerns of homeowners and landscape protectionists, overriding local and state concerns. The 2014 amendment allows state governments to limit the installation of new wind turbines. Bavaria has already taken advantage of this opportunity, sharply restricting the growth of onshore wind energy in this state.[34]

The German government attempts to steer the pace of the energy transition by manipulating the yearly growth of renewable energy through flexible rates—a renunciation of the fixed rates the EEG had introduced 14 years earlier. Inevitably, this measure decreases investors' confidence in the renewable energy market. The 2014 amendment further foresees that operators of renewable energy installations who produce renewable energy for their own consumption have to pay between 30 and 100 percent of the EEG surcharge, making it less attractive to invest in small installations (very small installation such as the common solar installations on family homes remain exempted though).

Even more damaging for small investors might be a new rule under the 2014 amendment that is likely to take effect in 2017 (after the completion of a pilot program). According to this rule, public tenders will determine the rates set for newly installed renewable energy installations, varying from energy source to energy source. The lowest bids will thereby determine the new rates (they only apply to new installations though). It is likely that the lowest bids will come from the operators of larger renewable energy installations (e.g., wind farms). This regulation will therefore favor big investors.[35] In 2012, farmers and private individuals owned almost half of the installed renewable energy capacity in the energy sector, thereby generating a lot of public support for the *Energiewende*. In sharp contrast, the largest four utilities owned just five percent.[36] The 2014 EEG amendment will most likely reverse this trend in ownership in favor of large utilities and investment banks.

Discouraging small investors is no accident. It is clear that the CDU/CSU–SPD government fully intends to pave the way for the return of large investors and utilities. For instance, the political foundation of the SPD, the Friedrich Ebert Foundation, explicitly states that the involvement of small investors in Germany's renewable energy transition would not be a priority, as their involvement would potentially be inefficient. The foundation therefore questions whether special incentives should be given to small investors to participate in the public tenders that will be rolled out in 2017.[37]

How do we explain the about-face in Germany's energy transition in the wake of and despite the Fukushima disaster? In 2014, various factors joined to create a favorable environment for the policy entrepreneurs of the coalition of the skeptics of *Energiewende*. These factors in several ways resulted from neglect of existing institutions and smaller institutional changes, called drift and layering.[38] To begin with, the move from centralized to decentralized energy production and the integration of an ever-increasing share of renewable energy pose complex economic and technological challenges. The *Energiewende* in the electricity sector necessitates a massive extension and upgrading of Germany's high-voltage grid system. It also requires the development of "smart grids" and energy-storage capacities to avoid creating massive overcapacities, which are currently needed to cope with the breakdown or sudden shutdown of large power stations. Despite the dominant narrative in public energy discourses, an energy system consisting of several sources of renewable energy is quite predictable. To make it better than the current system, however, it needs technological innovations to avoid the expensive idling of conventional power stations as backup sources of energy.

Experts and politicians have long known about these challenges. For instance, in 2005, the German Energy Agency published a widely read report that strongly urged the federal government to expand the grid system.[39] For administrative, political, and financial reasons, the German government has largely failed to heed the agency's advice. For instance, the federal government would have to overrule German state governments that are responsible for permitting high-voltage power lines. As a consequence, windy Northern Germany cannot absorb an overcapacity of renewable energy, turning wind turbines off, whereas industrial Southern Germany still relies on fossil fuels and nuclear power to keep the lights on.[40] Moreover, as domestic power lines are increasingly congested, renewable energy is diverted from Northern to Southern Germany via the technically inferior electricity grids of Germany's eastern neighbors. This in turn has created problems for the electricity systems of Poland and the Czech Republic, whose governments have already complained about this situation.[41]

Furthermore, since the increasing use of renewable energy drives out fossil fuels, utilities have begun to decommission power plants. However, since renewable energy is an intermittent source of energy, and sufficient storage capacities have not been developed yet, reserve capacity remains crucially important to maintain the integrity of the energy system and avoid blackouts. In response, the Ministry for the Economy passed the

Reservekraftwerksverordnung (Reserve Power Plant Act), requiring utilities to receive governmental approval before decommissioning power plants that are deemed strategic for securing continuous power supply. Yet, utilities have already introduced legal challenges against this legislation, which also appears to be economically inefficient. New business and market models are therefore inevitable to maintain reserve capacities for the foreseeable future. Supporters of the *Energiewende* currently contemplate a compensation scheme for utilities, paying them for maintaining critical power plants even when they are in stand-by mode.[42] However, as of today the federal government has largely failed to develop politically and legally feasible proposals.

In short, the *Energiewende* has suffered from drift—that is, institutional stasis in times of contextual change. Institutional adaptive measures are not taken even though the rapid growth of renewable energy necessitates such measures. Equally detrimental to Germany's energy transition has been institutional layering—the attempt to weaken institutional support through the creation of interdependent institutions that contradict or undermine the core institutions. In some cases, layering has reinforced the *Energiewende*. The thorough revision of the StrEG through the introduction of the EEG serves as the most telling example, but the institutional addition of the eco-tax and the change of the Federal Building Law in 1996 also deserve mentioning.

In other cases, however, layering has undermined and weakened the institutional structure of the German energy transition. Direct attacks on the EEG/StrEG have predictably failed, given the opposition of vested interests and the existence of numerous veto points in Germany's political system. The most recent and widely discussed attempt to thoroughly revise the EEG was the federal government's plan to introduce a ceiling on the EEG surcharge, freezing it at 5.28 cents per kilowatt-hour (kWh) until 2014, followed by a maximum annual increase of two and a half percent thereafter.[43] This ceiling would have put a very effective brake on the expansion of renewable energy in Germany without changing the EEG itself. In the end, the proposal died in the *Bundesrat*, as a coalition of German states in the East and those governed by a Red–Green coalition opposed it for economic and political reasons.

Yet, smaller institutional changes to the EEG have already had long-term detrimental effects, undermining popular support for the *Energiewende*. For instance, to protect the international competitiveness of Germany's energy-intensive industries, these industries have been exempted from the

EEG surcharge. They benefit from falling energy prices at the European Energy Exchange due to the rapid expansion of renewable energy, but they do not pay their share for the energy transition. Moreover, the rules for exempting energy-intensive industries from paying the EEG surcharge have been increasingly loosened. Initially, only companies that competed in international marketplaces enjoyed the exemption. This stipulation was dropped, and the standard for determining whether a company is energy-intensive was lowered—from ten to one gigawatt-hours (GWh) per year. A decreasing number of companies, therefore, participate in sharing the costs of the *Energiewende*, putting the burden on smaller companies and private households, whose energy bills have increased.[44]

This situation of unequal burden sharing has an additional social component. Homeowners and farmers face higher electricity bills, but they also benefit from their solar panels, wind turbines, and biogas plants. Less affluent Germans, however, live in large apartment buildings that are not well suited for renewable energy installations (however, they are more efficient than single-family homes which expose them less to rising energy prices). Moreover, the lower income strata do not have the extra savings to invest in renewable energy funds. The *Energiewende* is therefore socially unbalanced, distributing income related to the energy transition from the bottom to the middle class and top. Opponents of the current energy transition have not missed this opportunity and criticize the EEG for being socially unjust and a job killer (due to rising energy costs).[45]

While Germans might still be willing to pay for a cleaner energy system, the expansion of renewable energy initially had the opposite effect—that is, CO_2 emissions increased, albeit only for a couple of years. This paradoxical development owes much to the temporary building of new coal power plants prior to 2011 due to low carbon prices. These low carbon prices are directly related to Germany's unconstructive responses to developments in the EU emission trading system. For the last few years, the price of certificates to emit greenhouse gases has plummeted because too many certificates were initially issued. Yet, until 2013, the German government repeatedly vetoed attempts by other EU member states to curb this inflation.[46] Dirty coal has, therefore, become cheaper than cleaner natural gas. When utilities decide to turn off power plants, they start with cleaner, but more expensive gas-powered plants. For instance, Europe's most modern and energy-efficient gas power plant, Irsching, is about to be decommissioned.[47] The trend toward more CO_2 emissions has recently been reversed. Yet, for the time being, it provided ample ammunition to the critics of the *Energiewende*.

All of these developments might have had a detrimental, but most likely just a marginal, impact on the pace of Germany's energy transition. However, two events provided the opportunity for much more radical change. Paul Hockenos, therefore, rightly speaks of a "critical juncture."[48] First, in 2013, authority over renewable energy was transferred back from the Ministry for the Environment to the Ministry for the Economy, now called the Ministry for Economic Affairs and Energy. While the Ministry for the Environment is still responsible for climate change policies, it is clear that the economic authorities are now in charge of the *Energiewende*. The same party, the SPD, heads both ministries. Yet, the political heavyweight Sigmar Gabriel, vice chancellor and SPD chairman, heads the Ministry for Economic Affairs and Energy, whereas the Ministry for the Environment is now run by Barbara Hendricks, a largely unknown political figure. The latter therefore takes a backseat, leaving the *Energiewende* to a ministry that has traditionally been skeptical of renewable energy and sympathetic to the interests of utilities and big business. However, the energy section of the ministry is now run by State Secretary Rainer Baake, a member of the Green Party, and strong proponent of renewable energy. It therefore remains to be seen which course Gabriel's ministry will take in the future.[49]

Second, in 2012 and 2013, the EEG surcharge increased rapidly for households and small businesses due to a variety of factors, including the explosive growth of solar energy before 2012, the need to balance the reserve fund for the EEG surcharge and increase liquidity of this fund, and the drop of energy prices at the European Energy Exchange. Despite falling wholesale prices at the European Energy Exchange, the EEG surcharge led to an increase in electricity prices for households and business that are not energy-intensive, stirring a heated political debate that lasted for months and provided ample room for the skeptics of the *Energiewende* to position themselves. It did not matter that most of the cost-driving factors were only of a temporary nature.[50] In fact, in 2015, the EEG surcharge has declined for the first time since its introduction.[51] It was also ignored in public discourses that, Germany's electricity consumers do not pay much more for electricity today, as a percentage of their income, than they did some 20 or 30 years ago. The *Energiewende* has become so complex that most citizens, and even officials, are unable to fully comprehend the technical and economic intricacies of the project. The proponents of the transition are therefore on the defensive, unable to provide simple arguments in support of the *Energiewende*.[52]

Under these circumstances, it was relatively easy for the Ministry for Economic Affairs and Energy to push through the EEG amendment of 2014. Minister Gabriel further profited from the tremendous pressure that the EU Commission had imposed on Germany. The Commission, under the leadership of Energy Commissioner Guenter Oettinger (a German national, staunch supporter of nuclear power, and skeptic of renewable energy), threatened to revoke special exemptions made to the EEG surcharge, which it considered an illegal state subsidy. Given the time pressure, neither the *Bundestag* nor *Bundesrat* had the time to carefully review the EEG amendment. Moreover, the German states were too intimidated by the threats made by Brussels to insist that the government revise the far-reaching changes laid down in the amendment. The most important veto point that in the past had protected the *Energiewende* was therefore neutralized and the Federal Ministry for the Economy and Energy prevailed.[53]

In short, small incremental institutional changes and political neglect, leading to institutional drift, created an environment ripe for a fundamental reform of the feed-in system. Policy entrepreneurs in the utilities, their associations and think tanks, and those in the economics ministry took advantage of this policy window to push through the 2014 amendment. Temporary pressure exerted by price hikes and the EU provided additional ammunition.

Conclusion

This study of renewable energy promotion at Germany's federal level has relied on an analytical framework that focuses on both institutional inertia and institutional change. Germany's *Energiewende* is remarkable insofar as largely unknown elected officials and public servants in the Ministry for the Environment contributed significantly to the expansion of renewable energy in the 1990s and the early 2000s. These policy entrepreneurs depended on the right conjuncture to emerge: the Chernobyl nuclear accident, growing concerns about climate change, legal challenges against coal subsidies, and the 1998 electoral victory of the SPD–Green coalition. In the end, they also benefited from happenstance—namely, Germany's reunification and the resulting lack of attention that key opponents of renewable energy spent on the introduction of the StrEG in the German

Bundestag. Yet, when the political climate was ripe, Germany's renewable energy advocates skillfully pushed through far-reaching institutional changes which led to a politically and economically reinforcing dynamic, paving the way for the *Energiewende*. Moreover, they marshaled various groups and interests in support of renewable energy when political and legal blowback threatened to reverse early achievements. One theoretical lesson that can be drawn from this case study is therefore that exogenous events do not automatically lead to change. A more careful analysis must focus on interests that take advantage of these events. Kingdon's concept of policy windows thereby adds insights to the concept of critical junctures.[54]

A further lesson that can be drawn is that political losers do not simply disappear or give up. And they do not have to wait for fortuitous circumstances to emerge and introduce far-reaching institutional reversals or changes. As renewable energy rapidly expanded in the German energy system, the *Energiewende* became vulnerable to political neglect, leading to institutional drift, and intentional and unintentional attempts to alter the institutional setup of the *Energiewende* at the margins—for instance, by exempting thousands of companies from the EEG surcharge and letting the price of CO_2 emission certificates drop. Institutional drift and layering would have slowed down the *Energiewende* on their own. Yet, more significantly, they opened a window of opportunity for policy entrepreneurs from the anti-*Energiewende* camp to push through more far-reaching institutional changes, the 2014 EEG amendments.

It is too early to tell whether the 2014 EEG amendments will significantly reduce the speed of the German energy transition. It is clear, though, that Germany needs more time to address the tremendous technical, economic, financial, and social challenges of the *Energiewende*. In this regard, the amendments might not be all bad news. Yet, putting large investors and the utilities back in the driver's seat must raise eyebrows. From the very beginning, the *Energiewende* has largely been a process that was driven from below, from environmentally conscious citizens, start-up companies, small investors, and environmental movements (see Chap. 2). This grassroots momentum has in many ways sustained the *Energiewende* through even the most difficult times. A recentralization of energy production exposes the transition to the whim of only a few powerful players with strong political connections.

Coming back to the goals the *Energiewende* is supposed to achieve, how well does Germany do in reaching those goals outlined in the Introduction of this chapter? There are few doubts that Germany will achieve its goals concerning the expansion of renewable energy in the energy market. Renewable energy will cover 80 percent of electricity consumption and probably even 60 percent of total energy consumption by 2050. Yet, it will fall short of the goal to reduce greenhouse gas emission by 40 percent by 2020. More likely is a reduction of around 32 percent. The reason is that, although economic growth and energy consumption have been largely unlinked, substantial progress in promoting energy efficiency is still lacking. Cutting primary energy consumption in half by 2050 or earlier is an elusive goal unless the government undertakes more far-reaching steps to promote energy efficiency and renewable energy, especially in the transport sector.[55] In short, much has been achieved. Yet, further steps are needed that will put Germans' willingness to make heavy investments in the energy transition to the test. It is not entirely clear whether the current political and economic climate is ripe for those steps. The federal government would have to assume a much more assertive role to accomplish the goals that were set in 2011. Taking into account that Germany serves as a role model for energy transitions around the world, it would be a major setback for the supporters of decarbonized and denuclearized energy systems if Germany derailed the *Energiewende* at this critical point.

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4

The German *Energiewende* in a European Context

Miranda A. Schreurs

Introduction

German energy and climate policies are influenced, supported, and constrained by neighboring states and the European Union (EU). As part of the EU, Germany must transpose European directives and conform to European regulations. Because of the large size of its economy, Germany also exerts a great deal of pressure on others through its domestic energy choices.

The German government's Energy and Climate Concept of 2010 set out plans for reducing greenhouse gas emissions. The targets are ambitious: to reduce greenhouse gas emissions by at least 40 percent by 2020, 55 percent by 2030, 70 percent by 2040, and 80–95 percent by 2050, relative to 1990 levels.[1] In addition, there are targets set out for final energy consumption, further broken down by sector (electricity, heating, and traffic), as well as energy-efficiency targets. These goals are to be achieved while at the same time phasing out nuclear energy by 2022. This means doing away with the majority of the country's coal-fired power plants and reducing reliance on oil. Natural gas is seen as a bridging technology in this plan, but eventually it, too, needs to be largely scaled back. This planned transformation is of a massive scale. It will require large-scale

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improvements in energy efficiency and large-scale expansion of renewable energy infrastructure, including on- and offshore-wind parks, rooftop and other solar installations, and biomass plants. There is also a strong need to increase electricity storage capacity and to extend and reinforce the electricity grid. Finally, energy efficiency improvements will be crucial.

Paralleling developments in Germany, Europe has set targets to achieve a 20 percent reduction in greenhouse gas emissions by 2020, 40 percent by 2030, and an aspirational 80–95 percent by 2050 (relative to 1990 levels). If Germany fails to achieve its reduction goals, there is little chance Europe will be able to meet its targets. The German and the European low-carbon energy transitions are deeply intertwined.

European economies have largely been driven by coal, oil, and natural gas. These energy sources, which made the technological transformation of the past century possible, are non-renewable. They have also contributed to many environmental and health problems, and are a major source of the greenhouse gas emissions contributing to climate change. For a variety of reasons, Europe is now putting a strong emphasis on environmental protection, climate policy, and resource efficiency. There is a fairly stable consensus in Europe about the importance of a low-carbon energy transition and in expanding renewable energy production. However, there is considerable debate regarding what role nuclear energy should play in a low-carbon world, as well as how to reduce dependence on coal. Germany, with its *Energiewende* (energy transition), is a central player in this process. As Germany is Europe's economic powerhouse, no energy transition in Europe is possible if Germany does not succeed in its own transition.

The challenge for Germany and Europe is in providing the right incentives and structures to make their energy transitions succeed. The transformations will require not only technological innovations and engineering solutions, but also an appropriate policy framework and public understanding and acceptance. This challenge is complicated by the different energy endowments, economic levels, industrial interests, and political coalitions in the different European states.

Factors Driving Germany and Europe's Low-Carbon Energy Transitions

A variety of factors are behind the push for Germany's and Europe's low-carbon energy transitions. One is that fossil fuel resources are non-renewable, which means that once they are consumed, they are no longer available for future use, including by future generations. There are, thus, many ethical questions associated with fossil fuel use.[2]

A second factor is linked to the question of resource scarcity. When supplies of oil, gas, and coal will be fully depleted is uncertain, and there have been many false predictions.[3] New technological developments are expanding our ability to extract fossil fuels from, for example, the Canadian tar sands, shale formations in the USA, and deep in the oceans off the coasts of Brazil, Norway as well as in the Mediterranean. Yet, these developments do not change the basic fact that these fossil fuel resources are limited and eventually will be diminished. As this occurs, they will become increasingly hard and expensive to extract. Moreover, European supplies of fossil fuels are limited. For the EU, which is the world's single largest energy importer, this is a matter of energy security. The EU was dependent on imports for 53.2 percent of the energy it consumed in 2013.[4] EU energy dependency is particularly high in relation to oil and natural gas. With growing demand for energy resources and minerals coming from emerging economies (e.g., China, India, South Africa, Brazil), expectations are that eventually energy prices will rise, hurting European economies if steps are not taken to diversify energy supplies.

A third and very important factor is climate change. The Intergovernmental Panel on Climate Change (IPCC) has once again warned in its scientific reports that the burning of fossil fuels and destruction of forests are contributing to warming of the atmosphere.[5] The warming of the planet will affect seasonal temperatures and rainfall patterns, turning some parts of the planet into desert-like regions and inundating other regions with rain. The melting of polar ice and glaciers could contribute to sea level rise, impacting coastlines and low-lying states. More severe storms, hurricanes, and periods of excessive heat and drought are also predicted. The survival of plant and animal species could be put at risk. Johan Rockström et al. have argued that humans can continue to prosper, but only if they find ways to respect planetary boundaries in relation to climate change, ocean acidification, stratospheric ozone, the biogeochemical nitrogen cycle, phosphorous, global freshwater use, and the rate of biological diversity loss. Exceeding any of these planetary boundaries could trigger non-linear, abrupt, environmental change of disastrous proportions.[6] Steffen et al. warn that four of the nine planetary boundaries they have identified have already been exceeded.[7]

Fourth, targets for the expansion of renewable energy sources and energy storage systems, as well as energy savings and energy-efficiency programs, can be sources of innovation. A transformation on the scale demanded by the German and European energy transitions will require innovations in most sectors. New economic and societal opportunities will be opened up. Innovative societies tend to be robust societies. The energy transitions are, thus, viewed as a way of developing a more sustainable economy, stimulating new industries and creating new jobs. They may also be a way to develop new societal living concepts.

Finally, there is a sense in Germany and in Europe that if Europe can lead the way and show that a low-carbon energy transition is possible, then others will follow. Germany accounts for more than two percent of global CO_2 emissions, and the EU about ten percent. These are significant amounts, but much smaller than emissions from China (more than 25 percent) or the USA (about 14.5 percent) in 2012.[8] The influence of Europe in the international climate negotiations is less than it was at the time of the Kyoto negotiations, when Europe accounted for a substantially larger share of global emissions (about 15 percent). As Europe's influence in the international negotiations declines, an alternative path to influence is through the power of example. There is considerable evidence that policies, ideas, and technologies can diffuse across countries in relatively short periods of time. This is visible in the spread of environment ministries, the growing number of countries with some form of renewable energy feed-in-tariff, and the growing interest globally in emission trading systems. Perhaps, the concept of lower carbon energy transitions will also follow the European lead.

Overcoming Path Dependencies for the Energy Transition

There are many barriers to overcome for a successful energy transition. Path dependencies remain strong. The oil, coal, and gas industries are entrenched and often have powerful backing from politicians and political parties dependent on their support. In many European countries, these industries are major employers, and workers are concerned about their jobs. For many decades, these industries have been supported by subsidies that have helped keep energy costs low.

Environmental groups and green parties are also not equally strong across Europe, weakening the ability of alternative visions to gain visibility. Environmental groups, local initiatives, and green parties have played crucial roles in promoting alternative forms of energy in many European countries. But in other countries, especially in the new member states that were formerly under the influence of socialist economic models, such alternative groups tend to be weak. Coalitions supporting renewable energies need to gain a foothold in order to start to bring about change.

As renewables have grown in some parts of Europe, so too have efforts to block their progress. Opposition comes from incumbent industries that fear competition, as well as from some communities opposed to the development of renewable energy infrastructure. In the less economically prosperous areas of Europe, there are often strong concerns about the costs of renewables even though prices of the technologies have dropped dramatically. These and many other challenges must be overcome if the German and European low-carbon energy transitions are to fulfill the ambitious targets that have been set.

Germany Within a European and Global Context

Germany is Europe's largest economy, accounting for about one-fifth of the EU's combined gross domestic product. This compares with about 15 percent each for France and Great Britain, 12 percent for Italy, and eight percent for Spain. Germany is also responsible for the largest share, about one-fifth (21 percent) of the EU's total CO_2 emissions (data for 2012). This compares with about 13 percent for Great Britain, 11 percent for France, ten percent for Italy, eight percent for Spain, and nine percent for Poland.[9] Germany has Europe's largest installed energy production capacity, and produces and consumes the most energy. Being the biggest source of greenhouse gas emissions in Europe, Germany's responsibility for reducing emissions is the largest. Within Europe, there are expectations that Germany will and should take the lead in transitioning to a low-carbon economy. There are, however, various views regarding the path Germany has chosen to pursue. While some are following similar paths, other countries feel threatened by Germany's approach, as it challenges key industries, for example, the nuclear and coal industries. Germany's energy shift is being watched by other European states. Success in fulfilling the goals of the energy transition could have positive spin-offs elsewhere in Europe; failure could slow similar efforts in other countries.

For cost, as well as international political, environmental, and climate protection reasons, German transition to a low-carbon energy system requires partners and cooperation with Europe, as well as with other regions of the world going through their own energy transitions, like California or Japan. Given the plans to stop using both nuclear energy and eventually most fossil fuels, the scale of the German energy transition is revolutionary. Winning other countries over to pursue similar transitions will require much cross-societal learning and exchange of experiences. It is a reason for the increasingly strong emphasis on climate and energy issues within Germany's foreign aid programs.

Energy Transitions Across Europe

It is not only Germany but also many European countries that have ambitious low-carbon energy transition plans. The Swedish Parliament decided in 2009 to meet 50 percent of its energy needs through renewables by 2020, a 40 percent greenhouse gas emission reduction by 2020 (compared to 1990), no use of fossil fuel heating in the housing sector by 2020, and to become a completely climate-neutral country by 2050.[10] Denmark has committed itself to a target of 30 percent renewables by 2030, to a further expansion of its already world-leading levels of bicycle use, and to be free of fossil fuel dependence by 2050. Norway plans to cut greenhouse gas emissions by 40 percent compared to 1990 levels by 2030. In the Netherlands, for the first time in the world, a citizens' group has successfully sued the government, forcing it to take on a more ambitious climate policy. In the Urgenda lawsuit, the court ruled in favor of the plaintiffs, who argued that the Dutch government was not fulfilling its responsibility to protect its citizens from climate change. The district court of the Hague ordered the Dutch government to reduce emissions by a minimum of 25 percent by 2020 compared to 1990 levels (compared with the 17 percent path that the country was on).[11]

Energy Structures in Europe

There are large differences in energy endowments across European states. Along with these differences come strong positions regarding various paths toward a low-carbon energy future. The interests of different energy sectors, the strength of environmental groups, and the composition of governing coalitions in European countries strongly influence their enthusiasm for, and engagement in, the energy transition.

Renewable energy has become a major energy source in Europe. The five largest producers of renewable energy are Germany, Italy, France, Spain, and Sweden. Renewables have a particularly high share in total energy consumption in Portugal, Denmark, Finland, Austria, Sweden, Latvia, and Norway.[12] Hydropower is one of the most important renewable energy sources. Norway covers all of its electricity as well as much of its heating from hydropower. With its abundant renewable energy supplies, Norway has also become a global leader in introducing electric automobiles on its streets. Other states in Europe, with substantial hydroelectric power generation, include Sweden, France, Austria, Italy, and Switzerland.

Onshore, and increasingly offshore, wind is also becoming increasingly important. Across much of coastal Europe as well as in wind-rich regions of Europe, wind parks have become a common sight. Germany is Europe's leading producer of wind energy, followed by Spain, the UK, France, Italy, and Portugal. By the end of 2014, installed capacity was enough to produce about ten percent of European electricity consumption.[13]

Photovoltaic (PV) capacity is also expanding. Residential PV systems have dropped in price by approximately 70 percent, making the technology increasingly affordable. Here too, Germany leads in terms of installed capacity, both within Europe and globally. Other European countries with large installed capacities include Italy, France, the UK, Spain, and Belgium.[14] Investments in wind and PV electricity have been less strong in many central and eastern European countries.

Although Europe remains heavily dependent upon fossil fuels, a clear shift in the energy mix is becoming visible over time. In 2013, renewables accounted for close to 15 percent of gross final energy consumption, and about 25 percent of gross electricity consumption. This compares with only 11.9 percent in 1990 and 13.8 percent in 2000.

Europe is starkly divided on the question of nuclear energy's future. Nuclear power accounts for more than 75 percent of electricity production in France. Under President François Hollande, France announced its plans to reduce the share of nuclear power in the energy mix to 50 percent, but there is no discussion at the highest government levels of phasing out nuclear energy. Other European states deriving more than 50 percent of their electricity from nuclear energy include Slovakia and Hungary, and between 30 and 50 percent include Belgium, Sweden, Switzerland, Slovenia, Czech Republic, Finland, and Bulgaria.[15]

In contrast, numerous European states have chosen to either not pursue conventional nuclear energy generation (Austria, Denmark, Greece, Ireland, Italy, Latvia, Liechtenstein, Luxembourg, Malta, Norway, and Portugal), or to phase out its use: Belgium (by 2025), Germany (by 2022), Spain (nuclear moratorium on new plants), and Switzerland (by 2034).[16]

Numerous countries are also expressing intentions to build new reactor units. The UK has announced plans to build a new reactor at Hinckley Point. Finland has a fifth plant under construction. Romania, Slovakia, Bulgaria, and Poland also have plans for new power plants.[17] Whether all of these plants will be realized is uncertain.

Fossil fuels are still very important to the economies of many European states. As one of the world's largest producers of oil and gas—almost all of which is targeted for export—Norway is in an unusual situation. Norway has invested much of its oil profits in a sovereign wealth fund to be used for the long-term benefit of its society. As owner of one of the largest investment funds in the world, the government came under great pressure to pursue more ethical investments. As a result, in 2015, the parliament voted to divest from coal companies worldwide. It has also chosen to divest from environmentally destructive palm oil operations.

For other less wealthy European countries heavily reliant on coal, a more defensive position has been taken. Poland has been a major voice in the push to protect coal jobs. It has demanded financial and technical assistance from the EU to improve the efficiency of, and to modernize, its coal companies.

Even in Germany, the phase-out of coal remains a divisive issue. An Enquete Commission set up by the Berlin state government to look into how Berlin can become a low-carbon economy by 2050 unanimously called for the state's divestment from lignite by 2025.[18] Other states in Germany, and especially North Rhine Westphalia, however, have fought to protect the jobs of coal miners. The Federal Government has tried to find a compromise with coal-rich regions, with a plan to put the oldest and dirtiest lignite-based power plants into a reserve power system.[19] The companies will be paid to maintain these power plants, which will only be operated on days when there is insufficient energy supply from renewables. Critics argue that this is an expensive and unnecessary subsidy to the coal companies.[20]

The Bi-lateral Context

Germany shares its borders with nine countries: Austria, Belgium, the Czech Republic, Denmark, France, Luxembourg, the Netherlands, Poland, and Switzerland. Germany imports and exports some electricity with these neighbors. Critics of the German *Energiewende* are quick to argue that one reason that Germany has been able to quickly expand its renewable energies is that it can turn to neighbors to import electricity on days when there is little electricity production from wind and solar. While there is some truth to this argument, Germany is by far Europe's largest net exporter of electricity. The expansion of renewables in Germany is leading to an export of electricity (coal-based and renewables-based) into neighboring countries. In total, Germany exported approximately 74.4 terawatt hours (TWh) of electricity, importing a much smaller 38.9 TWh.[21] In 2014, the largest consumers of German electricity were the Netherlands, Austria, Switzerland, and Poland. Germany imported the most from France, and smaller shares from the Czech Republic, Austria, Switzerland, Denmark, and Sweden.

There is good reason for greater coordination of efforts among European neighbors.[22] Germany is by no means the only European country in the midst of an energy transition, and many European states have a much higher share of renewable energy in their primary energy mix than does Germany. Austria, Sweden, and Norway, could, for example, be potential partners that could help store electricity produced from renewables in dams, making use of pumped hydro storage.[23]

To the extent that more electricity interconnectors are built between countries, the import and export of renewable energy will be facilitated. A challenge for the stability of electricity generation with renewables is that it is not available at all times; enhanced interconnectivity would facilitate the ability to balance the supply of, and demand for, renewables among different regions of Europe. When there is limited renewable energy available in Germany, for example, it might still be possible to import wind energy from Denmark, Great Britain, or Norway, or solar power from the south. Greater interconnectivity could also reduce the amount of renewable energy infrastructure that is needed, as the comparative renewable energy advantages of different countries could be better pooled. It makes more sense to have wind turbines located in regions that produce strong and steady wind, and PV energy in regions that have long hours of available sun. Greater interconnectivity would strengthen energy security. This is beginning to happen. New grid lines are under construction between Norway and Germany (as well as other European countries), so that Norway can act as a green battery for the continent, storing cheap electricity produced from renewables on windy or sunny days in its hydro dams, and exporting it at times of high demand.

Not all countries are happy about expanded electricity exchange, however. Poland, in particular, has complained about the large amounts of electricity from Germany traveling through its grid system, arguing that the system is not designed to handle such large shares of fluctuating renewable electricity. The complaints may, however, also be seen as an effort to protect Poland's domestic energy producers from German competition.[24]

The EU Context

The EU has a population of close to half a billion, a membership of 28 countries (as of 2015), and the world's largest market. Contrary to what one might expect, the political, economic, and geographic diversities that characterize the EU have not brought climate and low-carbon energy policymaking to a standstill, but, instead, have challenged policy makers to develop innovative strategies and skills for overcoming differences and sharing burdens.

Concern over global climate change owing to the accumulation of CO_2 and other greenhouse gases in the atmosphere has been quite strong in Europe, and has led to a search for effective means of reducing dependence on fossil fuels. Although the field of energy is still an area where states have substantial sovereignty, efforts at cooperation and harmonization have occurred in relation to greenhouse gas mitigation initiatives, renewable energy development, and the creation of a European energy market. Climate change has become one of the most important global environmental issues on the EU's agenda, and the EU has striven to be a global leader not only in the international climate change negotiations, where it has pushed for stronger targets, but also by the power of example.

Early efforts at a European approach to promoting energy transition include the 1997 European Commission's *White Paper: Energy for the Future: Renewable Sources of Energy*.[25] This was the first time that the European Community set a renewable energy goal: 12 percent of total energy consumption from renewables by 2010.

In 2001, following the implementation of renewable energy legislation in Germany, Spain, and Denmark, the European Community issued Directive 2001/77/EC with a goal to achieve 21 percent of the EU's electricity from renewable energy sources by 2010. Indicative targets were established for each EU member state.

In March 2007, the European Council endorsed a Commission communication that called for a 20 percent improvement in energy efficiency, 20 percent renewable energy in final energy consumption, a 20 percent reduction in greenhouse gas emissions by 2020 (relative to 1990 levels), as well as a ten percent target for energy from renewable sources in the transport sector.[26] The Parliament gave its consent at the end of 2008 to these "20-20-20 by 2020" goals.

The subsequent European Renewable Energy Directive 2009/28/EG, which replaced the earlier renewable directives, set national targets for each member state to contribute toward the European 20 percent renewable target in what is commonly called a burden-sharing agreement.[27] Member states' targets were determined on the basis of a formula that included a flat rate increase in renewables of 5.5 percent above their 2005 levels, and an additional increase based on per capita gross domestic product. Ten states took on renewable energy targets ranging from ten to 15 percent, 11 states took on targets of 16–25 percent, and six states took on targets of 30–49 percent. Germany took on a target to achieve 18 percent of its final energy consumption from renewables by 2020. The German target is lower than some other European states that have better renewable energy conditions, primarily those with large amounts of hydropower like Austria and Sweden. Europe is on track to meet the renewable energy target. A 2015 progress report found that 25 of 28 countries had met their 2013/2014 interim renewable energy targets, and that the projected share of renewable energy in gross final energy consumption was 15.3 percent for 2014. More challenging will be the target to achieve ten percent renewables in transport fuel. In 2014, the share stood at 5.7 percent.[28]

The 20 percent greenhouse gas emission reduction target is separated into targets for large industrial installations, which are covered by the EU's Emissions Trading System (ETS), and a separate target for non-ETS emissions, such as from buildings, transportation, agriculture, and smaller industries and installations. The non-ETS emissions are covered by an effort-sharing decision. The EU's ETS is expected to deliver a 21 percent reduction in emissions, and the non-ETS sectors are tasked with achieving a ten percent reduction relative to 2005 levels. Combined, this will amount to a reduction of 14 percent below 2005 levels, which is equal to a reduction 20 percent below 1990 levels. National targets cover the period 2013–2020. The richer states are expected to reduce their emissions the most, and the less well-off are allowed to increase their emissions. Denmark is expected to achieve a 20 percent cut, France and Germany a 14 percent cut, and the UK a 14 percent cut. In contrast, Romania can allow its emissions to increase by 19 percent, and Bulgaria by 20 percent.[29] Overall, the EU had reduced emissions by 19 percent compared to 1990 levels as of 2013, and thus had already, almost fulfilled its 2020 target.[30]

Where the EU has had more difficulty is with its energy efficiency target. To address this directive, 2012/27/EU was issued with the aim of strengthening EU energy efficiency efforts, including greater emphasis on renovation of buildings in order to improve their energy efficiency, energy-efficient purchasing by government agencies, establishment of indicative national energy efficiency targets, introduction of energy efficiency obligations, and metering requirements to enhance transparency for consumers related to their energy consumption.[31]

This EU directive has also had an influence in Germany. In December 2014, the German government passed additional far-reaching measures to enhance energy efficiency, including tax incentives for energy-related building renovations, energy efficiency programs for small- and middle-size companies, climate-friendly buildings and living practices, and the shut down of some coal-fired power plants.[32]

The 2015 Paris Climate Negotiations and the European 2030 Targets

New European targets for 2030 were set in October 2014, in preparation for the 21st Conference of the Parties to the Framework Convention on Climate Change, held in Paris in December 2015. The targets are a 40 percent greenhouse gas emission reduction relative to 1990, a renewable energy target of 27 percent of final energy consumption, and a minimum energy efficiency improvement target of 27 percent. Germany, France, and the UK had proposed a more ambitious climate target, but were met with strong opposition from Poland. Germany and France wanted a 40 percent minimum target, as this would have allowed the EU more flexibility in the Paris climate negotiations. The UK called for a 50 percent reduction target.

Poland threatened to use its veto in the European Council to oppose the setting of such ambitious greenhouse gas emission reduction targets, arguing that Europe was taking on too much of the global climate burden, and that its coal-dominated economy would be threatened by the changes. Poland demanded financial assistance for modernization in exchange for its support, as well as lower renewable energy and energy efficiency targets. Both Poland and Great Britain, for different reasons, were opposed to Germany's proposal of a 30 percent renewable energy target for Europe. Poland opposed it due to cost and the competition renewables pose to its coal industry. Great Britain opposed the German push for a higher renewables target because of their ambitions to invest further in nuclear energy at the Hinkley Point facility.[33] Thus, in the end, the EU settled on 40-27-27, rather than the higher targets wanted by some member states.

The 40 percent greenhouse gas emission reduction target is relative to 1990. As was the case with the 20 percent greenhouse gas emission reduction target for 2020, it is based on emission reductions that are to occur through the EU's ETS, and by reductions to be made from non-ETS sectors. Emissions covered by the ETS will be expected to be cut by 43 percent of 2005 levels by 2040.[34]

To date, no effort-sharing agreements have been reached among the member states to determine what a fair allocation of burden should be toward meeting the non-ETS emissions and renewable energy targets. Substantial compromise was needed to achieve the general targets; even more compromise will be needed when it comes to determining how much each member state is expected to contribute to the overall targets.

The EU Emissions Trading System

Emissions trading is considered a crucial instrument for meeting greenhouse gas emissions reduction goals. In October 2001, the European Commission proposed a greenhouse gas emissions trading scheme to the European Parliament and the European Council.[35] Modeled on the successful sulfur dioxide emissions trading system employed in the USA, the EU's ETS was the world's first and is still the largest international carbon emissions trading scheme. It came into effect in 2005 and covers the 28-member states of the EU, as well as Liechtenstein, Iceland, and Norway. It addresses more than 11,000 major emissions sources (e.g., utilities and manufacturing industries, such as the cement industry and the pulp and paper industry). The first phase of the ETS, which ran from 2005 to 2007, encountered serious problems stemming from an over allocation of emission allowances by individual member states to their industries. The number of allowances national governments issued during the second phase, which covered 2008–2012, was controlled more closely by the Commission. The third phase started in 2013 and lasts through 2020. It has introduced a single, EU-wide emissions cap as opposed to the national caps that existed during the second phase. In the past, allowances were provided freely, but now 40 percent of allowances are auctioned, with the percentage set to increase each year. Additional greenhouse gases (nitrous oxides and perfluorocarbons) are now also covered by the system.

A major and controversial expansion of the emissions trading scheme to cover emissions from airlines went into effect in 2012. Air transportation is a growing source of greenhouse gas emissions. The system applies to both domestic and international carriers. With this expansion, the EU's ETS covers about 45 percent of EU carbon emissions.[36]

A major challenge to the effectiveness of the EU's ETS has been the low price of a ton of carbon, which has reduced much of the expected incentive for emitters to reduce their emissions. This has been tied to the reality that too many carbon allowances were issued, making it relatively easy for industries to continue to pollute. As a result, further technical fixes to the EU's ETS have been made to try to improve its functioning. They include decisions regarding the timing of auctioning of allowances and the establishment of a Market Stability Reserve, which will adjust the supply of allowances to be auctioned starting in 2018. There are also calls for speeding the rate at which allowances are removed from the system, from the current 1.74 percent per year to 2.2 percent each year starting in 2021, when the fourth phase of the system begins.[37] Despite the many design flaws in the system, emissions from installations covered by the EU's ETS have been dropping such that the EU is likely to meet its 2020 target several years early.

Roadmap to a Resource-Efficient Europe

Economic transformation through resource efficiency has become an increasingly important guiding theme in the European context. This is also related to the energy transition, as consumption is tied to energy use. In 2011, the European Commission issued a roadmap outlining strategies for Europe to enhance resource efficiency in all fields. Critical to the initiative are the establishment of benchmarks and targets. Two types of indicators are being introduced. A Resource Productivity indicator will measure economic performance in relation to use of natural resources. Additional indicators will measure the EU's global consumption of resources, including water, land, materials, and carbon. Barriers to the efficient use of resources are to be identified and measures taken to remove those barriers. Consumers will be provided with information regarding the efficiency of products so that they can make more informed choices, and producers are to be incentivized to be more efficient. Waste will be considered a resource as opposed to an undesired end product, and subsidies that encourage inefficiency are to be removed.[38]

An Energy Union for Europe

Calls for an Energy Union have been growing with time. In 2011, the European Council focused attention on the importance of securing a safe, sustainable, and affordable energy supply that would also contribute to European competitiveness. It called for developing an interconnected and integrated internal energy market to allow the free movement of gas and electricity across the EU. The goal should be to "ensure that solidarity between Member States will become operational, that alternative supply/transit routes and sources of energy will materialize and that renewables will develop and compete with traditional sources."[39]

In February 2015, the European Commission set out a plan for a Resilient Energy Union with a Forward-Looking Climate Change Policy. This is intended to move forward plans for an Energy Union, which will create a more integrated energy structure and market in Europe. The current market is still primarily determined by national energy choices. Some steps to a more integrated market appear likely, but given strong concerns about sovereignty over energy decisions, there will be limits to how far markets will become more integrated.

The Commission's plan envisions new legislation to redesign the electricity market, ensuring more transparency in gas contracts, enhancing regional cooperation to enable a more integrated and better regulated energy market framework, new legislation to ensure the supply of electricity and gas, increased EU funding for energy efficiency, and a new renewables energy package, among other items. The plan also calls for establishing measures to assure the attainment of ten percent electricity interconnection by 2020.[40]

Conclusion

The German and the European energy transitions will entail significant costs. The transitions will not be easy, as the changes demanded implicate existing economic structures and routines, and affect so many interests. But a transformation to a low-carbon energy system could also bring with it many benefits and opportunities. A low-carbon energy transition can stimulate new technologies, new industries, alternative urban designs, better housing quality, and alternative lifestyles. Reducing dependency on fossil fuels for electricity production, heating and cooling, and transportation can improve air quality, thereby also cutting pollution-related health problems and costs. Higher energy efficiency and more renewables will make it possible to reduce dependency on energy imports and reduce the need for invasive extractive technologies. Shifting away from oil, hard coal, lignite, and natural gas will entail costs, but will also afford new approaches to economic development that are less environmentally destructive and more respecting of planetary boundaries. Germany and Europe aim to be global leaders in green energy technologies.

As the energy transitions in Germany and Europe progress, greater attention will need to be given to how to ensure their success. This will require greater coordination and planning. To date, much of the energy transition has been realized through grassroots and local innovation and initiatives. Such local creativity, flexibility, and competition should be encouraged, as without it, the energy transitions are likely to fail. At the same time, however, information exchange, dialogue, critique, support, and monitoring will be necessary to smooth a transition that will not always be easy and will certainly be expensive. Coordination of goals, plans, and instruments across states will be necessary to minimize redundancies and costs. A transformation on the scale being planned cannot happen without considerable learning, information exchange, and regulatory coordination among different levels of government. Finally, without greater attention to the concerns of the public and the fair distribution of costs and burdens, the energy transitions will meet opposition.[41] The governance challenges are significant, but the opportunities for Germany and Europe in pursuing low-carbon energy transitions are also great.

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5

Avoiding Transitions, Layering Change: The Evolution of American Energy Policy

Frank N. Laird

Introduction

American energy policy has gone through distinct phases. During the energy crisis of the 1970s, American policy makers created new laws, subsidies, and regulations intended to engineer a transition in the energy system away from oil. People spoke of a post-petroleum world, but also engaged in a vigorous and often bitter debate over what would come next. "Post-petroleum," after all, just tells you what will not be in the new system. During the 1980s, a resurgent conservative movement gained power and rejected efforts at government planning for the energy system, instead insisting on the benefits of the free market and the legacy energy industries; support for renewable energy sources fell dramatically. Since 1992, again spurred by problems with the oil supply and encouraged by policy makers and advocates concerned about global warming, the federal government created policies that aim to change some parts of the system. However, those policies have avoided any articulation of the shape and content of a new energy system, despite some vague rhetorical support for a new "clean energy economy" by a few political elites. The process has, instead, been one of incremental, and often erratic, change, which has led to the growth of one of the largest renewable

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energy industries in the world. In recent years, those incremental changes, at both the federal and state levels, have grown increasingly favorable to renewable energy.

In contrast to the German policy of *Energiewende* (energy transition), which is explicit about phasing out fossil fuels, American policy seeks to expand all energy sources, an "all of the above" strategy. Given the institutional blockages to large-scale policy change in the USA and the substantial power of veto players in the energy sector, change in American energy policy has come through layering new policies and new institutional rules on top of the existing system. Layering, and the avoidance of stating an explicit policy of seeking an energy transition, has led to significant growth of renewable energy in the USA, though less so than has been the case with the more ambitious policies of Germany. Layering enables renewable energy advocates to partially avoid conflict with the legacy energy industries, gives the American policy makers and firms the time to work on the myriad problems that an energy transition will entail, and provides them the opportunity to learn from Germany and similar countries as their more rapid transitions encounter those problems first.

Pushing for a Transition in the 1970s

The energy crisis of the 1970s was a textbook-focusing event or critical juncture, calling into question all of the political, social, and economic assumptions that had guided elite policymakers, the broader public, and the myriad institutions that provided the energy services that enabled modern technological society itself.[1]

In this atmosphere of crisis, when the existing system seemed irrevocably broken, the Nixon and Ford administrations pushed for organizational reforms and some new programs, but never advocated for a full-scale energy transition. It was the Carter administration, aided by outside analysts, that called for an energy transition and pushed through various reforms and laws aimed at creating and managing it. President Carter's ambitious effort failed to trigger a full-scale energy transition, though the laws and institutions it created did make subtle shifts in the framing, substance, and institutional capacities for energy policy. In addition, talk of a transition led to the deeply divisive question of the end-state of such a transition. What was the goal? Different groups in society had radically different answers to that question, which led to intense and acrimonious debates.

On June 4, 1971, more than two years before the 1973 oil embargo, President Richard Nixon sent Congress a Special Message on Energy Resources, proposing greater energy research and development (R&D), more energy production from federal lands, assorted other policies, and a new cabinet-level department that would centralize control over all federal natural resource policies, including energy.[2] Two years later, President Nixon's post-embargo energy initiative, completed under President Ford, was Project Independence, a large-scale interagency study that sought policies that could insulate the USA from the market influences of Organization of Petroleum Exporting Countries (OPEC). None of these initiatives aimed explicitly at a transition of the energy system. Instead, both presidents sought to increase production of traditional fuels or push for the next generation of existing technologies, like the fast breeder nuclear reactor.[3] In their view, the system needed incremental improvements, not wholesale change, and the overall goal was to preserve the social status quo with changes only at the margin.

It was, instead, the Carter administration that brought the concept and language of an energy transition into its policies and the official discourse about energy. Just a few months after he took office, President Carter made an "Address to the Nation on Energy."[4] Depicting America's energy situation as a dire crisis, he also put it into historical terms as the next energy transition, saying, "Twice in the last several hundred years, there has been a transition in the way people use energy …. Because we are now running out of gas and oil, we must prepare quickly for a third change—to strict conservation and the renewed use of coal and to permanent renewable energy sources like solar power." This transition language appeared again a few days later when the White House released its National Energy Plan, the study on which his address was based.[5] The National Energy Plan depicted two previous transitions, the decline of wood as a fuel when coal became popular and the decline of coal that accompanied the rise of petroleum and natural gas. His plan was based on the idea that the next transition was near.

President Carter emphasized publicly that the upcoming energy transition would be neither painless nor simple. The National Energy Plan was certainly not simple; it was based on ten principles and contained dozens of initiatives. Nonetheless, he stressed that the transition was also not a matter of choice, but that it was happening because of growing scarcity of oil and natural gas. The transition would inevitably happen, and government policy should therefore make it as smooth as possible and mitigate the worst consequences of it, leaving future generations better off.[6]

The plan put a heavy emphasis on conservation, stressing the need for the USA to be much more efficient in the way it uses energy. President Carter framed this part of his plan as the only path that could avoid disaster. Using a classic narrative of sin and redemption, he took Americans to task for their wasteful ways and insisted that only a profound shift in attitudes toward energy could save the USA from the disastrous consequences of its wasteful energy use, asserting, “Ours is the most wasteful nation on Earth. We waste more energy than we import. With about the same standard of living, we use twice as much energy per person as do other countries like Germany, Japan, and Sweden.” The looming geological shortages of oil and natural gas meant that the day of reckoning was near. “If we fail to act soon, we will face an economic, social, and political crisis that will threaten our free institutions. But we still have another choice. We can begin to prepare right now.”[7]

In arguing for this new energy ethos, President Carter was, to say the least, swimming against the currents of mainstream social and economic practice. Twentieth-century America was in every sense a creation of heavy and rapidly expanding energy use.[8] By the beginning of the Great Depression, three-quarters of American homes were wired for electricity, and firms like General Electric were busy selling consumers ever more goods to use that electricity. And of course there was the huge expansion of the automobile market led in the early part of the century by Henry Ford’s relentless efforts to make the Model T cheaper every year. Its price went from $850 in 1908 to $360 by 1916, and sales took off. “By the time of the Middletown study, in the 1920s, there was roughly one car for every five Americans, and an astonishing 78% of the cars in the world were in the United States. In France or Great Britain there was only one car for every 30 people, and in Germany only for every 102.”[9] After World War II, these trends only accelerated, with increased consumption of all kinds of fuels, especially oil, thanks to increases in the consumption of goods that used energy, especially cars. “The high-energy economy more than tripled family real income in less than 25 years [1947–70], and the public had no difficulty finding ways to spend it”. Nye cites the example of televisions, with Americans owning less than one million of them in 1949, ten million of them by 1951, and 42 million of them by 1958.[10] Thus, President Carter’s call for a transition to an energy system based on “strict conservation” went against deeply ingrained habits of mind, not to mention the basis of economic growth that had been in place for the entire twentieth century.

To implement the National Energy Plan, President Carter sent a package of legislation to Congress. Remarkably, the legislation passed the House of Representatives intact by August of 1977, thanks mainly to the strong support from Thomas P. O'Neill, then Speaker of the House. The Senate, however, was not willing to give the President what he wanted, due mainly to disagreements about policies on natural gas and energy taxes, and, during 1977, the two chambers could not iron out their differences. Nonetheless, by late 1978, the Congress was able to pass five important energy bills, put together as the National Energy Act of 1978.[11] These laws put a heavy emphasis on improving energy efficiency for automobiles, appliances, and government offices.

Two laws in particular in the National Energy Act created policies that would eventually prove important for supporting renewable energy.[12] First, the Public Utilities Regulatory Policies Act tried to compel utilities to buy more electricity from renewable energy independent power producers. Though only modestly successful, it laid the groundwork for later policies that have been important for the growth of the renewables industry and was, at a modest level, the forerunner of the feed-in tariff, a centrally important policy for the *Energiewende*.[13] Second, the Energy Tax Act used tax credits to subsidize renewable energy deployment, a subsidy fossil fuels had been getting for decades.[14] Those tax credits did expire in the 1980s, but came back in the 1990s.

All three presidents in the 1970s increased the federal research and development budget for renewable energy substantially, often with the Congress appropriating even more money than the administrations requested.[15] Though such research took considerable time to pay off, the investment of federal funds helped to provide a research base that would eventually contribute to lower prices for renewable energy technologies. Finally, all three administrations worked to create what eventually became the Department of Energy (DOE), which included an institutional champion for renewable energy, a division devoted to renewable energy, which had previously been an incidental feature of other agencies' missions.[16] Though DOE and its renewable division have had many critics, it is still an important development that a permanent and significant part of a cabinet agency seeks, as its standard operating procedure, to advance renewables. The federal government did not create DOE from scratch, but instead merged together other agencies and programs. This new renewable energy institution did not displace other institutions, but rather layered new rules, procedures, and norms on top of the old ones.[17]

This layering did not result in a new institution that could straightforwardly push the country toward a renewable energy economy, and eventually a complete energy transition. Several barriers stood in the way, not least the sheer size of the conventional energy system and, correspondingly, the size and resources of the firms that wanted to defend that system. An energy transition is, even in its simplest form, a stunningly difficult job, requiring investments in the trillions of dollars and the creation of new regulatory, financial, and social institutions.[18] Moreover, the renewable energy division of DOE was subservient to a higher-level set of rules and processes, such as the Secretary of Energy, the President and his staff, and the Congress. Thus, institutional actors had to maneuver within a nested, complex, sometimes contradictory, and often changing, set of rules and processes.

In addition to these more obvious problems, the experiences of the 1970s suggest two other barriers to an energy transition. First, the veto players are not just the firms in the fossil fuel industries, but in a sense every consumer in the USA. The 1970s made it clear that rapidly increasing prices and insecure supplies of energy are a politically explosive combination in the USA. President Carter started his term declaring that Americans would need to adjust to a world of strict conservation and higher energy prices, talking repeatedly of the sacrifices the energy transition would require. By the end of his term, he was, in contrast, proposing to sweep aside local objections and environmental concerns in order to speed up the siting of new energy facilities. Whatever they may have said to opinion pollsters, a large percentage of US citizens would resist losing the way of life that relied on cheap fossil fuels.[19]

The second problem is the politically contentious issue transition to what? Where will this transition take us? That question roiled debates among advocacy groups during the 1970s, and those debates became very heated, very quickly.[20] For example, Amory Lovins, then an energy analyst working for Friends of the Earth, published an article in the high-profile journal *Foreign Affairs* in October 1976, just before President Carter won the election.[21] The article made the case for an energy strategy that would be a sharp departure from the past and result in a very different energy system, one based on much greater energy efficiency and renewable energy. The article unleashed a firestorm of commentary, both supportive and critical. What was so striking about the critical responses to his article is that they often homed in on this question of the nature of a future society with a very different energy system, despite the fact that Lovins's article said relatively little about the social features of that final state and that he never said many of the things that his critics accused him of saying.[22] The fierceness of the debate showed that the transition of the energy system was inextricably linked to questions about the nature of a future society, making the debate intensely emotional and ideological. The discussion of Lovins's work reached the Congress in the form of a committee hearing in December 1976, and included testimony and written submissions from both sides that exceeded 2200 pages.[23] This controversy meant that when President Carter spoke of the need for an energy transition in early 1977, he was stepping into a heated debate that was as much social and political as it was technological and economic. With such fraught stakes on the line, it is surprising that President Carter and the Congress were able to agree on anything at all. It is not surprising that he was the first and last president to frame the issue in those terms.

Renewable Energy In, Energy Transition Out

For roughly a decade after President Carter left office, renewable energy was mostly off the official agenda and saw a sharp drop in federal government support. The Reagan Administration slashed the budgets for R&D and other renewable energy programs, and the fragile, embryonic renewable energy industry suffered as expected, with bankrupt firms and industry contraction. Oil prices plunged in the second half of the administration, which also did not help the market for renewables.[24] The only saving grace at the federal level was that President Reagan was not able to abolish the DOE, as he had pledged in his 1980 campaign and sought to do when he took office.[25] Talk of eliminating DOE was so pervasive that many employees assumed they would lose their jobs and "Even lobbyists no longer bother to talk to the department"[26] However, eliminating a Cabinet-level department requires an act of Congress, Members of both parties resisted Reagan's initiative, and the Department survived.[27] While this seemed like a rather minimal victory at the time, it meant that the government retained a set of institutional structures to support renewable energy, and a friendlier president and cooperative Congress could revive them.

In addition, the industry had a few successes in California and other small pockets around the country, mostly due to support from individual states. Though the solar heat and hot water industry declined sharply in the 1980s, sources of renewable electricity grew slowly, especially wood, waste, and geothermal power plants.[28] By 1989, the start of the George H.W. Bush administration, renewable sources provided 1.9 percent of US electricity, compared to 1.12 percent that they supplied in Germany. In terms of the actual kilowatt-hours (kWh), the USA produced more than ten times the renewable electricity than did Germany.[29]

The George H.W. Bush administration resurrected renewable energy policy on the agenda. On July 26, 1989, President Bush ordered the DOE to develop a "comprehensive National Energy Strategy." This lengthy process involved not only analysis within the government but also three rounds of hearings held all over the country, the release of white papers and early drafts, and the efforts involved in pulling all of this material together into a coherent document.[30] Before this policy development process was over, Iraq invaded Kuwait on August 2, 1990, setting in motion a US-led coalition that counter-attacked the Iraqi Army on January 16, 1991, and pushed it out of Kuwait, ending the war on February 28.[31] Given Kuwait's importance as an oil exporter, the Gulf War pushed the energy issue higher on the political agenda. West Texas Intermediate spot market crude oil prices had already increased to $24.50 in 1990, up from $15.97 just two years earlier, also helping energy rise on the agenda.[32]

While the war was still on, the Bush administration released its final National Energy Strategy report. On March 6, 1992, less than one week after the end of the war, President Bush sent bills based on the report to Congress. By that time, members of the House and Senate had introduced their own energy legislation, and a legislative battle ensued before the Congress finally passed the Comprehensive National Energy Policy Act (EPAct) of 1992 on October 24.[33]

Before EPAct 1992 even passed, President Bush signaled his administration's interest in renewable energy. The federal government's largest research center devoted to renewables was the Solar Energy Research Institute in Golden, Colorado, established under the Carter administration, and almost wiped out by the Reagan administration budget cuts in the early 1980s. President Bush elevated the research institute to the status of a national laboratory, renaming it the National Renewable Energy Laboratory. While the move was, in the short-term, symbolic, it suggested that the Bush administration took renewables more seriously than its predecessor and, contrary to Reagan's efforts to eliminate it, held the promise of greater funding for the lab in the future.[34]

The EPAct of 1992 was certainly not aimed at creating an energy transition, either in its stated intent or in the substance of its provisions.

At more than 358 pages, it had something for every fuel source. The final law did leave out some items that advocates wanted, such as opening up the Arctic National Wildlife Refuge for oil drilling, which the oil companies wanted, or increasing vehicle fuel efficiency standards, which the environmentalists wanted. Much of the bill focused on energy efficiency and electric utilities, and it also included several provisions to make the expansion of nuclear power easier.[35] This wide range in the bill gave it political popularity in the Congress. The House passed the final version by a vote of 363 to 60, and the Senate passed it by voice vote, a procedure the Senate uses when the outcome is not in question.[36]

As part of its wide range, the law contained provisions supporting renewable energy, the most important of which were tax credits for electricity from wind, biomass, solar, and geothermal facilities. The wind and biomass plants got a production tax credit for ten years of 1.5 cents per kWh that the facility produced, and the credit would increase with inflation. Solar and geothermal power plants could qualify for a ten percent investment tax credit.[37] Tax credits and deductions (referred to as tax expenditures) are very popular with American legislators as an indirect means of providing subsidies to a wide range of social activities. Tax expenditures impose a real cost to the government as revenues that the government does not collect due to the tax breaks. Nonetheless, they are less visible and carry less social stigma than direct subsidies. They are also easier to pass into law. For direct subsidies, the Congress needs to pass and the President needs to sign two separate laws, one that authorizes a program to spend money and another that actually appropriates the funds that the program can spend. Tax expenditures, in contrast, require only one law that makes changes to the tax code. The current federal budget lists 182 tax expenditures (often called "loopholes" in popular discourse) that vary in size, from a few million to hundreds of billions of dollars per year.[38]

The renewable energy tax credits have sometimes lapsed since 1992, but have mostly been in effect. The production tax credit cost the government an estimated $2.24 billion in fiscal year 2014 and the investment tax credit cost $1.87 billion that same year, for an indirect subsidy of $4.11 billion.[39] Analysts have highlighted their importance to the growth of the wind and solar industries in the USA, showing how those industries have greatly slowed down during years when the Congress let the tax credits lapse.[40] These tax credits may have been only one small section of a very big law, but they have channeled billions of dollars into deploying renewable energy in the USA.

The next major revision to energy laws came 13 years later under the next President Bush. The Energy Policy Act of 2005 was several years in the making, at 550 pages even longer than its 1992 predecessor, and just as sweeping. Like the 1992 version, this Act sought to promote every form of domestic energy, from fossil fuels to nuclear power to renewables. Renewable energy sources such as wind and solar got authorization for incentive payments, but no money to fund them, and also got some mandates for federal purchases of renewables.[41] The big winner in renewables was biofuels, as the Act provided a regulatory mandate that the nation's liquid fuel supply include 7.5 billion gallons of ethanol or biodiesel by 2012, more than double the volume in the previous year, in addition to tax credits for biofuels.[42] The final version passed by 74 to 26 in the Senate, and 275 to 156 in the House, large majorities, but not as overwhelming as the 1992 Act.[43]

Subsequent legislation renewed production and investment tax credits for wind and solar, but those credits have occasionally lapsed for a year.[44] The renewable energy industry continues to suffer from financial supports that are short-term, which makes planning difficult for the industry, in contrast to Germany, where policies are longer term and steadier.[45]

In addition to renewing the tax credits, the 2005 Energy Policy Act created a loan program within the DOE that makes loans and, especially, loan guarantees to energy projects, whether for manufacturing innovative energy technologies or deploying them. The Obama administration got legislation that continued and expanded that program.[46] In 2007, another law, the America COMPETES Act, authorized the creation of another program within the DOE, the Advanced Research Projects Agency-Energy (ARPA-E). Modeled on an agency in the Defense Department, ARPA-E supports applied research projects that the traditional research and development programs in the DOE were neglecting, with the intention of funding high-risk, but potentially high-payoff, projects. The program did not receive any funding until President Obama took office in 2009 and has continued to operate since, funding numerous projects for advanced renewable energy and energy storage systems.[47]

Despite the short-term renewals of these policies and, in some cases, inadequate funding of them, renewable production of electricity has grown steadily and is a multi-billion dollar industry in the USA, in part due to regulatory mandates at the state level. Between 1989 and 2013, non-hydro renewable sources quintupled their electricity generation, and just from 2004 to 2013, they more than tripled, from 83,068 to 253, 328 gigawatt-hours (GWh), and were on track to increase those totals again in 2014 (Fig. 5.1).[48]

As a percentage of total electricity supply, US renewables are well behind those in Germany, only 5.7 percent of the US total versus 20.8 percent of the German total in 2012.[49] Nonetheless, in terms of the absolute number of non-hydro renewable kWh produced, the USA produces almost twice as many as Germany does. Part of the reason for this progress in the USA is that the technologies are simply more mature now than they were in the 1970s, and so vastly less expensive. That decline in price is more than just a technology maturing over time. The global market for these technologies has been growing, thanks in part to aggressive German policies supporting their deployment, with price declines coming along with the increased volume of production. Talking about "the price" of wind or solar can be misleading, since the price of electricity from those sources varies by project due to the many site-specific variables. That said, in broad terms, the wholesale prices that wind developers have charged in power purchase agreements with utilities came down steadily between the 1980s and the early 2000s, rose after about 2004, and has declined again since about 2010. At the best sites, developers are selling wind electricity for about 2.5 cents per kWh (the developer also gets the tax credits of 1.5 cents per kWh, making the revenue about 4 cents), a very competitive price for electricity.[50] Similarly, prices for solar photovoltaic (PV) systems

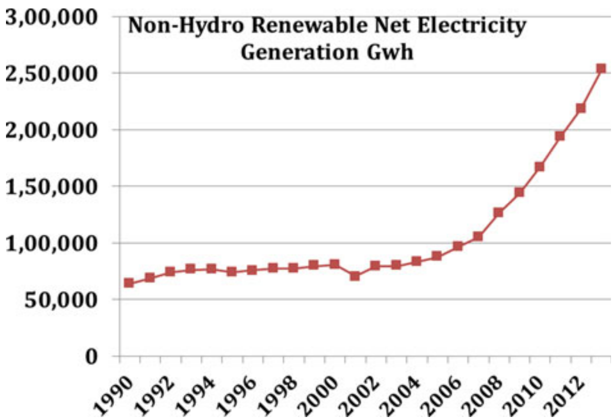

Fig. 5.1 Non-hydro net electricity generation GWh (*Source*: EIA (2015), Table 7.2a)

have dropped sharply in recent years, though electricity from that source is still more expensive than wind.[51]

This technological and economic progress of renewable energy in the USA is occurring in a policy context that makes no overt effort to engineer an energy transition. The US energy policy seeks to increase all forms of domestic energy production. Not only do energy laws exhibit this broad scope but official discourse about energy does as well.[52] President George W. Bush, at the beginning of his administration, ordered an energy policy study, led by his Vice-President, that set out the framing of his energy policy as the expansion of all forms of domestic energy.[53] The study, like so many before it, emphasized the need to expand energy production to preserve the American way of life, not to make a transition to some new one. The Obama administration took a similarly expansive view. President Obama stated repeatedly that his energy policy was an "all-of-the-above" approach, emphasizing all forms of energy. He used the phrase in several State of the Union addresses and in dozens of other speeches.[54]

However, a push to increase domestic oil and natural gas did not preclude promoting renewable energy. In many of his speeches, President Obama referred to the importance of promoting "clear energy" as the energy system of the future. Renewable energy got substantial resources in the stimulus plan of President Obama's first term, and he put it at the center of his notion of "clean energy."

> After decades of dragging our feet, this plan will finally spark the creation of a clean energy industry that will create hundreds of thousands of jobs over the next few years—manufacturing wind turbines and solar cells, for example—millions more after that. These jobs and these investments will double our capacity to generate renewable energy over the next few years.[55]

But President Obama used "clean energy" as an expansive term:

> In the near term, as we transition to cleaner energy sources, we're going to have to make some tough decisions about opening up new offshore areas for oil and gas development. We'll need to make continued investments in advanced biofuels and clean coal technologies, even as we build greater capacity in renewables like wind and solar. And we're going to have to build a new generation of safe, clean nuclear power plants in America.[56]

While President Obama promoted renewable energy, the new clean energy economy he talked about included many old energy sources. President Carter's transition discourse was nowhere to be seen.

Layering and the Possibility of an Energy Transition

The notion that massive fossil fuel systems provide the foundation for modern society has moved from axiom to cliché. But the idea is no less true for being overused. So smoothly and efficiently do these systems work that it is easy to forget how dauntingly complex and staggeringly large they are. That complexity and size mean that the actors and institutions that make up those legacy systems are massively powerful veto players. They could lose not only many hundreds of billions of dollars in revenues, but also their very identity, their reason for being. It would be remarkable if they did not resist a transition to other energy sources. But the barriers to change are even higher than those the legacy firms and their supporters in government would erect. Almost every single consumer is a veto player, which is where the cliché becomes concrete. High energy prices are, and have been for decades, political poison in the USA, and insecure access to energy even more so. Expensive and insecure energy can cause problems in many countries; by now, there are many fossil fuel-dependent societies in the world. But nowhere does this show up more starkly than in the USA, the quintessential high-energy society.[57] Cheap gasoline is not just an economic commodity, it is a birthright. Thus, the entire population of the country consists of veto players when it comes to engineering an energy transition, which tells us that any effort to make a wholesale replacement of the legacy fossil fuel systems would encounter fierce resistance. This broad-based social resistance to change is part of what provides the energy system with momentum, a feature that Thomas Hughes ascribed to all socio-technological systems.[58] The larger the system, the more momentum it possesses, and so the greater its resistance to change.

American consumers may be veto players, at least as they express their desires in their purchases, but they are complex in their attitudes toward energy. They buy fossil fuels but tell pollsters that they wish they could buy alternatives. Public opinion data have consistently shown support for renewable energy sources over fossil fuels and nuclear energy. In a series of polls conducted between 2002 and 2011, analysts asked Americans if they wanted to increase, decrease, or leave the same the use of various energy sources. Coal and oil came out at the bottom, with a large majority wanting to decrease their use. The public was evenly split over increasing or decreasing natural gas and nuclear power, but overwhelmingly favored increasing solar and wind energy use.[59] This apparent conflict between people's purchasing decisions and their responses to polling questions might seem to put policy makers in a bind; what does the American public actually want? But for politicians, ambiguity in public opinion can be an opportunity, one that gives them the flexibility to develop policies that are not focused on a clear and consistent goal, and therefore avoids the divisive issues that such clarity entails.[60] In the case of energy, policy makers can do much to support renewable energy as long as they do not unduly burden citizens' access to fossil fuels, a circumstance that lends itself well to layering.

Institutionalists have delineated layering as an approach to change when veto players loom large, a circumstance in which existing rules, norms, and processes are left in place and new ones are simply layered on top of the old, making the system more complicated, but nudging it incrementally in the direction of change.[61] The layering process depicts just what is going on with renewable energy policy in the USA. The existing rules and systems for fossil fuels are left in place. Not only are the technologies themselves left in place, but they operate within a social and political set of rules and norms that have changed only slightly in many years. Those rules can include everything from tax breaks to regulatory systems to financial networks. To be sure, that institutional stability is not completely rigid; over time, the tax breaks become more or less generous, or the regulations more or less stringent. But those changes do not change the system itself. Moreover, the discourse of an "all-of-the-above" energy strategy provides legitimacy for the legacy systems.

Layered on top of those systems are supports for renewable energy, as well as for greater energy efficiency. Government-funded R&D, loan guarantees, tax credits, and regulatory mandates provide opportunities and social legitimacy for renewable energy firms and consumers. The extent and timing with which these new energy sources can displace the legacy systems depend on a host of unpredictable factors, not least of which are the future developments of the technologies themselves and the social systems that enable their functioning. But despite these problems, the layering on of support for renewable energy leads to political and institutional developments that push the systems further toward change. As the industry grows larger, more firms and workers see it as their source of livelihood. In addition, new types of firms become involved in the industry, as with Google investing in Solar City, a firm that leases PV panels to homes and businesses.[62] Renewable energy even has the potential to be ideologically destabilizing. While much of the conflict in the Congress over it has become quite partisan, there is no reason renewable energy could not cut across party lines. As noted earlier, even conservative administrations at least support it rhetorically. At a basic ideological level, small government conservatives could embrace distributed renewables, something they used to do in the 1950s and 1960s, and in fact some conservative groups have recently started championing greater use of renewable energy.[63] The actual production of renewable-based electricity reinforces the idea that ideology need not confine these energy sources. As of 2014, California generated the most renewable electricity, no surprise politically. But the next four states, in order, were Texas (just barely behind California), Iowa, Oklahoma, and Kansas. Three out of these five are some of the most conservative states in the country. If we order the states based on renewable electricity per capita, the results are even more striking, with the top five states being North Dakota, Wyoming, Iowa, Kansas, and Maine.[64] North Dakota, Oklahoma, and Wyoming have large fossil fuel industries in addition to their conservative ideologies, but still manage to deploy renewable energy.

Despite those optimistic possibilities, the layering process in the USA is going slowly and has not yet (and may never) achieved a social and elite consensus on the need for an E*nergiewende* to renewable energy that one observes in Germany. As discussed elsewhere in this volume, even German policy makers have encountered some pushback from citizens due to high prices for electricity. But so far, policy elites in Germany remain committed to seeing the E*nergiewende* through and understand it to be a major sociotechnical transition as such.

Layering has its limits, and policy makers will need to solve numerous problems if the USA is to achieve a smooth and deliberate energy transition. An incremental approach can stretch out over time the huge costs of large-scale systems change, but it cannot eliminate them. The USA has seen a steady increase in renewable energy consumption, which rose from about 3.5 percent of total energy consumption in 1990 to about 6.9 percent in 2013, while at the same time the amount of energy it needs to generate a real dollar of GDP has dropped by more than a factor of two since 1970.[65] Despite those gains, renewables are still a small part of total energy consumption, and as they grow they will encounter new problems. The renewable energy sources with the largest ultimate resource base, wind and solar, are also intermittent, which means that cheap electricity storage, or some other dispatchable source of electricity, will, at some point, be important to enable them to keep expanding.

To complicate matters further, no government can comprehensively control a large-scale systems change. Unanticipated social and political problems, in addition to economic and technological ones, are certain to show up. For example, what will be the future role of traditional utilities? What kinds of disruptions will changing that role, or eliminating it altogether, cause? Incremental approaches like layering can provide the modest pace and flexibility to deal with the unexpected, but incremental layering can also leave the government suddenly confronting a problem it could not anticipate and has no way to solve.

Finally, layering and incremental change can have the benefit of learning from others. The German efforts involved in *Energiewende* can inform US policy by helping to alert us to future problems that Germany is already confronting and the steps they have taken, successful or otherwise, to deal with them. For example, since Germany gets much more of its electricity from intermittent renewables than does the USA, German grid managers will, of necessity, develop experience from which US grid managers could benefit. Planning for the unpredictable is hard, but learning from others can make it easier.

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group called the Green Tea Party that lists, as the first item in its policy agenda, a "5 year plan to convert all fossil fuel use to renewable energy," a goal far too ambitious for the Sierra Club or Greenpeace.

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6

Exercising Power: China's Transition to Efficient, Renewable Energy

Stephanie Ohshita

Introduction

In November 2014, Chinese President Xi Jinping made a bold international pledge: China would strive to reach 20 percent non-fossil fuel in the country's energy supply by 2030, and would aim to peak carbon dioxide (CO_2) emissions by 2030, making best efforts to achieve that peak earlier. Standing next to President Xi in Beijing, US President Barack Obama pledged that the US would target a 26–28 percent reduction of greenhouse gas emissions from 2005 to 2025, striving for the higher reduction. This bilateral announcement by the world's two largest greenhouse gas emitters, made one year in advance of the 21st Conference of the Parties (COP21) under the United Nations Framework Convention on Climate Change (UNFCCC), is the biggest international commitment to climate protection the two countries have ever made. The two Presidents noted, "these actions are part of the longer range effort to transition to low-carbon economies, mindful of the global temperature goal of 2°C."[1]

In the past decade, China has expanded its efforts to reduce energy intensity and begin the shift away from fossil fuels. Domestic achievements thus far gave China a sufficiently strong footing on which to make this international pledge. Yet China faces a daunting transition

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in its energy system: to move away from industry-dominated energy demand and coal-dominated energy supply. China's transition to a sustainable energy system is first and foremost a story of energy efficiency and conservation, motivated most strongly by the country's economic goals. Energy demand drives energy supply, and had China not begun its work on energy conservation in the 1970s, the country might be consuming three times the amount of energy it does now.[2] More efficient enterprises typically have lower input costs and higher quality products, making them more economically competitive, especially in international markets. From an environmental perspective, energy conservation has the added benefit of reducing impacts throughout the energy life cycle, from extraction and processing to conversion, distribution, and end-use. An easing of energy demand then makes it possible for renewable energy sources to provide a greater share of energy supply, further alleviating the environmental damages of fossil fuels, notably air pollution and climate disruption.

This chapter addresses China's energy-efficiency transition and its transition to renewable energy supply. As the forces shaping the transition are multifaceted, so too is the analytical framework. The chapter examines the physical underpinnings, political priorities and economic motivations, institutional structure, and social and environmental dynamics of China's energy transition during the recent decade (2006–2015).

The central argument throughout this chapter is that China's central government is exercising and maintaining political power in energy transition by utilizing energy efficiency and low-carbon energy supply to deliver economic development and social stability. Certainly, other issues influence China's energy choices: human livelihood, energy security, pollution, climate change, low-carbon leadership, and innovation.[3] Yet here I focus on political power and economic development as dominant forces. I argue that China's transition to sustainable energy is shaped by the social contract between the central government (and the Communist Party) and the Chinese people. Political power is maintained by delivering economic development and social benefits. When energy extraction and consumption have negative social effects, the government is compelled to address those problems to avoid protest and social instability. To achieve goals for economic prosperity, the government seeks to promote new types of industries and enterprises, and to discourage the most damaging enterprises. We see this argument play out in policy choices surrounding energy efficiency and renewable energy.

Rather than seeking to be comprehensive, this chapter provides illustrative examples of China's energy transition on the demand side (efficiency and conservation) and on the supply side (renewable power). In terms of institutions, the chapter focuses on central government efforts, and how they connect to local-level implementation by government agencies and enterprises. Selected policies and programs are examined in light of their energy and environmental effects, their political motivations and economic incentives, and the institutional structure that affects their implementation.

The chapter is organized around the following questions: What is the underlying physical structure of China's energy system and air pollution? What are the political and policy priorities that shape China's energy choices? How does institutional structure influence implementation of China's energy policies? Why does industrial energy efficiency feature so prominently in China's transition to sustainable energy? What policy strategies is China utilizing to promote energy efficiency and conservation? How is China encouraging renewable energy and carbon savings? Why has China made swifter progress in manufacturing renewable energy technology than in generating electricity from wind and solar? How does China's energy transition interact with that of Japan, the USA, and Germany? What are the next steps in China's transition to sustainable energy?

Physical Underpinnings and Political Priorities

To provide an answer to the first question, this section examines the physical underpinnings of China's energy structure, as well China's national, political, and economic priorities as expressed during the 11th and 12th Five-Year Plans (FYP) from 2006 to 2010 and 2011 to 2015, respectively.

China's Energy Structure

China is well known for its large coal consumption and coal resources. Figure 6.1 shows how consumption of coal increased dramatically soon after China joined the World Trade Organization (WTO) in 2001. Industrial production surged, consuming roughly 70 percent of the country's energy in the form of coal, oil, and electricity. Urbanization spurred a domestic construction boom and the production of energy-intensive materials, especially cement, steel, and glass. The rising numbers of urban dwellers and businesses demand electricity, heating, and cooling, causing

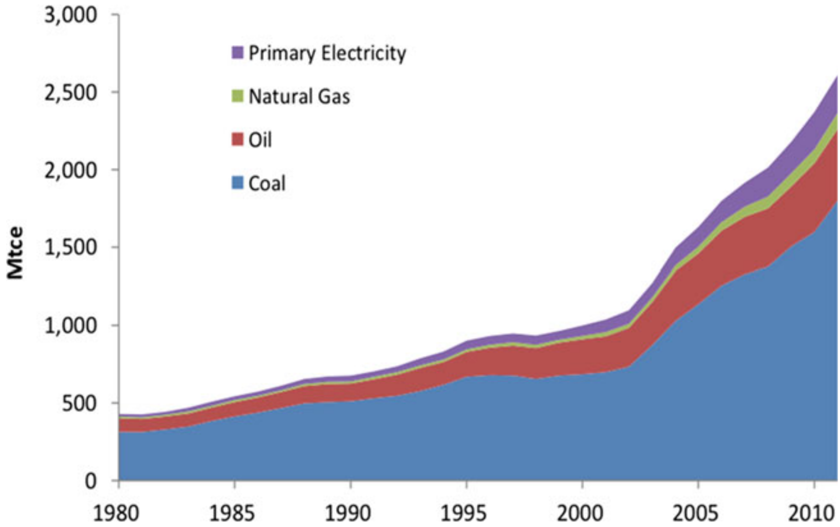

Fig. 6.1 Primary energy consumption, by Fuel Source (1980–2011) (*Note*: Primary electricity is produced by non-fossil energy, mainly hydropower. *Source*: LBNL China Energy Databook 2014, version 8)

a rise in building sector energy consumption in the form of electricity and natural gas. Energy demand for transportation is also increasing, in the form of oil and electricity.

Delving further into the connections among energy supply, transformation, and demand, coal dominates energy supply, accounting for 67 percent of total energy in 2013.[4] More than half of China's coal supply is converted into electricity. Most of the remaining coal is used directly by industry or used to make coke for the iron and steel industry. Natural gas supply is limited in China, and currently provides four percent of total energy, less than hydropower. Nonetheless, China aims to increase the share of natural gas as a substitute for coal. Oil provides 18 percent of total energy, nearly half of which is consumed by the transportation sector.

Not only does the dominance of coal influence China's energy choices, but the *distribution* of energy supply and demand and the availability of alternative energy underlie China's options for sustainable energy. Energy demand is concentrated in the large coastal cities, with scattered centers of demand throughout the rest of the country. Due to the large size of the country, any form of energy supply must either be localized or must utilize long-distance transport or transmission to go from the source to the demand. Whereas rail lines transport coal, conveyance of oil or natural gas requires a specific pipeline infrastructure. To connect the high wind potential in China's northern and western plains with high demand in coastal cities, efficient and large-scale transmission infrastructure is required. The situation is similar for hydropower, which is most abundant in central and southern China. Solar power is widely distributed, although the cloudy conditions and severe smog in some areas reduce that potential. China became a net importer of oil in 1993, and the world's largest net oil importer 20 years later in September 2013, surpassing the USA.[5] Thus it is especially important for China to pursue energy efficiency and conservation, and delve further into distributed power (localized energy) options, to overcome the dispersed and uneven availability of energy supply. All of these physical features of China's energy structure indicate why its energy transition focused first on industrial energy efficiency, then on renewable energy, and now on low-carbon cities.

Energy and the Air Pollution Crisis

At the March 2014 meeting of the National People's Congress, compelled by recurring air pollution episodes so severe as to be termed the "airpocalypse," Chinese Premier Li Keqiang declared a war on pollution.[6] For years, Beijing has experienced elevated concentrations of ground-level ozone (smog) and extremely fine particulate matter (PM2.5), exceeding Chinese standards and those of the World Health Organization (WHO). On the worst day in 2013, PM2.5 levels hit a stunning 755 micrograms per cubic meter, more than 30 times the WHO standard.[7] The air pollution crisis is occurring not only in the capital, but also in cities across the country. An evaluation by the Ministry of Environmental Protection (MEP) in 2013 found that 96 percent of Chinese cities exceeded the PM2.5 standard.[8] Nitrogen oxides (NO_x), which react to form smog, particulate matter, and acid rain, exceeded standards in 61 percent of cities. The situation is improving with sulfur dioxide (SO_2), which is infamous as it causes acid rain, directly impacts respiratory and cardiovascular systems, and forms particulates; 87 percent of Chinese cities are now meeting the SO_2 standards.[9]

While China continues to struggle with air pollution from coal-fired power plants and industrial facilities, the intensifying urban pollution crisis has a new flavor: vehicle emissions. Much as US air quality challenges shifted from localized pollution in Pennsylvania steel towns to urban smog in gridlocked Los Angeles, China is facing the impacts of smog and PM2.5 from exponentially rising automobile use. Because PM2.5 is emitted both directly—from vehicles, combustion ash, construction dust, burning of crop residue—and indirectly—as a secondary pollutant from chemical reaction of SO_2, NO_x, and other substances—a great deal of analysis is needed to determine the sources and amounts of pollutants yielding high PM2.5 concentrations. Source apportionment analysis in Beijing, conducted through Sino–German cooperation, identified that vehicles cause 31.1 percent of local PM2.5 emissions; the remainder comprised 18.1 percent from industry, 22.4 percent from other coal combustion, 14.3 percent from dust, and 14.1 percent from other sources. Furthermore, industrial emissions from outside Beijing contributed roughly 30 percent of the city's total PM2.5.[10]

Civil action and public protest over the horrible air pollution has been mounting, along with the death toll; more than one million premature deaths per year are attributed to air pollution in China.[11] Protesters are organizing around severe smog and haze episodes, as well the impacts of air toxins and other pollution. One notable example is the 2013 protest in the southwestern city of Kunming against the construction of a new oil refinery and petrochemical plant that would process crude oil from Myanmar.[12] Through leafleting, texting, and online networking, hundreds of citizens took to the streets. Public protest halted expansion of a similar facility in the eastern city of Ningbo, and public concern caused the withdrawal of plans for a lithium battery plant in Shanghai.

Since 2008, public sharing of hourly data from a PM2.5 monitor atop the US Embassy in Beijing has had a profound ripple effect through the smog.[13] Whereas Chinese public data sharing was limited and based on monitoring of larger particulates, the availability of real-time data on the more harmful PM2.5 better matched people's experience of the severe pollution. When limited visibility shut down Beijing highways and the airport in December 2011, the official reason was given as "weather conditions."[14] Yet, anyone peering through the brown haze could tell that smog, not fog, was the culprit. Public protest against government opaqueness and inaction continued. By 2013, the new Air Pollution Prevention Plan was announced, and a network of 500 PM2.5 monitors was created across 70 Chinese cities.[15]

In September 2013, the State Council released the much anticipated National Air Pollution Prevention Plan, recognizing that air pollution is "harming people's health and affecting social harmony and stability."[16]

The FYP (2013–2017) calls for at least a ten percent reduction of PM10 in cities across the country. The Plan places the strictest standards on three industrial-metropolitan areas, calling for reduction of PM2.5 levels of: 25 percent in the Beijing/Tianjin/Hebei (BTH) area, 20 percent in the Shanghai/Yangtze River Delta (YRD), and 15 percent in the Guangzhou/ Pearl River Delta (PRD) area.

The Air Pollution Prevention Plan also makes direct connections with energy, industrial, and transportation policy to achieve its goals. Limitations on coal consumption are specified, including a target for no more than 65 percent coal in China's overall energy mix by 2017. New coal-fired power plants in the BTH, YRD, and PRD areas are prohibited, and replacement of existing power plants with electricity from natural gas and non-fossil energy is sought. Reduction in iron and steel production is called for, as well as limits on the number of vehicles in large polluted metropolitan areas.[17] Renewable energy targets are also specified. Implementation of all of these measures will require careful attention to central-local government dynamics and government-industry dynamics in state-owned enterprises (SOEs).

In April 2014, the National People's Congress pushed through more than a decade of controversy and passed amendments to China's Environmental Protection Law. One important amendment is the allowance of public interest lawsuits concerning the environment. Although the lawsuits can only be filed through roughly 300 approved green NGOs across the country, they can be filed, giving concerned citizens legal recourse against pollution.[18] As a further sign of the growing power of civil society, journalist Chai Jing released her pollution documentary, *Under the Dome*, in late February 2015, well-timed following the Asia-Pacific Economic Cooperation (APEC) Summit and prior to the next meeting of the National People's Congress. The online documentary went viral in China and beyond, was viewed more than 200 million times, lauded by China's new Environmental Minister Chen Jining—then censored and blocked online.[19] Likened to *Silent Spring* and *An Inconvenient Truth* in the USA, the film documents the extent of personal and national harm caused by air pollution, and calls out the corruption and lack of environmental law enforcement that enable pollution to continue. As journalist Isabel Hilton commented, Chai Jing has channeled people's awareness of air pollution "professionally and brilliantly, into a clear story line that vindicates existing public fears and gives a direction for public frustration."[20] Notably, the documentary had official review and support; indeed, some officials from MEP and other agencies have been looking to utilize public support on the environment to push forward difficult reforms.

Political Priorities: 11th and 12th Five-Year Plans

Examination of energy, environmental, and economic goals in China's recent FYP shows the political priorities of the central government and Communist Party for delivering economic prosperity and maintaining political power. Air pollution plans and international climate pledges indicate increasing recognition of environmental impacts and their importance for social stability.

The 11th FYP emphasized the theme of "Constructing a Harmonious Socialist Society." This theme encompassed further economic development of the countryside, energy efficiency, and environmental protection. For the first time, the plan included greater support of tertiary enterprises including the improvement of the service sector, the balance of job opportunities, competitiveness, and the overall structure of the economy.[21] The 11th FYP set an ambitious goal of reducing economic energy intensity by 20 percent, while targeting a GDP growth rate of 7.5 percent. By the close of the 11th FYP period, China had nearly achieved the energy intensity target, with a 19 percent reduction. Annual GDP growth was higher than planned, reaching 11 percent.[22]

The 12th FYP signaled a shift in the nature of China's economic development, emphasizing growth that is of higher quality, sustainable, and inclusive, with the latter meant to address the increasing disparity in wealth among China's people.[23] Energy efficiency and environmental protection are prioritized—especially actions related to climate change—along with scientific development and moving up the value chain. Recognizing the negative impacts of an economy dominated by energy-intensive, low value-added industry, the 12th FYP promotes development of the domestic economy, giving more emphasis to domestic consumption and less to exports.

The key economic target in the 12th FYP is for annual GDP growth of seven percent, which represents a slowing of growth in heavy energy-intensive industry.[24] To support more value-added industry, the 12th FYP targets an increase in research and development (R&D), spending to 2.2 percent of GDP, ensuring that R&D investment will rise as the economy grows. A related economic goal is to increase the share of the service (tertiary) sector from 43 percent to 47 percent of total GDP. The service sector—including healthcare, information services, and finance—is typically less energy-intensive, enabling development of the economy with fewer environmental and social damages from energy-related pollution.

Along with the theme of promoting the domestic economy, the 12th FYP targets an increase in urbanization from 47.5 percent to 51.5 percent.[25]

The main energy target in the 12th FYP is a 16 percent reduction in economic energy intensity (tonnes coal equivalent per unit GDP), an easing from the ambitious 11th FYP target of 20 percent. The use of an *economic* energy intensity target (rather than *physical* energy intensity, such as energy per tonne of steel produced) provides flexibility and gives priority to economic development, seeking to utilize less energy in the generation of GDP. However, this type of target does not ensure that absolute energy and environmental goals will be met. Although China has achieved significant reduction in economic energy intensity, absolute energy consumption has continued to increase along with its negative impacts on human health and the environment.

Highlighting China's commitment to action on climate change, the 12th FYP includes a carbon-based target for the first time, with a goal of 16 percent reduction in economic carbon intensity (tonne of CO_2 per unit GDP). This carbon intensity target signals support of renewable energy within the country. The carbon intensity target, like the energy target, offers flexibility in how the target can be met. Yet even with reductions in carbon intensity, absolute carbon emissions are still on the rise and need to decline to avoid more climate change impacts.

As a further signal for support of renewable energy development, the 12th FYP includes a target for the increase of non-fossil energy to 11.4 percent of total primary energy. To support that target, the 12th FYP industrial policy promotes seven new industries including solar and wind power, as well as energy-efficient technologies, energy service companies, and clean energy vehicles (see Table 6.1). These industries are rapidly emerging and are seen as an opportunity for China to leapfrog ahead in global competitiveness.[26]

Central-Local Dynamics in Implementing the Transition

While the central government exercises its power through the promotion of energy and economic goals in the 11th and 12th FYP, it has to utilize multiple implementation mechanisms to encourage achievement of those goals by local governments and enterprises. Despite the popular view of an all-powerful authoritarian central government, economic reforms have

Table 6.1 Efficiency and renewable energy among seven strategic and emerging industries in 12th FYP industrial policy

	Old pillar industries	*New strategic and emerging industries*
1	National defense	Energy saving and environmental protection
2	Telecom	Next-generation information technology
3	Electricity	Biotechnology
4	Oil	High-end manufacturing (e.g., aeronautics, high-speed rail)
5	Coal	New energy (nuclear, solar, wind, biomass)
6	Airlines	New materials (special and high performance composites)
7	Marine shipping	Clean energy vehicles (PHEVs and electric cars)

Source: Lewis 2011

increased the decentralization of decision-making and budgetary authority. As a result, central-local government relations in China have become more akin to federalism.[27] For any sustainable energy policy to yield results, it must compel local-level government agencies and enterprises to action, and it must be informed by local-level data and conditions.

Vertical–Horizontal Tensions in Bureaucratic Structure

A look at the structure of the Chinese bureaucracy provides insight on the country's choice of implementation mechanisms for energy and environmental policy. The bureaucratic structure of China is composed of intersecting vertical and horizontal relationships, known as *tiao-tiao kuai-kuai*. Function-oriented *xitong* (hierarchical agencies), such as Development and Reform Commissions (DRCs), manage economic and energy functions, with *tiao* (vertical reporting) from the local levels (counties, cities, large municipalities, and provinces) to the National level (NDRC). Similarly, the national Ministry of Environmental Protection has local-level branches known as Environmental Protection Bureaus (EPBs) that implement environmental policies. Territorial agencies, such as city government agencies, manage budgets and personnel of local-level agencies with *kuai* (horizontal reporting) to the mayor's office. At the same time, however, functional agencies must also answer vertically to higher-level offices. For example, the staff of a local EPB are hired and paid by the local government, and must work on local government initiatives, even as they are obliged to carry out central government environmental policies. The tensions that arise in energy and environmental policy implementation have their roots in this bureaucratic structure.[28]

Target Responsibility System and Cadre Performance Evaluations

The primary administrative measure utilized to manage central-local tensions in energy policy implementation over the recent decade is the Target Responsibility System (TRS).

In both the 11th and 12th FYPs, national-level energy-saving targets were allocated among the provinces and large SOEs. The provinces in turn allocated those targets to local governments and enterprises. Absolute energy-saving targets (in tonnes of coal equivalent) were specified, along with physical and economic energy intensity targets. Monitoring and reporting were required, and progress toward the targets evaluated. The TRS clarified responsibilities and enabled tracking of progress toward the overall national target.

For the rapid deployment of the 11th FYP, nearly equal targets were assigned for energy intensity improvement. Some provinces made quick progress toward their target, while others struggled and sought financial and technical support. As 12th FYP targets were being developed, there were calls for a more scientific methodology for allocation to achieve greater economic efficiency and greater compliance. Provinces and enterprises also sought to manipulate the allocation system, to avoid onerous targets. After research institutes and key agencies considered a range of methodologies, the State Council announced more varied targets for the provinces in light of economic conditions, past energy-saving performance, and other political considerations.[29]

One component of the TRS is the inclusion of energy-saving targets and pollution-reduction targets in cadre performance evaluations. The inclusion of these targets in the evaluations gives them high priority, in light of the intensifying energy and environmental crises in China over the past decade.[30] The cadre performance evaluations have been a long-standing tool of the central government and Communist Party to achieve policy implementation in China. Bureaucrats and enterprise managers, in their dual roles as party members, have typically been evaluated on achieving the highest priority economic and social goals, notably GDP growth.[31] Strong performance, as well as strong connections within the Communist Party, leads to promotion and choice location for a cadre's next position. Funding allocations to enterprises, cities, and provinces are also connected to achievement of the highest priority targets in central policies. The achievement of energy and environmental targets in the 11th FYP and progress in the current 12th FYP have been attributed, in part, to their inclusion in performance evaluations.[32] Indeed, the extreme measures that some local officials undertook to meet targets in the last year of the 11th FYP—including counterproductive power plant shutdowns that left residents and enterprises without electricity—is a sign of the strength of cadre performance evaluations. Supportive funding and financing mechanisms have surely helped as well.

Local Engagement via Pilot Projects

China's utilization of pilot projects to test multiple approaches when developing policy for new issue areas is referred to as "Crossing the River by Feeling for the Stones" (过河摸着石头). Pilot projects are also a way for localities to push their expertise and preferences to the national level. For example, China has launched seven carbon trading pilot projects in Beijing, Shanghai, Guangdong, Shenzhen, Tianjin, Chongqing, and Hubei.[33] At the same time, differential electricity pricing is being explored, as are options for carbon fees. Pilot programs in power contracting directly between provinces and electricity generators are being tested, along with a Shenzhen pilot on opening up the grid to new generating companies.[34] Indeed, international experience shows that a combination of complementary policy mechanisms can be highly effective. In the UK, for example, a combination of a carbon tax, with a waiver for industrial facilities that entered into an energy and carbon saving contract with the government, has achieved notable improvements in energy efficiency and reduced greenhouse gas emissions.[35]

China has piloted numerous policy mechanisms for sustainable energy with a mixed success rate, as some require deeper structural reform. One notable success on the energy demand side is a local pilot project on industrial energy-saving contract; this is analyzed in the following section. Ongoing pilot programs at the city level include the NDRC Low-Carbon Cities and Provinces pilot program, and the Ministry of Environmental Protection Eco-cities pilot program. These are examined in the following section as well.[36] On the supply side, renewable energy projects supported through R&D programs and contract bidding have led to larger national policies and programs; these are examined later in this chapter.

Energy Efficiency First for Economic Development

In light of China's goal to shift away from an energy-intensive, severely polluting, industrial economy, energy efficiency and conservation have high priority. Some of the wealthiest economies in the world have achieved economic advantage through industrial efficiency, including Japan, Germany, and the USA (all three discussed in this volume). This section briefly traces China's efficiency initiatives and highlights recent efforts in industrial energy saving and in urban energy and carbon savings.

Industrial Energy Efficiency

China's modern emphasis on energy efficiency and conservation dates back to 1980, and to the 6th FYP that followed (1981–1985). Previous decades of subsidized energy prices and central allocation of energy to industry had led to large inefficiencies, pollution, and an imbalance of energy supply and demand. Recognizing the need for substantial reform, the government announced equal emphasis on energy conservation and development of energy supply.[37] The State Council established an administrative network of agencies at multiple levels of government to implement, monitor, and enforce energy conservation programs. More than 200 energy conservation centers were founded during the 1980s to provide technology services, feasibility studies, monitoring, and training.[38] In terms of policy mechanisms, the effort focused on control of physical energy intensity through quotas and technology requirements. Economic support was facilitated through low-interest loans for energy-efficiency investments, tax breaks, and monetary rewards.[39]

The 1990s was a decade of market and administrative reforms in China, including partial deregulation of energy prices, shifting of tax revenues between central and local governments, gradual establishment of environmental protection administration, and ownership reforms in Chinese industry.[40] Tax breaks for energy efficiency were eliminated, low-interest loans dwindled, and monitoring of energy intensity faded. Yet the problems of industrial energy consumption were still growing. As a next step, the 1997 Energy Conservation Law set guidance for industrial energy performance and pushed for the closure of the most inefficient industrial enterprises.

In the 2000s, China renewed attention to end-use energy efficiency in the 10th FYP (2001–2005), formulating regulations, annual energy conservation plans, and economic measures to achieve the goals of the Energy Conservation Law. At that time, China's steel production was on the upswing, supported by a domestic construction boom for urbanization. Construction material industries (cement, glass) were similarly increasing output, leading to a dramatic increase in overall energy consumption in the country.

Recognizing the great potential for energy savings in these industries, collaborators from China, the USA, and the Netherlands examined successful Chinese and international policies and chose energy-saving contracts (also known as voluntary agreements) as a policy mechanism to pilot in two Shandong steel mills.[41] The two steel mills assessed their energy-saving potential, negotiated targets, developed and implemented energy-saving measures, and reported on their progress.[42] The pilot project proved sufficiently successful to serve as the basis of a large industrial efficiency initiative in the 11th FYP (2006–2010): the Top 1,000 Program. The NDRC identified the 1,000 largest energy-consuming industrial enterprises that then signed contracts with the provincial or municipal government overseeing them.[43] The Top 1,000 Program was a crucial element of the 11th FYP, accounting for 33 percent of China's total energy consumption in 2004. By September 2011, the Top 1,000 industrial program had saved 150 metric tonnes carbon equivalent (MTCE), well above the target of 100 MTCE.[44]

The 12th FYP saw an easing of the overall energy intensity target to 16 percent from 20 percent; at the same time, implementation programs were strengthened. The successful Top 1,000 Program of industrial energy-saving contracts was expanded tenfold to become the Top 100,000 Program, with enhanced support for industrial energy audits, monetary awards for target achievement, and stronger reporting requirements.[45]

Slow progress on overall national targets during the first two years of the 12th FYP period (2011–2012) raised concerns that targets might not be met. But by the end of 2013, overall economic energy intensity was reduced to 9.03 percent compared to the five-year target of 16 percent reduction. Similarly, carbon intensity per unit of GDP was reduced to 10.68 percent at the end of 2013, compared to an overall 17 percent reduction target.[46] By all indications, the Top 10,000 Program has a strong foothold and is likely to help industry make a strong contribution toward "crossing the river" and achieving the overall savings goals.

Energy Efficiency in Urbanization

The rapid rise in urbanization since the 2000s led to a construction boom that caused a surge in China's steel, cement, and glass production. The massive population shift from rural areas to cities has been creating demand for new buildings, new transportation infrastructure, new urban energy infrastructure, and entirely new cities. Roughly 13 million people are migrating annually to cities, and by 2030 it is estimated that 230 million Chinese will have migrated over a two-decade period, roughly equivalent to the size of the entire US population.[47] In addition to the large amounts of energy embodied in new urban infrastructure, operational energy is on the rise in the transportation and buildings sectors. Whereas urban dwellers in Tokyo and New York typically have lower per capita energy consumption than rural residents of Japan and the USA, urban dwellers in China may consume three times as much energy as their rural counterparts, as a result of higher wages and greater comfort and amenities.[48] Thus, even as China improves industrial energy efficiency, it must quickly establish patterns of energy-efficient urban development in order to achieve a sustainable trajectory.

Environmental damage, including climate disruption, has become a growing concern for China's leadership, and these concerns have found a nexus at the city level. Aligning economic and environmental goals, China is emphasizing "low-carbon development" and "low-carbon energy." Considering the undefined nature of these terms, as well as the great variability in geography, economic structure, and cultural mix across Chinese cities, the government is pursuing a pilot program approach. In December 2003, the Ministry of Environmental Protection launched a program for eco-cities. In July 2010, the NDRC launched a pilot program to encourage low-carbon development and examine ways to achieve it. Five provinces and eight cities joined in the program: Yunnan, Guangdong, Hubei, Shaanxi, and Liaoning provinces, and the municipalities of Tianjin, Baoding, Hangzhou, Chongqing, Nanchang, Guiyang, Xiamen, and Shenzhen.[49]

Aside from initial guidelines, provinces and cities were left to develop more detailed definitions and low-carbon action plans.[50] Energy-efficiency measures for low-carbon urban development include tougher standards for building energy efficiency, and expanded labeling and rating systems for green and efficient buildings.[51] Urban renewable energy efforts include promotion of biogas, photovoltaics (PV) solar, and other renewable energy installations, along with low-carbon government procurement. Thus far, progress on low-carbon urban development is emerging and not well quantified. Development of quantitative indicators is underway, along with procedures for additional data gathering. These early efforts are important for setting urban development on a sustainable energy path.

Renewable Energy as New Competitive Industry

On the energy supply side, China faces a daunting task: shifting away from coal, the most carbon-intensive fossil fuel, presently supplying nearly 70 percent of the country's total energy. The industrial energy efficiency and conservation programs highlighted in the preceding section contribute to a reduction in direct coal use by industry. While it is difficult to use alternative fuels for some industrial processes, there is opportunity to reduce the indirect use of coal via electricity, by shifting to renewable-generated electricity. How is China encouraging renewable energy and carbon savings? Why has China made swifter progress in manufacturing renewable energy technology, than in generating electricity from wind and solar? This section focuses on the political and economic motivations for renewable power in China, and on the key policy mechanisms the country is utilizing to promote renewable energy technology and its use.

Wind Power

In absolute terms, China has become the world's largest wind power market, both in manufacturing wind power technology and in installed capacity. China's Goldwind, founded in 1998, is the world's second largest manufacturer of wind turbines with 10.3 percent of the global market.[52] United Power and Ming Yang ranked eighth and ninth, respectively, with just under four percent each of global market share. Denmark's Vestas remains in first place, reflecting its more than 100-year-old history as a sole wind power company. Germany's Enercon, Siemens, and Nordex are in the top ten. Nordex has been involved in China's domestic wind industry, through direct sales as well as a joint venture with a relatively small Chinese firm based in Xi'an.[53]

Chinese wind turbine manufacturers have had predominantly domestic sales, with only 4.3 percent of sales as exports in 2013.[54] With production capacity exceeding expected domestic sales, Chinese manufacturers are looking to enhance exports. Zhang et al. note that overcapacity problems typically occur in more mature industries, whereas the Chinese wind industry is encountering this problem early on.[55]

The Chinese wind industry has gotten ahead of itself in another way: not all installed capacity is actually delivering power to the grid.[56] By the end of 2014, China became the first country to surpass the 100 gigawatts (GW) mark of installed wind power.[57] Yet grid connections and purchasing agreements are lagging capacity by roughly 30 percent.[58] In 2011, nearly 17 percent of China's wind-generated electricity was curtailed, representing 15 terrawatt-hours (TWh) of missed renewable power. Nevertheless, wind power now contributes nearly three percent of China's electricity.[59] Considering the rapid pace of wind expansion in the country, however, and barriers in the structure of China's electricity sector, some turbulence should be expected in China's wind power development. Examination of grid and utility structure, and policy priorities, gives further insight.

Solar Photovoltaics

For all the international attention on sales of Chinese-manufactured solar PV technology, PV represents a much smaller share of electricity generation within China. Estimates for 2015 foresee 25 TWh of PV-generated electricity compared to190 TWh of wind power.[60] In the 2000s, the cost of wind-generated electricity was much lower than that of solar-generated electricity, and China promoted the lower-cost option domestically. Recognizing the opportunity for PV in foreign markets, the Chinese government encouraged the manufacturing of PV for export. With industrial policies that required a high share of local content and strong Chinese control of joint ventures, China nurtured a fledgling domestic PV manufacturing industry into a global competitor.[61] And despite the charges of Chinese PV prices undercutting PV from other countries, the Chinese strategy has provided a global benefit: economies of scale brought prices down, encouraging the uptake of PV, thereby displacing a growing amount of fossil fuel power.[62]

The Structure of China's Electricity Sector

Renewable electricity cannot be utilized if it cannot get on the grid and be delivered to customers. Several challenges face China's electricity sector: reliability problems due to an imbalance between supply and demand, growing energy intensity of both generation and demand, severe pollution from coal-fired power, lack of competition, problematic pricing, uneven investment, and lack of independent oversight.[63]

In 2002, the State Council laid out important objectives and tasks for reform of the power sector, with the goal of providing reliable, efficient, and environmentally sustainable power supply. The means to this goal is development of a competitive, market-based power sector.[64] China has already taken key steps in power sector reform. Generation has been separated from the grid, and the grid split into two main companies: the State Grid Company (with five regional grids), and the South China grid. This separation of generation from transmission and distribution was a bold move on China's part. In the USA, California and several other states have made such separation of vertically integrated utilities, while others have not yet done so. The number of generators has expanded, an important step toward a competitive market. Institutionally, China established the State Electricity Regulatory Commission (SERC) to provide independent regulation of the sector, which has been controlled by NDRC.

Yet the structure of the power sector today looks much the same as it did in 2002. Generators sell electricity to the grid companies, not directly to end-use customers. As a result, there is little competition, and customers or municipalities are unable to purchase renewable generation directly. Unlike Germany, where strong local control over utilities enabled innovation and contracting for renewables (see the Chap. 2 by Schönberger and Reiche in this volume), even populous Chinese municipalities must defer to the giant grid companies that provide electricity to the entire country. At the same time, despite the large size of the grid companies, most generation and end-use consumption are regionalized, with little trading in between. This results in inefficiencies, as underutilized capacity in one region is not tapped to provide for neighboring demand.[65]

China’s electricity sector is caught midway through market reform. A larger number of state-owned generators and independent power producers (IPPs) have been created and some ancillary services separated from the grid companies. However, strictly regulated prices make profitability difficult for near-monopolistic utilities, which resist incorporating tariff-laden renewable generation. Conflicting pricing structures on coal and electricity add to the difficulty of getting renewable generation on the grid. Decisions on investment and resource allocation in the power sector are still dominated by the central government, not the market.[66] Despite the formation of regional grid companies, the State Grid has weakened its functions. Separation of transmission and distribution could contribute to contracting between renewable generators in customers, yet is still contentious. Finally, NDRC still dominates control of the power sector, and SERC has not yet achieved sufficient authority to provide independent oversight board to direct the next phase of power sector reform.[67] Further reform is challenging and needs care, as it bumps up against larger issues in the structure of China’s economy and governance.

Policies for Renewable Energy Manufacturing and Utilization

How is China encouraging renewable energy and carbon savings? Why has China made swifter progress in manufacturing renewable energy technology, than in generating electricity from wind and solar? Germany's renewable energy policies focused on generating electricity from renewable energy, which had the indirect effect of nurturing German manufacturers of renewable energy technology, which, in turn, gave a boost to traditional industries supplying necessary materials such as steel, aluminum, and glass.[68] From the start, China's priority has been on manufacturing the technology. Zhang et al. highlight that China's renewable energy transition has been driven by an economic "growth imperative" rather than a "green imperative."[69] Examination of renewable energy policies (summarized in Table 6.2), in addition to the 11th FYP and 12th FYP targets, illustrates how support of the renewable energy industry meshes with economic and political goals.

China's Renewable Energy Law took effect at the start of 2006, in time with the 11th FYP. With its amendments in 2009, the Renewable Energy

Table 6.2 Key renewable energy plans and policies (2005–2014)

Key laws and plans
Renewable Energy Law (promulgated 2005, effective January 1, 2006)
11th FYP for Renewable Energy Development (11th FYP for RED)
Medium- and Long-Term Development Plan for Renewable Energy Development (MLP for RED)
11th FYP for Science & Technology (11th FYP for S&T)
Medium- and Long-Term Development Plan for Science & Technology (MLP for S&T)
Industrial policies for renewable energy manufacturing industry
Financial support for innovation and R&D
Financial support for renewable energy technology manufacturing: import tax Exemptions, export tax credits, low-interest loans, R&D grants
Local content requirements
Renewable energy policies
Guaranteed grid connection and full purchase
On-grid price setting: competitive tendering and feed-in tariffs (FITs)
Renewable portfolio standards (RPS)/mandatory market share
Government concession program
Government financial support for renewable energy projects: Solar Roofs Program, Golden Sun Demonstration Projects
Carbon trading pilot projects

Source: Compiled from Lewis 2011, 2013; Zhang et al. 2013; Lo 2014

Law laid the foundation for pricing, purchasing, market share, and grid connection of renewable-generated electricity. Specifics on implementing the renewable energy law, and measures to encourage the utilization of renewable energy, were put forth in the 11th FYP for RED, and the MLP for RED. Two of these measures are discussed later in the chapter, namely, FIT and RPS. As early as the 9th FYP, China had begun promoting renewable energy manufacturing, seeing an opportunity to leapfrog to a competitive position in these emerging industries.[70] During the 11th and 12th FYP periods, industrial policies for science and technology (S&T), namely, the FYP for S&T and the MLP for S&T, specified technology priorities and government support for wind and solar power, among other new energy technologies. Two supporting measures for the renewable energy manufacturing industry are discussed in the following section, namely, local content requirement and government financial support.

Local Content Requirement

Significant policy and financial support for Chinese wind power began well before the 11th FYP period. In keeping with the priority for economic development and local economic benefits, the Chinese government put in place a local content requirement from 1996 through 2009. As part of the 9th FYP National High Tech R&D Program, 40 percent local content was required in support of the developing wind power industry. In 2004, the local content requirement was as high as 70 percent, pushing international wind turbine manufacturers to establish local facilities or assembly plants to incorporate Chinese-made components.[71] Though the WTO called on China to remove the local content requirements in 2009, the policy fostered local technological capacity during the crucial early years of Chinese wind technology manufacturing.[72]

Financial Support for Renewable Energy Technology Manufacturing

Financial support for renewable energy technology manufacturing has taken multiple forms in China: tax exemptions, preferential export credits, low-interest loans, R&D grants, and establishment of national laboratories and R&D centers. Tax exemptions are provided on import of foreign-made parts needed by domestic manufacturers. In the 1990s, entire turbines were given import tax exemption to bring new technology to China. Over time, the Chinese government adjusted the value-added tax to modulate imports and support the domestic wind and solar manufacturing industries.[73] For the solar PV industry, which has had an export focus, the government provides export tax credits at preferential rates.

In other financial support, state-owned banks and local governments have invested large sums in Chinese wind and solar industries. In a single year (2010), the China Development Bank provided 30 billion USD in low-cost loans to the best performing Chinese PV manufacturers.[74] National research projects under the MLP for S&T target particular technologies and innovation more broadly. For example, research on large-scale (two to three MW = megawatt (a measure of electrical generation capacity)) wind turbine technology received as much as 22 million RMB over a five-year period per project. When polysilicon was in short supply in China, R&D support from the government enabled domestic research institutions to develop the technology and disseminate it to polysilicon manufacturers in China. By 2010, the National Energy Administration (NEA) had established 38 national energy R&D centers, supporting all types of new energy technologies.[75]

Feed-In Tariffs

Feed-in tariffs (FIT) are one of several policy mechanisms to create a supportive economic environment for renewable-generated electricity. The FIT guarantees renewable generators a price above market value, to overcome market-entry barriers. For onshore wind power, China implemented four categories of FITs across the country in 2009, taking into account wind abundance. The tariffs ranged from 0.51 to 0.61 RMB per kilowatt-hour (kWh), giving a boost to wind power, compared to the 0.385 RMB per kWh tariff for coal-fired electricity.[76] Prior to this, in 2003, China utilized competitive tendering, determining the tariff amount on a case-by-case basis. The tendering approach caused intense competition and speculative bidding, which was counter to the development of the Chinese wind industry overall. The shift to government-fixed pricing with the FIT has proved beneficial to the installation and utilization of wind power domestically. China's wind FIT is on par internationally, within the range of tariffs in Germany, the UK, and Malaysia. However, at 1.00 RMB per kWh, China's PV FIT is lower than other countries, except for the UK. Germany has an FIT of 1.71 for solar power, while Spain's FIT is 2.34 RMB per kWh.[77] China's utilization of solar power would benefit from a higher tariff. Furthermore, the large variation in solar output across China, and therefore the variation in costs of solar power production, indicates the need for a range of FITs to encourage PV generation across the country.

Renewable Portfolio Standards
In 2007, China introduced the equivalent of RPS, as part of the MLP for RED.[78] The standards specified mandatory market share of non-hydro renewables in the generation mix of the major national generation companies (three percent by 2010; eight percent by 2020), as well as renewable targets for the grid companies (one percent by 2010; three percent by 2020). All of the large generators and grid companies regulated by RPS are SOEs. The initial RPS encountered a number of problems. Due to weak monitoring and compliance requirements, none of the six largest generators met the 2010 target. With the emphasis on installed generation, and weak integration with the grid, wind power experienced curtailment by the grid companies.

The NRDC began to develop an improved plan in 2011, and released a draft on new RPS requirements in May 2012.[79] The draft assigned specific targets to each large generator and grid company. The draft also better aligned generator and grid company targets, to overcome the problem of curtailment. Monthly compliance monitoring was assigned to the NEA. The draft also included the use of Renewable Energy Certificates (RECs) to track compliance, although the certificates cannot yet be traded. All of these proposed additions to China's RPS requirements draw upon international best practices and would likely strengthen the uptake of renewable power in the country. Finally, to address specific challenges of policy implementation in China (as discussed earlier), NDRC called for compliance with the RPS to be included in managers' performance evaluations.[80] Perhaps, not surprisingly, the utility managers have been opposed to these updates on RPS. As of early 2015, the updates were still pending and under debate.

International Interaction

The promotion of energy efficiency and renewable energy has become an increasingly international exercise. Differences in energy endowments and political vagaries affect the priorities and pace of the sustainable energy transition in each country, while intertwined markets and policy exchanges also influence the progress. China engages in numerous energy efficiency and renewable energy cooperation efforts, and business ventures, bilaterally and multilaterally. For example, US–China cooperation on energy efficiency for more than 25 years has contributed to significant energy savings in industry, appliances, and buildings. In particular, policy development cooperation between Chinese research institutes and agencies and US national laboratories and agencies has had an enduring effect; once efficiency standards and monitoring programs are implemented, they continue to deliver savings.[81] Energy-efficiency advances in Japanese and German industry have spurred technical improvements in China as well; China's newest steel mills and power plants are some of the most efficient in the world.

Exchange of international best practices, cooperation on policy development, and pilot projects are leading to progress on low-carbon urbanization in China. One of the highly successful efforts to date is the development of a sustainable transport system for the bustling metropolis of Guangzhou. The Guangzhou system integrates Bus Rapid Transit (BRT) with the metro rail system, biking system, and walking. The Guangzhou BRT system includes bicycle parking in its station design and a greenway parallel to the corridor, connecting with the city's bike share program of nearly 5,000 bicycles and 50 bike stations.[82] The BRT system carries more than three times the passengers per hour than any BRT in Asia. The system developed from cooperation between the municipal design institute and other Guangzhou city agencies and the Institute for Transportation and Development Policy (ITDP), building upon the invention of BRT in Curitiba, Brazil. The UNFCCC hails the system as "a model for the affordable, low-carbon high-volume public transit desperately needed by fast-growing cities."[83] Another example since 2010 is cooperation of the German Deutsche Gesellschaft fur Internationale Zusammenarbeit Gmb (GIZ). GIZ is an organization that assists the German government in international development efforts with multiple agencies and cities in China on sustainable transportation initiatives, ranging from traffic demand management to pollution-control strategies.[84]

On the energy supply-side, China is now the largest manufacturer, has the largest installed capacity, and is the largest generator of electricity by renewables, in absolute terms.[85] Joint ventures, local manufacturing with international firms, and international sales have propelled China's wind turbine and PV manufacturing industry.[86] The progress of renewables in China, Germany, Japan, and the USA can all be traced to the volume and steadiness of investment. Over 20 years of investment in renewable energy made Germany the clean power leader and demonstrated benefits in employment, environment, health, and energy security.[87]

Dialogue on Germany's *Energiewende* (energy transition) and its implications for China is active, although China uses terminology such as "low-carbon development" and "circular economy." The countries have parallel experiences of a coal-dominated, heavy industrial economy, causing severe pollution and health and environmental impacts, thus prompting policy and market developments for cleaner energy. Germany and Japan can offer lessons to China from phasing out their domestic coal industries; indeed, China is utilizing a series of worker subsidies to help them transition out of closed industrial facilities under the Obsolete Capacity Retirement Program. However, the scale of China's coal industry is more akin to that of the USA and therefore requires a larger-scale shift of workers and employment. In this regard, China would do well to avoid the long-lasting devastation and dangers of mountaintop removal strip mining of high-sulfur coal in the USA, which addresses neither sustainable energy nor worker benefits.

Next Steps in the Transition

A crucial next step in China's transition to sustainable energy is further reform of the electric power sector. Although China has made significant improvements in the efficiency of its thermal power plants, problems with electricity and coal pricing, as well as problems with grid connections for renewables, have limited further improvements in the sector. In late March 2015, China's State Council released *Decree No. 9 on Deepening Reform Of The Power Sector*, a long awaited update since the 2002 reforms. The new decree outlines five areas for reform, one of which is the promotion of "energy savings, emissions reductions, and increased use of renewable and distributed generation."[88] Already, China's push for renewable and distributed generation has led a surge of PV installations in 2014, neck-to-neck with Japan. To further promote distributed generation (DG), China seeks to remove market barriers and to allow DG to participate in power trading (e.g., to sell back to the grid). To better integrate renewables into China's electricity mix, *Decree No. 9* includes improved generator dispatch to prioritize renewables, and the inclusion of ancillary services such as inter-provincial and cross-regional power trading.[89] Another provision is the enabling of direct access and retail competition. Building on provincial pilot programs, large electricity customers will be able to negotiate prices directly with generators and demand-side providers, bypassing the grid companies. This is a welcome development, as it may allow municipalities, as well as enterprises, to make long-term contracts for renewable power. Reliability of the grid must be addressed as a foundation for further reform. Importantly, for sustainability, end-use energy efficiency and demand-side management are highlighted.

Beyond the electricity sector, China will need strengthening of existing energy efficiency and energy pricing policies. Continued provision of economic incentives and financial support can encourage greater energy and carbon saving in cities and value-added enterprises. In the push for renewable energy manufacturing, China must still protect the environment, overcoming pollution problems from fluoride-laden wastewater discharge from PV manufacturing and extraction of rare earth metals. Sustainable energy systems for urban development hinge upon budgetary assets and decision-making authority of local government. And most importantly, holistic attention to social and environmental considerations is needed, such that an energy transition with "Chinese characteristics" can support a flourishing culture in a flourishing natural environment.

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7

Renegotiating Japan's Energy Compact

Llewelyn Hughes

Introduction

In this chapter, I examine Germany's *Energiewende* (energy transition) in comparative perspective, using the case of Japan. There are important differences in the institutional setting of energy policymaking in the two countries, most notably Germany's embeddedness in European institutions (see Chap. 4 by Schreurs in this volume). This has important implications for energy policymaking: European energy market policy has influenced the industrial organization of Germany's power sector, and its fuel mix. Germany's electricity grid is also connected physically to other countries within Europe, enabling firms to buy and sell power from other national markets, an option that is unavailable to firms in Japan. In addition, Germany's political institutions are federal, while Japan continues to have considerable centralization of decision-making power.

A comparison between the two countries is, nevertheless, instructive. Germany and Japan have mixed economies in which the state has traditionally played an important role in industrial development. Both Germany and Japan have sought to promote renewables uptake in the energy mix. Private capital has historically been a key actor, with which the Japanese and German governments have bargained in the development

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and implementation of industry policy, including in the energy sector, in contrast to more statist models such as France.[1]

In this chapter, I argue that in the case of Japan, the uptake of renewable energy has been limited by the industrial organization of the electricity market. While Japan attempted market reform of the power sector in the 2000s, its effects were limited, leaving important barriers to market entry in place. This deterred new market entry, with solar power development initially focused in the residential sector rather than in grid-connected industrial-scale renewable power generation. The structural power of Japan's utilities has thus limited the uptake of renewables in the power grid.

More generally, I suggest that the structural power of business can emerge from sources other than capital mobility. The structural power of business, first defined by Lindblom, emerges when firms limit the choices available to others by controlling the framework within which other actors are embedded.[2] Models of political economy that privilege the importance of businesses' structural power differ from pluralist models, which tend to understand public policy as a negotiation between government, business, labor, and other actors, or between industries that compete against one another to influence policymakers.

The case of power market suggests a third model, however, which is distinguished from existing models of structural business power in two ways. First, in contrast to models in which the threat of market exit generates disproportionate business power, the model defined here emerges from factors *within* the domestic economy, specifically the organization of industries, and the power this confers to some actors to exercise market power. Second, unlike models that emphasize an uneven balance of power between business and government as a result of firms' ability to threaten to exit national economies, here power is exercised not only against government, but *also against other firms.* In this sense, I chart a third course between theories that emphasize the monolithic nature of business, and pluralist models that pay little attention to how forms of industrial organization, institutions, and other factors can increase the power of some market actors relative to others in shaping regulatory outcomes. This power emerges, I argue, because of the industrial organization of power markets in Japan prior to the promotion of renewables.

In making this argument, there is insufficient space to consider in detail a number of additional factors that affect patterns of energy supply and demand in Japan. Energy services are delivered through complex systems that supply a range of different fuels for use in differentiated tasks, and these fuels often cannot be substituted for one another. Despite long-standing efforts to diversify energy sources, for example, oil continues to take up the largest share of Japan's primary energy supply because of the lack of substitutes in the transport sector. A detailed description of these dynamics is not offered here. Further, while local politics play some role in the energy mix, and have been an important factor in the German case in limiting nuclear power, I also do not engage in an extended discussion of the role of local politics in shaping Japanese energy policy. This partly reflects the success the government has had in using financial inducements to promote the uptake of nuclear power regionally in Japan. As described later in the chapter, localism has reemerged as a theme in the wake of the March 11, 2011, earthquake and is now having a more significant effect on Japanese energy policymaking, although it has not stopped the government from continuing to promote a more limited vision for nuclear energy.

Japan's Energy Compact

The earthquake and subsequent nuclear disaster of March 11, 2011, rendered planning for Japan's energy mix highly uncertain. Initial proposals to eliminate nuclear power from the energy mix were eventually scaled back to reincorporate nuclear power, but at lower levels than proposed in earlier energy planning. What is left is something short of the transformation pursued in Germany, in which the elimination of nuclear power is coupled with a maximal use of renewable energy sources, with the goal of producing a reduction of carbon emissions from the power sector in the medium term. The contours of the new energy compact in Japan, instead, point to a reduced but ongoing role for nuclear power, coupled with a rise in renewables, but also in coal and natural gas.

Change in the energy sector is necessarily incremental given the path dependence built into large, capital-intensive infrastructure.[3] It is also limited by the properties of fuels themselves, which shape their end-uses and competitiveness relative to potential substitutes. Aside from the constraints of infrastructure and physics, however, the mix of fuels used within national energy systems can also be understood as the result of political settlements. In Japan, the energy compact negotiated between business and government historically placed power utilities with monopoly status over their regional service areas at the center of service delivery, in common with Germany, and promoted nuclear power as a central component of the fuel mix. The Basic Law on Nuclear Energy was established in 1955; the first nuclear power unit began to be constructed in 1954, and came online in 1966. Nuclear power's share of the power generation mix increased over time, reaching a peak of 36.8 percent of electricity generated in 1998.[4] With small exceptions, the ownership of these generating assets was in the hands of ten privately owned power utilities.

The promotion of nuclear power within Japan's electricity mix was not uniformly accepted. Incentives were put in place to promote local communities' acceptance of power stations within their localities, for example, through education campaigns and the disbursement of funds for the construction of schools and other public facilities. Local politicians were allocated part of these funds as block grants, giving them some discretion over the use of funds.[5] An important source of revenue for these subsidies was a tax levied on electricity consumers.[6] Spending thus redistributed wealth from consumers to localities and private firms, with the purpose of gaining local support for the siting of nuclear and other power plants.

The most important private sector actors in this compact were the power utilities. Policymakers in Japan accepted the natural monopoly status of the power sector until the 1990s. Ten power utilities operated as regional monopolies—including one for the southern island of Okinawa—which dedicated service areas and limits on their ability to compete in each other's service areas. The size of these utilities varied significantly depending on the size of the residential and industrial customer base, with the Tokyo Electric Power Company (TEPCO) dominant.

Politically, the Liberal Democratic Party (LDP) controlled the executive and legislative branches throughout the postwar period, other than short interludes between 1993–4 and 2009–2012. The LDP consistently supported the development of nuclear power, while passing responsibility for detailed planning to the competent ministries and agencies, and the power utilities themselves. The Agency for Natural Resource and Energy (ANRE), with the Ministry of Economy, Trade, and Industry (METI), played the central role in determining energy target-setting.[7] The energy policy coordination process was formalized with the passing of the Basic Law on Energy in 2001, which requires the cabinet to reassess its energy strategy every three years and issue a Basic Plan on Energy (BEP). This underpins a process of coordination between energy firms, along with representatives from consumer organizations, and academic and other experts selected by the government, in order to set a series of targets for the fuel mix. Targets included the share of nuclear power in the electricity mix and energy efficiency goals, and are underpinned by a system of subsidies, tax policies, and laws, regulations and ordinances designed to shift the behavior of firms and consumers.[8]

Most importantly, regulations governing the power market afforded the regional power utilities virtual monopoly status within their service areas. The Electric Business Act granted licenses to the power utilities to supply power to customers within a service area. They also owned the transmission grid, determined access rules, and enjoyed virtual monopoly power over the generation, transmission, and distribution of power within their service areas. Although small adjustments were made to this structure beginning in the 1990s, which is described later in the chapter, it continues to shape competition, including the rate of renewables uptake and the types of investments made.

Beginning in 1995, the vertically integrated power utilities, regulators, and the governing LDP negotiated a series of changes to the structure of the power market, with the twin public policy goals of promoting competition and increasing the role of renewable energy in the power mix.[9] In 1995, the Electricity Business Law was revised for the first time in 31 years, enabling wholesale power producers to sell power to the utilities, and power producers to sell to customers within delineated geographic areas. The changes also relaxed the constraints utilities faced, introducing more flexible pricing structures into contracts with customers. In 1999, the retail market was then liberalized for large-lot customers, and the rules were changed to provide access to power producers seeking to sell power to customers within the deregulated segment of the market. Retail liberalization was extended in 2003 to include users contracted for 50 kilowatts (kW) or more. Rules and rates were also put in place to ease third-party access to the transmission and distribution system, including the creation of the Electric Power System Council of Japan (ESCJ) to oversee third-party access to the transmission grid, although the infrastructure remained regionalized and part of the vertically integrated power utilities' assets. A national wholesale marker—the Japan Electric Power Exchange (JEPX)—was established, although participation was voluntary. It was followed by new competition rules in 2008, designed to increase liquidity in the wholesale market.

Legal changes, thus, introduced a framework enabling competition in power generation and the retail of power to final consumers. The results of these changes were limited, however. By 2013, a total of 60 companies were registered to participate in JEPX, but data show that trading volumes represented just half of one percent of total demand in 2010. This is unsurprising given the voluntary nature of participation in the JEPX and the lengthy process of building new thermal generation, limiting the ability of new market entrants to obtain supply in order to enter the retail market.[10] The utilities represented 83.5 percent of total generation in 2011, wholesalers 7.9 percent, independent power producers 7.7 percent, and new market entrants just 0.1 percent. Importantly, there were also few attempts by the regionalized power utilities to compete in one another's service areas in the liberalized segment of the market.[11]

Climate change also emerged as an important public policy issue. One response focused on measures designed to reduce energy use relative to economic output. A voluntary action program negotiated with peak industry body Keidanren in 1997 saw 36 industries adopt voluntary targets, with coordination occurring through each industry's peak association.[12] A Law on Energy Efficiency, initially enacted in 1979 in response to the oil shocks, also focused on demand-side measures, and was revised numerous times.[13] A central component is the "Top Runner" system, which creates energy efficiency standards on a wide range of products. The law also includes requirements that commercial and other buildings allocate personnel to energy management. In return, a system of subsidies is provided to industry to help meet regulatory requirements. In 2002, a Law Promoting Policies Against Global Warming was passed, with the latter revised in 2005, partly motivated by Japan's position under the first commitment period of the Kyoto Protocol.

On the supply side—which is the focus of this chapter—the Japanese government implemented a range of measures concurrently with power market reform. In 1993—two years before power market reform commenced—a research and development plan was created under the moniker of the "New Sunshine Program," with the goal of spurring the deployment of solar photovoltaics (PV) and other technologies by driving down their costs through innovation and economies of scale.[14] In 1994, subsidies for solar installations on public facilities were introduced for residential-scale (i.e. 3–4 kW) PV systems, lowering the installation costs borne by consumers. Subsidies were provided for utility-scale PV facilities when owned or approved by public authorities. The government also established guidelines for interconnection and net-metering for small-scale solar power systems, enabling residential solar owners to sell excess power generated back to the utilities. No rules were enacted giving special treatment to larger renewable energy sources seeking access to the grid, however. The rapid deployment of PV following the implementation of feed-in-tariff (FIT), described later in the chapter, suggests this was one factor limiting a rapid increase in renewables uptake.[15]

A Renewable Portfolio Standard (RPS) Law entered into force in 2003, with the stated goal of increasing the share of renewable energy in the electricity mix. Through the RPS, firms involved in the sale of electricity—chiefly the utilities, but also including new market entrants—were required to purchase a certain amount of their power from renewable energy. The law targeted not only solar power, but also wind, geothermal, hydropower, and biomass. Firms were also able to produce this electricity themselves, in addition to purchasing it from renewable energy suppliers. Targets under the RPS were low, however: in 2010, the amount required to be purchased was 1.35 percent of total electricity supplied, equivalent to 12.2 billion kilowatt-hours (kWh) of power.[16] As with competition laws, therefore, while the formal institutions were put in place to ease market entry by new participants in energy supply, outcomes fell short of expectations.[17]

Summary: Nuclear Entrenched and Limited Growth in Renewable Energy

The structural power of the power utilities, and ineffectual government policy, were not the only factors influencing the fuel mix in Japan. Economies of scale affect the competitiveness of solar power, for example, as does innovation that increases the efficiency of the conversion of sunlight into electricity. Japan's mountainous geography has also been noted as a barrier to the increased use of renewable energy as were high land prices, although estimates suggest that rooftop solar has considerable potential.[18] Japan's retail power prices have historically been high relative to other countries belonging to the Organization of Economic Co-operation and Development (OECD), which increase the viability of fuel types that would be uncompetitive under lower prices.[19]

Regardless, the outcome was a rising share of nuclear power within the generation mix and a modest increase in the share of renewables within generation, with the bulk of this relegated to residential grid-connected solar systems rather than utility-scale PV.[20] Growth in solar installations did increase more rapidly from the mid-1990s, although from a small base; in 1996, a total of 60 megawatts (MW) of solar capacity was installed, increasing to 330 MW in 2000, and 2.14 gigawatts (GW) by 2008.

Of this, residential solar installations represented the bulk, as shown in Fig. 7.1, with installations evenly spread across the country.[21]

In terms of industrial organization, consumers funded much of the development of the energy system through taxes levied on electricity consumption, while the beneficiaries on the supply side were large firms. In the electricity sector, the industry remained controlled by ten regional utilities that dominated market share within their service areas in terms of generating capacity and sales. Small measures introduced to enable the grid-connection of PV to the grid did not substantially reduce their market share in power generation.

In the renewables sector, of which solar PV retains the largest share outside hydropower, the benefits of increasing production tended to be large diversified firms, represented by Kyocera, Sharp, Sanyo, and Mitsubishi Electric. These firms expanded production capacity markedly in the 1990s, securing a significant share of domestic and international module demand. They also retained a solar unit as part of a diversified business group, and tended to be integrated vertically across the PV supply chain, incorporating cell and wafer fabrication as well as module assembly.

A small number of firms were vertically specialized. Tokuyama and Hemlock, for example, specialized in silicon production alone, and did

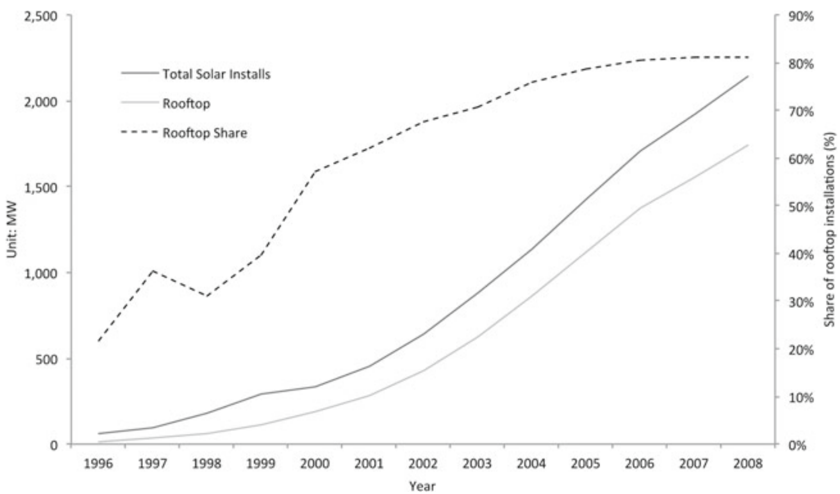

Fig. 7.1 Photovoltaic growth and share of rooftop installations (*Source*: Agency for Natural Resources and Energy 2010, Fig. 1)

not move into the production of solar cells, or modules. M. Setek and Sumco similarly focused on ingots and wafers, but did not operate in other segments of the solar supply chain. There were also a large number of firms operating as rooftop installers in the residential sector. The industry, nevertheless, dominated by large vertically integrated firms, retained solar units as part of a diversified business structure. Reflecting the industry policy character of the development of PV in Japan, local communities played little role in the development and installation of PV projects, in contrast to Germany.

Disaster, Uncertainty, and Japan's Energy Mix

Japan's renewables market thus developed under conditions of a vertically integrated power sector dominated by regional power utilities that faced little competition from new market entrants, or from one another. Within this structure of competition, nuclear power was positioned as the only fuel source meeting Japan's energy security and climate-related goals, while also being cost-effective in terms of generating costs.

This equilibrium was upended by two changes. First, in 2009, the opposition Democratic Party of Japan (DPJ) defeated the incumbent LDP. Although initially supportive of the status quo, the DPJ became less enthusiastic about nuclear power over time. The 2009 Election Manifesto produced by the DPJ proposed increasing renewable energy to ten percent of Japan's Total Primary Energy Supply (TPES) by 2020, and improving the international competitiveness of Japanese renewables industries through support for research and development and commercialization in fuel cells, biomass, and other areas. It continued to support a role for nuclear power in the energy supply, noting that the party would "resolutely engage in the peaceful use of nuclear power, while making safety the first priority and gaining the understanding and trust of the public."[22] As described later, this position shifted to emphasize greater support for renewable energy in the wake of the Fukushima disaster.

The LDP supported for increasing the share of power generated from nuclear power from 25.6 percent to 40 percent.[23] This matched the ambitions of the Basic Energy Plan of 2010, which identified a target of 50 percent for zero-emission power sources—defined as nuclear and renewable power—by 2020, and 70 percent by 2030. Nuclear power was identified as a core energy source, and committed the government to "proactively expand the use of [nuclear power] by promoting its new development, and increasing the use of facilities."[24]

The second important shock to the status quo was the March 11, 2011, disaster. Indeed, this led to a crisis in energy policy that remains in flux. One important change is in the management of nuclear safety: the Japan Nuclear Regulatory Agency (JNRA), for example, replaced the existing bodies charged with ensuring nuclear safety, and is designed to be better insulated from the interests of industry.

The disaster, and the response of the DPJ government, also led to the creation of incentives that more rapidly increased the share of solar PV in the energy supply, and shifted the distribution of solar PV installations toward larger grid-connected projects. The DPJ's greater enthusiasm for promoting renewables can be seen in its willingness to go beyond the mix of RPS and subsidies that the LDP used to produce limited results in terms of renewables deployment.

What are the implications of these shocks for Japan's future energy mix? Comparing the BEP released by the government in 2010 and 2013 offers one method for examining this question. Here, the 2013 version concludes that the disaster undermined each of the three public policy goals—energy security, environmental stewardship, and economic efficiency—at the foundation of Japanese energy policy. In terms of CO_2 emissions, for example, while emissions from non-utilities fell by 29 million tons, CO_2 emissions from the utilities increased by 112 million tons, leading to an aggregate increase of 83 million tons. Reflecting this, the BEP notes that this "called into question the position of Japan, despite the fact that it has led international global warming policy responses."[25] It also expresses concern about the implications of the loss of nuclear generating capacity, the limited ability of power to flow across the regionalized utilities' service areas, for the stability of power supply.

In contrast to Germany, however, the 2013 BEP reestablishes nuclear power within the energy mix by identifying it, along with coal, as base load power that is able to provide low-cost electricity on an ongoing basis. This differs from natural gas, which is identified as more expensive than base load, but able to adjust according to variation in demand. It also stands in contrast to renewable energy. For PV, for example, the government argued that intermittent supply of power produced and the high generating cost meant innovation is required in order to make PV more central within the fuel mix. However, for wind power, it notes that industrial-scale wind can be as low cost as thermal power, but effective incorporation into the power mix requires investment in the transmission grid, the use of grid storage, or other changes that would enable power to flow from the northern regions of Hokkaido and Tohoku to major demand centers in the Kanto region.[26]

Nuclear power is thus projected to remain part of Japan's energy mix, even as its overall share falls, to be replaced by increased renewable energy usage, energy efficiency measures, and greater use of thermal power. This is reflected in the long-term supply and demand forecast of April 2015, which estimates that renewable energy—defined as geothermal, biomass, wind, solar PV, and hydropower—will slightly outweigh nuclear power by 2030 in terms of both installed capacity and total electricity generated.[27]

There are a number of plausible explanations for the continued, but reduced, role of nuclear power, in contrast to Germany. One factor limiting the return of nuclear power lies in the change made to the regulation of safety for Japan's nuclear power plants, noted earlier. Following the disaster, the government ordered all nuclear units shut down until their safe operation could be assured. A particular criticism leveled at regulators following the disaster was that the oversight of safety was compromised because the safety regulator was located within the same bureaucratic organization that saw its central mission as promoting the development of nuclear power. Indeed, the independent review commission's assessment was that "the way safety regulations are deliberated and amended reveals a cozy relationship between the operators, the regulators and academic scholars that can only be described as totally inappropriate. In essence, the regulators and the operators prioritized the interests of their organizations over the public's safety."[28]

In response, the mandate to regulate safety of the remaining units was transferred to a new organization created within the Ministry of Environment, which was not historically responsible for making policy for the power sector and thus did not have strong ties to it. The Nuclear Regulatory Agency Establishment Act was passed into law on June 27, 2012, and the Japan Nuclear Regulatory Agency (JNRA) came into operation in September 2012. The body is an important new actor in nuclear policymaking. In July and December 2013, it established new safety regulations for Japan's nuclear power plants. All nuclear units are required to meet these regulations before being restarted. In some cases, the JNRA has examined whether the plants are lying on an active fault line, guaranteeing decommissioning. The time required to assess plants' safety, and the costs associated with meeting new safety regulations, have placed a significant burden on the power utilities, and some utilities have decided to decommission existing units because they are unwilling to bear the costs of retrofitting them to meet new safety standards. New safety regulations produced by the JNRA have thus functioned to reduce the share of nuclear power in the energy mix.

The return of nuclear power to the fuel mix, on the other hand, can be attributed to path dependence, given its importance to the profitability of the regionalized power utilities. The firms were not highly profitable prior to the order to stop the nuclear power units, and the costs of keeping these assets while unable to use them to generate revenues further undermined profitability.[29] The effect was magnified in the case of the TEPCO by the need to expend large sums to make the Fukushima Daiichi plant site safe and begin the process of decommissioning the four units located there. TEPCO recorded a loss of over US $9.5 billion in fiscal year 2012, even after including a capital injection into the firm from the Nuclear Damage Liability Facilitation Fund, asset sales, and an increase in rates in the regulated segment of the power market of 8.46 percent.[30] In addition to compensation payments and the costs associated with stabilizing the site of the disaster, the rise in fossil fuel purchases and an increase in prices led to a year-on-year increase in operating costs of 12.9 percent.[31]

There is little surprise, given this, that the power utilities were eager to meet the new regulatory requirements established by the JNRA and submit applications for restarting the plants. In 2013 and 2014, applications were submitted to restart 17 of the 48 remaining nuclear units, representing 15,632 MW of generating capacity, of a total of 44,264 MW of nuclear power, or 35 percent of the total remaining nuclear generating capacity.[32] The Sendai Nuclear Units One and Two, owned and operated by Kyushu Electric, were approved for operation in September 2014 by the nuclear regulator, demonstrating the divergent paths that Japan and Germany's energy transformations are taking.

Equally important, localism—in the form of increased opposition to nuclear siting—has certainly increased in the wake of the disaster. Overall voter sentiment has not forced the government, or the power utilities, to wholly abandon nuclear power. The governing LDP won both the House of Councilors elections of 2013 and the more important election for the House of Representatives in 2014. In each case it included support for nuclear power's continued role in the electricity mix in its policy platform.[33] While increased local activism is thus bringing into doubt the absolute number of nuclear power plants restarted, voters have not punished the government by rejecting it at the ballot box, despite its decision to allow nuclear power to return to the energy mix.

The disaster, nevertheless, meant a widespread expectation that the share of nuclear power will fall within the generation mix. The law establishing the JNRA includes a clause that sets operating limits on plants at 40 years, although ordinances establish that plants can continue to operate for a further 20 years if approval is obtained. Without new nuclear units being constructed, or legal change that relaxes this constraint, the importance of nuclear generation will thus fall as a share of the generation mix. Indeed, a large number of the first-generation nuclear units have reached, or are reaching, this 40-year limit in the decade 2010–2020, requiring resubmission to the JNRA, or their decommissioning.[34]

In addition, in return for the injection of public funds, TEPCO agreed to a plan to reorganize its business, preparing a business plan that adopts a holding company structure in preparation for further power market reform. The final stage of power reform—enacted in 2015—legislated the separation of the management of transmission and distribution from power generation and retail, and the implications for the power utilities balance sheets—and by extension their ability to increase the role for nuclear generation in their fleets—remain unclear.[35]

In terms of installed capacity, the fall in nuclear generating capacity is thus the most important short-term change in Japan's electricity mix.[36] A second important change is the rise of renewable energy, promoted through the introduction of the FIT, which began operation on July 1, 2012. Like Germany, the FIT is designed to improve the competitiveness of renewable energy sources by requiring power utilities to purchase power generated using designated fuel types (PV, wind, hydro, geothermal, biomass). The costs are recouped through the utilities placing a levy on consumers' electricity bills. This amounted to 35 yen per kWh in fiscal year 2013, or an approximately 120 yen increase on a power bill of 7000 yen.[37]

The merits of introducing a FIT in Japan were debated prior to the 2011 disaster. In 2009, a system enabling the sale of excess solar power from the household sector project was put in place, and a project team was established within METI, the main policymaking body for the energy sector, to examine the merits of a more comprehensive FIT scheme. When introduced, the latter proved remarkably successful, increasing the installed base of renewable power, particularly solar PV. It also shifted the distribution of the types of installations away from rooftop solar and toward grid-connected utility-scale projects.[38]

The FIT has been remarkably successful in increasing installations of solar power. Installations of solar power increased from 4,910 MW to 13,930 MW from fiscal year 2011 to fiscal year 2013. Installations have increased across both rooftop and utility-scale projects, although the rapid rise of the latter means the ratio of large-scale grid-connected solar projects to total installations—defined as those in excess of 2 MW—has increased.[39]

Nevertheless, the rise in renewables uptake does not make up for the lost generating capacity of the nuclear plants operated by Japan's power utilities. Japanese nuclear capacity stood at 46,148 MW—excluding the Fukushima Daiichi plant—while solar PV, as the dominant non-hydro renewable source of power, remains just a small portion of this. In terms of electricity generated the difference is stark. In 2010 nuclear power generated 271 terawatt-hours (TWh) of electricity. In comparison, according to Japan's 2016 energy white paper total renewables generated (excluding hydro-power) in 2014 stood at 29.5 TWh.

In addition, problems have begun to emerge between the industrial organizations of the power sector, which remains dominated by the vertically integrated utilities, and the increase in renewables energy uptake. In the latter half of 2014, five of the ten utilities—beginning with Kyushu Electric, which announced on September 24, 2014, that it would suspend grid connection for FIT-approved projects—stated that they would refuse to connect additional renewable projects to the transmission grid, citing capacity constraints in the grid as the reason.[40]

There is some justification for this claim. Japan's geography and population distribution meant that renewable projects are concentrated in particular regions of the country—notably in the southern island of Kyushu, and in the northern island of Hokkaido—which are relatively less populated, and the regionalized structure of Japan's transmission grid means this additional power cannot move easily from one part of the country to another. Furthermore, the approval process for registration under the FIT scheme did not take into account these regional transmission constraints, instead, focused on whether the applicant had secured a site and equipment for the project, and had negotiated grid connection and power purchasing agreements for the project. Importantly, the incumbent utilities were not allowed to refuse the latter under most cases. It is thus plausible that transmission constraints might emerge, especially given the concentration of population centers in the Kansai and Tokyo region.

On the other hand, there is also clearly an incentive for the utilities to limit the increase in renewables into the grid given they function as competition for their own generating assets. This is particularly the case given that they are obliged through the FIT scheme to purchase all power from registered projects. A sharp rise in renewables generating power, thus, has the potential to undermine the utilization rates for their own generating assets, as has occurred in Germany, lowering revenues at a time when all of the utilities are in a difficult financial position. This concern that market barriers, rather than transmission grid constraints, underpinned the utilities' decision to suspend connections of large-scale renewable projects to the transmission grid is highlighted in a statement issued on October 29, 2014, by the National Governor's Association, which called on the national government to force the power utilities to subject their claim that the transmission grid faces constraints to a third party for verification, and release the findings to ensure transparency.[41]

The emerging problems of renewables connection to the transmission grid thus have the potential to limit the penetration of renewables to Japan's power mix, in addition to commercial, geographic, and technological constraints. The three-tiered reform of Japan's power system may, however, help to relax this constraint. The Japanese government is fundamentally reorganizing the structure of competition in the power sector, including by grasping the nettle of vertical integration by forcing the power utilities to adopt a holding company structure, and separating management and oversight of their transmission assets to a third-party organization.

Power market reform is implemented in three stages, beginning with the establishment of a network operator with the responsibility of managing the transmission of power across the service areas of the power utilities. The second stage is the full liberalization of the retail sector, allowing competition for individual households. Finally, in the third stage, which is planned to be implemented in 2018–2020, price regulation is planned to be liberalized, and the transmission and distribution assets of the utilities will be spun off, although initially they will remain on the balance sheets of the power utilities.

The purpose of the power sector reform is to enable competition to occur in power generation and in the retail market, while ensuring that new market entrants are able to gain access to the transmission grid on a transparent and equal basis. If successful, it should remove barriers to market entry for renewable energy sources such as PV that stem from the continued dominance of the power utilities. Questions of how to maintain stability of the transmission grid, identifying suitable sites in order to promote the penetration of renewables at scale, and how to make renewables cost-competitive, will remain.

From Structural Power to Structured Pluralism?

At first glance, Japan's energy transformation appears to mirror that of Germany. In both countries, governments have committed to reducing the role of nuclear power, and to increase the share of renewable energy sources, within the electricity mix. Outcomes in Japan appear, however, to be a weak version of the German experience, with a smaller penetration of renewables and no commitment to abolish the role of nuclear power. The government is also committed to continuing the role of nuclear power within the power generation mix, although this will be at a lower level than previously achieved, and certainly lower than suggested prior to the March 11, 2011, disaster. Finally, fossil fuels, in the form of natural gas and advanced thermal coal technologies, are set to play an increased role in the fuel mix.

One framing of this outcome is that it reflects economic, technological, and geographic constraints. Japan is an island nation and there are no transmission lines connecting it with the power grid to other jurisdictions, in contrast to the German case. This means that demand and supply must be balanced within Japan itself, which some government officials argue limits the penetration of intermittent energy sources. The legacy of the regional monopoly supply structure means that interconnects between supply regions are limited, deepening this problem. Finally, there are geographic constraints to the introduction of renewable energies. Each can plausibly explain part of the outcome that we see in Japan.

A second understanding, however, is that the outcome is a function of the balance of structural power: the slow development of liberalization in Japan's power market has plausibly contributed to the continued dominance of the power utilities, deterring new market entry, and the renewables market developed primarily through the installation of small-scale grid-connected residential solar projects, rather than utility-scale independent power producers. The implementation of a FIT, which changed the scale of PV investments, was debated prior to the March 11, 2011, disaster and reflected the diffusion of the German experience. It passed into law, however, as a direct result of a shift in government that temporarily weakened the structural power of the power utilities. Indeed, former Prime Minister Kan Naoto made the passing of legislation enabling the FIT the condition on which he was willing to relinquish his position. It also occurred as the power utilities were weakened following the disaster of March 11, 2011, and thus in less of a position to oppose the introduction of a FIT scheme with such attractive terms for investors. Institutional changes implemented by this government in the wake of the disaster also enacted a more stringent regulatory process through the JNRA, which gave the utilities and others less control over the process of approving and restarting the remaining nuclear units.

The implications of legislation designed to end the vertically integrated structure of the regional power utilities are unclear. Power market reforms are being enacted in three stages, beginning with the establishment of a new regulatory body with responsibility for managing transmission across utility service areas, followed by the opening of the residential market to competition, and ending with the functional separation of the transmission grid currently both owned and operated by the utilities, from generation and distribution. The analysis here suggests that an increased role of renewable energy will certainly be influenced by geographic and economic constraints, but the effectiveness of these reforms on loosening the structural power of the utilities is a further factor determining the role these technologies will play in Japan's energy mix in the future.

Notes

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Conclusion: Lessons from the German *Energiewende*

Christoph H. Stefes

Introduction

As the world came together in Paris at the end of 2015, acknowledging the severe consequences of climate change and the need for a sharp reduction of greenhouse gas emissions, *Energiewende* in developed and developing countries has become even more urgent. Renewable energy sources, as well as measures to increase energy efficiency in the electricity, heating, and transport sectors, are the centerpieces of such energy transitions to sharply reduce greenhouse gas emissions. The Paris Agreement will, therefore, inevitably direct even more attention to Germany. Already today, hundreds of journalists, environmental activists, academics, and politicians from around the world visit Germany every year to learn about the country's experiences with the *Energiewende*.

As Europe's economic powerhouse and fourth largest economy in the world, Germany is a critical case for energy transitions. If Germany succeeds in creating a decarbonized energy system that is affordable and reliable, the country will give a clear signal to the rest of the world that it can be done. Beyond providing a blueprint and setting a positive example, Germany has also used its political influence and economic leverage

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to advance energy transitions across Europe, and to make the European Union a powerful leader in international climate change negotiations. Germany's *Energiewende* is therefore a linchpin for the world's attempt to limit global warming to less than 2° Celsius—reason enough for studying the country's energy transition carefully.

This concluding chapter will address three major questions. First, can, should, and will the German experience be replicated in other countries around the world? Second, what are the remaining challenges for Germany's energy transition, and how will the country deal with those challenges? Finally, how do the world's three biggest economies fare in comparison to Germany? Are energy transitions likely in the USA, China, and Japan?

The Uniqueness of the German Energiewende

To answer the first set of questions, Germany's energy transition can be replicated. Simply copying the German model might, however, not be an efficient strategy for every country. Finally, for many reasons, it is unlikely that the German *Energiewende* will be adopted in many countries. The good news is that energy transitions can be achieved through different paths. In fact, it might be wise to learn from Germany, acknowledging what has worked and what could work better.

To begin with, Germany's *Energiewende* is and will remain unique. As Carol Hager demonstrates in Chap. 1, the *Energiewende* has grown from the bottom-up. Born in the 1970s out of the anti-nuclear movement, Germany's renewable energy advocacy prepared the ground for later decisions taken by governments at the municipal, state, and federal levels. The early supporters of an energy transition challenged the expertise of the conventional energy industry, developed technological foundations, and created political and entrepreneurial networks that advanced the cause of the nascent renewable energy community. Their achievements as renewable energy pioneers in the 1970s enabled and encouraged municipalities and Germany's states in the 1980s to introduce renewable energy sources on a larger scale. Chap. 2, not all *Länder* and municipalities supported the energy transition to the same extent. Today, some *Länder*, for example, Bavaria, even attempt to put a brake on the *Energiewende*. Yet a sufficient number of actors below the federal level provided political and financial support, easing the market integration of renewable energy sources. Their positive experiences encouraged

Germany's federal policymakers to move beyond the provision of federal subsidies for research and development.

Chap. 3, the institutional foundation of the *Energiewende* at the federal level owes a lot to chance, a historical conjuncture of many unrelated events and developments, and the political skills of a few policy entrepreneurs located in the German parliament and the Federal Ministry for the Environment. The anti-renewable energy coalition, consisting of the Federal Ministry of Economy, the large utilities, and the energy-intensive industry, would have undoubtedly stopped the passing of the Feed-in Law in 1990 *if* it had foreseen the consequences of this legislation. Yet it did not, as it was distracted by Germany's reunification and had underestimated the self-reinforcing dynamics that this law would initiate.

In essence, the feed-in system that was created in the 1990s and significantly improved in 2000 did two things. It led to an incremental decentralization of energy generation at the expense of the large utilities, which missed the opportunity to enter the renewable energy market early on. Moreover, it spread the profits of the *Energiewende* widely, as small investors, such as farmers and other citizens with moderate incomes, invested in the new technologies. At the same time, funding for the *Energiewende* came through modest surcharges on consumers' electricity bills, removing the energy transition from legal challenges and the fierce political battles over state budgets. It was therefore not until 2014 that a reconstruction of the institutional foundation of the *Energiewende* was initiated.

It remains to be seen if reforms such as the auction system will eventually be fully implemented. If they were, the pace of the expansion of renewable energy in the electricity sector might slow down. However, Chap. 4, not only are Germany's municipalities, states, and federal government involved in the *Energiewende*, but the European Union has also assumed a larger and more assertive role. By setting ambitious targets for the reduction of greenhouse gas emissions and introducing a carbon trading system, the European Union puts pressure on its member states to decarbonize their energy systems. Even Germany will have to stay on course to reach the European Union's targets. In other words, the complexity of Europe's multi-governance system will make it next to impossible for Germany to slow down its energy transition.

As supporters and foes of transitions toward decarbonized energy systems carefully watch the German experience, it becomes clear that the German path will unlikely be replicated step-by-step in other countries around the world. First, the pioneering work has been done. Today, renewable energy sources are considered credible alternatives to fossil fuels and nuclear energy. Governments around the world therefore initiate energy transitions from the top. Although some governments have copied German institutions, many have shied away from feed-in systems, which would lead to a decentralization of their energy systems. Quota systems or renewable portfolio standards are instead introduced, leaving the energy transition in the hands of a few large energy companies that are either publicly or privately owned. The danger of such top-down initiations of energy transitions that implement quota systems is that they do not build up widespread popular support for renewable energy. These energy transitions are therefore more susceptible to the pressure of powerful energy companies and changes of government. The continuity that we have seen in Germany, and which owes much to the institutional dynamics of a feed-in system, is therefore threatened.

At the same time, central control over energy transitions potentially allows governments to implement the *Energiewende* more efficiently. For instance, oversubsidizing particular renewable energy sources, such as solar in Germany, is less likely in a quota system. Moreover, an assertive government might realize that introducing renewable energy in the electricity sector is only one piece of a larger puzzle. Introducing renewable energy in the heating and transport sectors, as well as increasing energy efficiency in all three sectors (electricity, heating, and transport), is also necessary to accomplish a complete decarbonization of energy systems. Germany has yet to find answers to these challenges, and it might not make sense for every country to focus on renewable energy in the electricity sector first. The early introduction of measures to improve energy efficiency, for instance, might be more cost-effective.

Remaining Challenges

Partially driven by the political dynamics in the European Union, Germany sets ambitious targets for the reduction of greenhouse gas emissions. By 2020, these emissions are supposed to be reduced by 40 percent compared to 1990. At the current rate, Germany is unlikely to reach this self-imposed target. While it is achieving its goals for the introduction of renewable energy in the electricity and heating sectors, renewable energy has barely made inroads in the transport sector. The number of hybrid and electric vehicles on Germany's roads is still minuscule. While the German government has initiated several programs to bring German carmakers on board, technological developments are still far behind what is needed to substantially increase the number of electric vehicles powered by renewable energy sources.

As far as energy efficiency is concerned, the goal of reducing primary energy consumption by 20 percent by 2020 compared to 2008 remains elusive. Again, substantial efficiency gains in the transport sector are wanting. Yet even in the electricity and heating sectors, energy is only slowly used more efficiently. These are the findings of the German government and not of environmental groups, which readily criticize the slow speed of the *Energiewende*.[1] The German government is therefore clearly aware that it has to double, if not triple, its efforts to accomplish the energy transition within the timeline it has set for itself. At this point, it is not clear which institutional structures the German government can and will introduce in order to reach these targets. The somewhat fortuitous introduction of the feed-in system is unlikely to be replicated in these other sectors.

Given the breathtaking speed at which renewable energy has entered the electricity sector, with all its unsolved market, technological, and financial challenges, it is arguably apt to start reallocating resources to the heating and transport sectors and increase energy efficiency overall. Even though Germany is undeniably one of the richest countries in the world, there are limits to what it can spend on the *Energiewende*, especially considering the other challenges it currently faces, namely, the large influx of refugees from Iraq, Syria, and Afghanistan, as well as the ongoing financial crisis in Europe. The efficient reallocation of resources in ways that further the overall goal of the *Energiewende*—for example, the drastic reduction of greenhouse gas emissions—is therefore needed, requiring the leadership of an assertive federal government.

The Energiewende in Comparison

Once a pioneer of renewable energy, the USA is far behind Germany concerning the transition toward a decarbonized energy system. Chap. 5, the federal government of the USA does not even have an energy plan that envisions the replacement of fossil fuels and nuclear energy with renewable energy sources. Instead, it pursues an "all of the above" strategy, providing public support to all energy sources. The resulting incrementalism, on one hand, reflects the wisdom of policymakers to let other countries lead the charge and learn from their successes and failures. Yet it is also the inevitable outcome of a political system that favors powerful economic actors through numerous institutional veto points that have allowed the fossil fuel industry to block anything in Washington that comes close to the German *Energiewende*.

The situation at the state and municipal levels, however, often looks different. Here, several states and municipalities have introduced ambitious targets for the expansion of renewable energy.[2] In many ways, what is currently happening in the USA resembles the situation in Germany in the 1980s, with some research and development (R&D) support, tax breaks from the federal government, and more concrete and ambitious measures being taken at the state and municipal levels. Whether this momentum will spill over to the federal government, as it did in Germany in 1990, remains to be seen. Some of the measures the Obama Administration has recently introduced (for instance, extending the Clean Air Act to CO_2 emissions) are promising. Yet there is legal room for more ambitious steps. For instance, the Interstate Commerce Clause would give the federal government the authority to introduce a nationwide feed-in or quota system. After all, energy is heavily traded across state borders. Yet, with Republicans in firm control of the Congress, it is unlikely that the federal government will become more assertive, even though Republicans at the state level are often more progressive in supporting renewable energy than their fellow party members in Washington.

In China, the intricacies of divided government, multilevel governance, and legal obstructions that come with the protection of private property would not stop a determined government from rapidly decarbonizing its energy system. Yet China's problem is a different one, Chap. 6. Its economy is still growing at a considerable pace, and the authoritarian regime depends on this growth, as its legitimacy is primarily built on increasing the living standards of its citizens. Reliable and cheap supply of energy is therefore a vital policy goal for the Chinese leadership, which favors the country's gigantic coal industry. On the other hand, a growing middle class also demands a cleaner and safer environment. The way out of this conundrum is by increasing energy efficiency, which would lower production costs and the emission of greenhouse gases.

The current emphasis on energy efficiency, however, does not mean that China neglects renewable energy. In fact, China is currently the biggest solar producer in the world. Yet most of these panels are exported and not installed at home. The introduction of renewable energy in the energy market still proceeds rather incrementally. The Chinese government experiments with various ways to promote renewable energy; feed-in and quota systems, for example, were introduced at the local and regional levels. The dominance of giant grid companies does prevent a more rapid expansion of renewable energy, though. The absence of functioning market structures and a regime that relies primarily on economic growth for its political legitimacy, therefore, hinder more ambitious policies. Furthermore, due to its authoritarian nature, the regime curtails China's civil society. A concerted push from below toward an energy transition that we saw in Germany is therefore not in sight.

Finally, of the three other cases covered in this volume, Japan probably resembles the German case most closely (see Chap. 7 by Llewelyn Hughes in this volume). As in Germany, utilities dominated vertically integrated and regional energy markets for a long time, but currently face deregulatory measures and an overall liberalization of the energy market. In Germany, this push for market liberalization has come from the European Union. In Japan, the national government is currently implementing these policies. And, as in Germany, the large industrial centers are far away from the regions where the conditions for the production of renewable energy are most favorable (in Germany in the North and in Japan in the South). Finally, Japan has Adopted a modest feed-in system, but has also experimented with a limited quota system.

Where Japan differs from Germany is in its willingness to hold on to nuclear power. This is surprising, considering that the Fukushima disaster, which caused the German government to accelerate its nuclear phase-out, initially stirred considerable public protest in Japan. When the government later decided to maintain nuclear power despite earlier promises to decommission nuclear power plants permanently, Japanese voters signaled support for this about-face. The Japanese government, therefore, faces much less pressure to advance its energy transition than Germany, which aims at a rapid decarbonization of its energy market *and* a simultaneous decommissioning of all of its nuclear power plants by 2022.

Japan is uniquely suitable for an *Energiewende*. Its long coastal lines favor the installation of off-shore wind parks, plenty of sunshine should advance an expansion of its solar installations, and numerous hot springs (*onsen*) could provide the fuel for geothermal power plants. Yet a comprehensive energy transition would necessitate massive investments in Japan's energy infrastructure. These investments are already considerable in Germany. In Japan, they would be even more expensive given the geography of the country and the lack of an integrated energy system. At this point, the political will to undertake these investments is clearly missing, as Japan's political leaders face a powerful energy lobby in the absence of a powerful movement for a comprehensive energy transition.

Conclusion

In this volume, we assessed the progress the four biggest economies of the world have made toward a decarbonization of their energy systems, focusing on Germany's *Energiewende*. While Germany is not the only country in the world that has moved toward a decarbonized energy system, and not even the country that has made the biggest progress (e.g., Denmark is clearly farther along), it is the only large economy in the world that has embarked on the ambitious task of reducing greenhouse gas emission by around 90 percent by 2050. If Japan, China, and the USA stay on their current trajectories, they will not even come close to this target. The reasons for Germany's already impressive achievements are manifold. Yet one of the principle reasons is arguably that Germany's *Energiewende* grew from the bottom-up, and its grassroots support was later institutionalized through a feed-in system that has widely spread the benefits of the country's energy transition. As a consequence, the *Energiewende* enjoys widespread popular support in Germany. This support is unparalleled in the world and makes an about-face nearly impossible.

Even so, the German case also warrants a word of caution. So far, the *Energiewende* has had its greatest success in the electricity market through the rapid and comprehensive introduction of renewable energy. Yet little has been achieved in the transport sector, and the overall record in regard to energy efficiency has been unimpressive. Germany still has a long way to go, and the organized opposition to the *Energiewende* has already put a brake on the pace at which renewable energy is expanding in Germany's electricity sector, relying on institutional layering and drift to undermine the structural foundation of the energy transition. Germany's *Energiewende*, therefore, faces not just technological and financial hurdles, but some lingering political challenges. The proponents of energy transitions in other countries are thus well advised to learn from the political battles that have shaped Germany's *Energiewende*. Finding and implementing institutions to put energy transitions on stable trajectories should be one of the lessons drawn from the German case.

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