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Carol Hager
Bryn Mawr College, chager@brynmawr.edu

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GERMANY'S GREEN ENERGY REVOLUTION

Challenging the Theory and Practice of Institutional Change

Carol Hager
Political Science, Bryn Mawr College

ABSTRACT

The energy revolution poses a fundamental challenge to the German corporatist institutional model. The push for renewables in Germany arose almost entirely outside the prevailing channels of institutional power. Eventually, federal legislation helped support the boom in local energy production that was already underway, and it encouraged the further development of new forms of community investment and citizen participation in energy supply. Recently, the federal government has tried to put the genie back in the bottle by shifting support to large energy producers. But, as this article shows, the energy transition has provided a base for local power that cannot easily be assailed. The debate over German energy policy is becoming a contest between centralized and decentralized models of political and economic power. Prevailing institutionalist theories have difficulty accounting for these developments. I analyze the local development of renewable energy by means of a case study of the Freiburg area in southwestern Germany, which has evolved from a planned nuclear power and fossil fuel center to Germany's "solar region". Incorporating insights from ecological modernization theory, I show how the locally based push for renewables has grown into a challenge to the direction of German democracy itself.

KEYWORDS

citizen initiatives, corporatism, ecological modernization, energy transition, historical institutionalism, renewable energy

Introduction

Germany has become a world leader in transitioning from a fossil-fuel economy to a renewable energy-based one. This transition is remarkable for its speed–the first national "feed-in law" facilitating the development of

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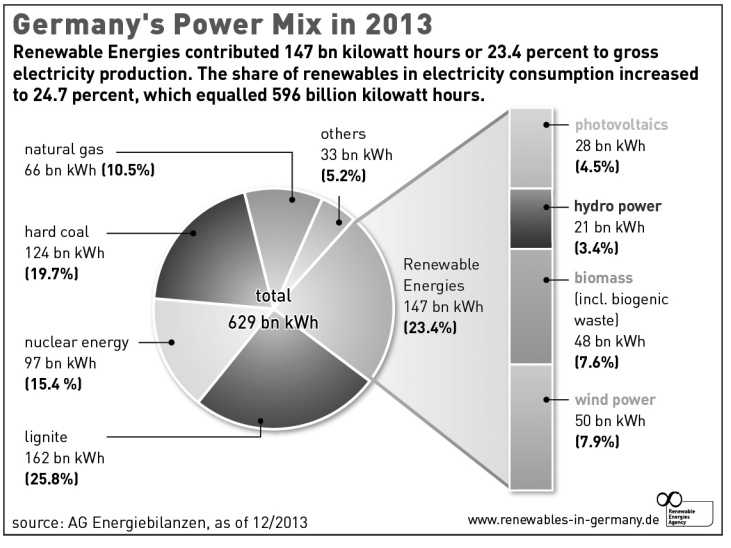
renewables was passed in 1990, and by 2013 renewables accounted for nearly 25 percent of Germany's gross electricity consumption (see Figure 1). What is less visible is the local networking that began in the 1970s and promoted this change. Renewable energy technologies emerged from and remained embedded in a local milieu characterized by concern with community quality of life and a commitment to grassroots activism. This movement crystallized with antinuclear protest, which was also a motivation for innovating in renewables.

Figure 1: GERMANY'S POWER MIX IN 2013



Remarkably, the early push for renewable energy grew up almost entirely outside the normal institutional channels of political participation and policymaking. German national-level and even state-level political institutions fought this change at first. So did the large energy utilities. Eventually, renewables advocates penetrated the federal ministries and the Bundestag. Federal legislation helped enlarge the boom in local energy production that was already underway, and it encouraged the further development of new forms of community investment and citizen participation in energy supply.

Recently, the federal government has shifted support back to the big energy producers. It has done this through direct mechanisms, like placing a ceiling on photovoltaic generation, which tends to be small-scale and privately owned. It has also acted indirectly by allowing policy "drift"–failure

to promote the new grid technologies necessary for decentralized supply, for example, and failure to make use of built-in mechanisms to control price increases.[1] But, the local and regional networks that were responsible for creating the push for renewables are still in place and are pushing back. They have developed their own supporting institutions, which supply "counter-expertise" in energy matters and which have come to occupy a prominent place in the German policy making scene. Furthermore, local economies have a large stake in the decentralized model of energy supply. Many municipal governments and private citizens have invested in renewables projects, and their success has empowered communities that are otherwise suffering from negative demographic and economic trends. Renewable energy has become a widely supported symbol of local independence. In a sense, the energy transition is shaping up into a battleground over the direction of German democracy itself.

The Energy Transition and Theories of Institutional Change

The energy transition can be a testing ground for theories of institutional continuity and change. The historical institutionalist literature focuses largely on why institutions tend to persist and how institutional breakdown or decay can occur as a result of shocks from outside.[2] Kathleen Thelen points out important limitations to this literature. She observes that institutions evolve in subtle and cumulative ways having to do with processes of inclusion and exclusion of aggrieved groups. Studies of institutional development should pay attention not just to what happens in the institutional core of the state, but also to "processes unfolding on the periphery" as they affect the center. The point is that excluded, aggrieved groups promote institutional change either by mobilizing from the outside, which may lead to institutional breakdown, or infiltrating institutions and promoting change from the inside, which may lead to "conversion".[3] At the same time, actors already included can make moves to reassert their power within institutions as they are challenged by newcomers or outside groups. This dynamic within institutions, which tends to be cumulative rather than abrupt, is the focus of much recent historical institutionalist analysis.[4]

This literature focuses on the way that endogenous and exogenous participants act on the central institutions of the state. At first glance, this focus would seem to be appropriate for Germany, whose policymaking style has generally been characterized as corporatist. The German system has clear insiders and outsiders. Policy is formulated by bureaucratic experts in coop-

eration with peak associations representing major societal interests (usually labor and industry). Elected officials are involved only after the policy details have been worked out behind the scenes. This system puts a premium on technical expertise and tends to exclude noneconomic interests.[5] A closer look at the trajectory of renewable energy in Germany suggests, however, that a more differentiated view is necessary. The move toward renewables arose from antisystem protest and took place almost entirely outside, and partly as a rejection of, the central state.

The German story may be better understood by bringing institutional theory in conversation with ecological modernization theory, which helps elucidate the processes unfolding on the periphery more on their own terms.[6] John Dryzek et al., in their book *Green States and Social Movements*, also focus on the relationship between states and outside groups. But, they add key insights about the ways that outside groups achieve influence in different institutional settings. They classify states' treatment of outside groups along dimensions of active and passive inclusion and exclusion. Corporatist Germany is classified as passive exclusive in part because the state does not purposefully shape societal participation but does act as gatekeeper, granting privileged access to certain groups. In addition, access by oppositional groups is limited by "the *Rechtstaat* tradition that sees the public interest in abstract, legal, and unitary terms, and an associated organic view of state and society that does not recognize conflicts, and so regards any opposition to the work of the administrative state as illegitimate and obstructive."[7] In the early years, fledgling environmental groups were regarded with suspicion by the center and kept well away from the core imperatives of the state.[8]

Dryzek's insight is that exclusion of environmental groups may actually foster a healthier civil society than inclusion where movements achieve little real influence. Moreover, Dryzek departs from Thelen by claiming that oppositional civil society may be able to create both policy change and change in the broader society even in the absence of overt institutional change at the center. This claim is borne out in the German case: the antinuclear movement was not coopted, nor did it prompt much institutional change at first, but the movement exercised a great deal of influence over energy policy nevertheless. Moreover, the passive exclusion of the movement "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."[9] Nuclear power became and has remained the focal point for a critique of technocratic decision making and for experiments in democratization and decentralization of authority that have gone hand-in-hand with the local promotion of renewables.

Dryzek's ecological modernization theory does not tell the whole story, either. The German case illustrates how the oppositional local culture fostered by passive exclusion is tied to technological innovation. The theory proposes that, when environmental protection becomes linked to the core economic imperatives of the state, environmental activists will be included (or coopted). Industry, already granted access to the state's core, will innovate in response to citizen environmental concerns. In renewable energy development, however, traditional industry has mostly resisted developing new energy technologies. Indeed, these are of a form–open source, local, small-scale–that fits uncomfortably to the traditional energy model. As David Toke points out, the critical public's involvement in energy politics is crucial for explaining the innovations that have occurred.[10] In Germany, the core industrial players responded to the local development of renewable energy technologies with retrenchment and use of political influence to reassert their monopoly control over energy. The lively debate over alternatives to fossil fuel and nuclear energy took place at first largely among the excluded groups, not at the center, and fostered networks of innovation[11] connected to this oppositional local culture. These networks maintain an uneasy relationship with the traditional energy giants, which still have not changed their business model to accommodate the array of new participants.[12]

Institutional accounts focusing on access to the core of the state may underestimate the extent to which social movements can create change by reshaping public perceptions of an issue from outside (and sometimes against) those political institutions.[13] This reshaping may have far-reaching consequences not only for public opinion, but also for policy makers as well as investors and developers of new technologies. As for the former, there is considerable evidence that anticipation of public protest now constrains German policy makers' choices at the policy formulation stage.[14] This has generally worked against large-scale energy projects. As for the latter, social movements help "shape entrepreneurs' perceptions of social and economic opportunities, as well as their motivation to take risks to exploit these opportunities."[15] This has worked in favor of the development of small-scale renewable energy technologies and local renewable energy economies.

The pattern of passive exclusion was important for technological and political innovation arising from the grass roots–the development of networks of innovation that eventually influenced federal policy but did not wholly depend on it for the spread of renewables. The prevailing institutions did not open up to renewables advocates at first, so they established their own, competing institutional network. Strengthened through iterated

conflict and pushed along at critical points by nuclear accidents and public concerns about climate change, this alternative network gradually won the ear of the German public, and legitimacy on energy issues shifted to these alternative institutions. Advocates did penetrate federal institutions, and with their help, federal policymaking eventually did accelerate the change that was already underway. But the local networks were already in place with an independent base of support, which continued to grow.

The necessity of changes to the federal renewable energy law, now that renewables account for more than a quarter of gross electricity consumption, has given an opening to conventional energy interests to reposition themselves.[16] Endogenous institutional players are attempting to turn the machinery of the federal government back to supporting a more centralized model of energy production implemented by the big utilities. Nevertheless, the local players, in part because of their exclusion, have developed their own power base from which to defend the decentralized model of renewable energy supply that has developed over the past three decades. The societal change and technological innovation that made the energy transformation possible have not depended upon movement at the core, so theories focusing on change there will miss important explanatory factors. Two models–for the organization of energy supply and for the organization of society–compete for Germany's future.

The remainder of this article explains the development and persistence of these two models. The following section focuses on national-level energy policymaking and grassroots opposition, beginning with the anti-nuclear protest of the 1970s. In the ensuing decades, the passive-exclusive German state succeeded neither in eliminating the opposition to its energy policy nor in coopting it entirely. I then turn to the growth of networks of innovation at the local and regional levels that propelled the German energy transition from below. This section is based on a case study of the Freiburg region in the southwestern German state of Baden-Württemberg. I use a process-tracing methodology to show how local citizens formed their own networks of supporting institutions, which defy the core/periphery relationship assumed in much of the literature.[17] The qualitative data were compiled from some forty-two interviews with participants in the Freiburg region's energy economy between November 2012 and July 2014. They are supplemented with archival research and reports from journals and newspapers. The last section shows how debates over changes to Germany's Renewable Energy Act demonstrate the confrontation of these two energy models, each corresponding to a different conception of state-society relations.

Overview of the German Energy Transition

Grassroots Citizen Mobilization and the Birth of an Eco-culture

The German energy debate arose around the permitting process for large, state-sponsored industrial projects. This process involved closed-door collaboration between federal and state economics bureaucracies and large energy utilities. The latter were nominally privately owned but enjoyed substantial subsidies. Lack of public access to this process provoked the citizen activism that characterized West German energy politics in the 1970s and 1980s.

The West German government's initial reaction to the energy crisis of the 1970s was to redouble its support for coal and nuclear power. Many citizens objected, however, and, from mid decade on, public protest against nuclear and coal-fired power plants grew. Energy protest was embedded in a larger array of citizen movements, including environment, women's rights, civil rights, and the peace movement, concerned with the quality of life and critical of what Jürgen Habermas termed the economic and administrative "system."[18] The protesters blamed Germany's corporatist authority structure for policy decisions that seemed sharply at odds with citizen values. They were especially critical of the established political parties, which in their view had failed to represent new societal impulses in government. By the mid 1970s, more West Germans identified themselves as members of grassroots "citizen initiatives" than of all political parties combined.[19] Of these, environmental citizen groups were by far the largest. Disgruntled citizens lacking access to the core of the state organized outside it and offered a fundamental critique of it. The federal government responded initially in the way that Dryzek et al. describe, by vilifying the movements, putting down demonstrations with force, and attempting to curtail the citizen participation provisions of the planning process.[20] Rather than quelling the unrest, this response seemed to confirm the meta-level concerns of the protesters.

The citizen activism around energy projects contributed to the founding of green and alternative voting lists throughout West Germany and eventually the national-level Greens in 1980. The original members conceptualized it not as a conventional political party, but as the parliamentary arm of the citizen initiative movement.[21] The Greens entered the Bundestag in 1983, where they worked to achieve more transparency in policy making and to bring the concerns of the citizen initiative movement into government by carving out a more substantive role for the legislature. One of their early actions was to force the formation of two special parliamentary commissions on energy issues. The many local and regional parties/voting lists,

along with the national-level Greens, formed a lasting tie between the challengers and the political establishment, but they had not yet penetrated the federal ministries at the core of state power.[22]

In the face of continued protests, public support for nuclear energy declined. The 1986 explosion at the Chernobyl nuclear power plant in Ukraine turned the West German public strongly and permanently against nuclear power.[23] This industry had occupied a key place in the government's long-term energy strategy. It had been especially hostile to the participatory concerns of environmentalists and to the introduction of renewable energy,[24] so its weakened position provided an opening for renewables advocates. The fossil fuel energy industry fared little better in the public eye after dramatic cases of forest die-off (*Waldsterben*) were linked to acid rain. Global warming became a target of grassroots mobilization by the 1980s, helped along by several widely publicized scientific reports warning of impending climate disaster. By the end of the decade, all the major political parties had declared climate change one of their priorities.[25]

It was against this backdrop that the German renewables industry arose. Citizen initiative groups were not solely focused on protest; they also pushed for decentralized, environmentally friendly industry and participatory decision making, which to them went hand in hand. This is the oppositional counterculture to which Dryzek refers. E.F. Schumacher's book *Small Is Beautiful* became something of a guidebook to the movements. Sustainable production using renewable resources was already a focus for them; renewable energy fit well with the new environmental paradigm, and experiments with renewables became part of the movements' general attempt to practice what they preached locally. Thus, grassroots groups were key to embedding alternative technologies in society *before* there was a federal policy framework.[26]

There were lots of experiments with small-scale solar and wind projects beginning in the 1970s. Some of these came directly from participants in the antinuclear movement. Wind power was developed by farmers, supported by greens, and helped along by people building prototypes in backyards, who were acting not for profit, but rather out of conviction. "Hence," writes David Toke, "an idealistic belief in a new alternative technology set up the conditions for a niche to develop in ways in which conventional industry, with its patent-based secrecy and expectation of early commercial returns, would find very difficult to replicate."[27] The local scale encouraged experimentation of a type that the big players could not coopt. It was completely separated from them and self-consciously opposed to their model. In this way, the passive exclusion that helped foster a strong counterculture also

inspired technological advances in keeping with its alternative, decentralized societal model.

Early Federal Policymaking and the Big Utilities

The federal government's contribution to this early phase mostly took the form of R&D funding through the Ministry of Research. It enabled universities, institutes, and firms to experiment with renewables, provided that these remain in a pre-market phase. Jacobsson and Lauber note that the more powerful Ministry of Economics kept a watchful eye on this development and generally supported the energy industry's desire to keep new producers off the market. Nevertheless, they write, "in spite of the fringe status of that R&D, a broad academic *cum* industrial knowledge base began to be built up ... for both wind turbines and solar cells."[28] But, this base was mostly outside the core institutions of the state. Partly in response to antinuclear activism, a publicly funded pilot wind turbine, Growian, was erected in northern Germany in the 1980s. The oversized turbine never functioned properly and was soon shut down; nuclear energy opponents "saw the project as a feint on the part of the state designed to prove that wind power was a lame duck."[29]

The concept of a feed-in tariff originated in Denmark and was developed in Germany not by the core players, but rather in the "counterexpert" institutes that had arisen from the energy protest of the previous decades.[30] A coalition of alternative energy advocates proposed the first feed-in tariff law. The law allowed small energy producers to feed extra electricity into the grid at a guaranteed price. Pressured by the public unrest and by organized advocates and their allies in the Bundestag, the government passed the law in 1990. The established utilities, busy with German reunification, did not pay much attention to it. In retrospect, it is clear that they misjudged its potential to alter the system of energy production.[31] The Ministry of Economics tried to substitute voluntary feed-in tariffs for a legislative mandate, but this effort failed.[32] The feed-in law accelerated the boom in small-scale renewable energy production, especially solar.

The interaction between the federal government, industry, and grassroots activists evolved from the 1970s to the 1990s. Government planners and investors in large projects wanted to avoid costly delays and to promote long-term "planning security." They had pursued this goal in the 1970s by attempting to repress citizen participation. In the 1990s, "even though the institutional configuration of the state had not changed much," writes Dieter Rucht, "state administrations had become more receptive to [activists'] demands."[33] For their part, citizen groups diversified their strate-

gies, promoting collaboration for expansion of renewables while maintaining the potential for grassroots protest, an inside-outside strategy that produced a two-pronged pattern of influence. The German environmental movement mobilized successfully to defend the feed-in tariffs on several occasions when the coal and nuclear energy industries tried to pressure the government to rescind them. Moreover, renewables producers began to professionalize, forming their own trade associations and gaining support from some existing organizations.

The law survived legislative and legal challenges at the national and EU levels. The traditional utilities joined with the Federation of German Industry and the Ministry of Economics to demand a reduction in the feed-in tariffs. They also challenged the law unsuccessfully in the European Court of Justice, arguing that it constituted a hidden subsidy. "The energy utilities had come to realise," writes Christoph Stefes, "that the [feed-in law] might herald the first step towards a new energy system that favoured small and decentralised generation."[34]

The Red-Green Coalition and the Renewable Energy Act of 2000

A Red/Green coalition government took office in 1998, some of whose members had first entered politics through the protest movements of the 1970s. The new government was much more committed to ending nuclear power and supporting the transition to renewable energy. Prominent among them was longtime solar energy advocate Hermann Scheer (SPD), who fought for the successful implementation of a "100,000 Roof Program" for solar power as well as a revised feed-in law, the Renewable Energy Act of 2000.[35] The new law expanded support for renewable energy and encouraged small producers by establishing guaranteed feed-in prices over a twenty-year period. The offered rates would decline over time to account for technological improvements. After gaining seats in the 2002 federal elections, the Greens successfully pushed for renewable energy to be moved from the purview of the Economics Ministry (led by the Social Democrats) to the Environment Ministry (led by the Greens).[36] This led to a reframing of renewable energy as a matter of environmental necessity rather than as a potential competitor to conventional energy sources.

This shift, while important, fell short of institutional conversion discussed by Thelen. The Environment Ministry remained at a distance to the core of state power and was susceptible to influence by subsequent appointment of less renewables-friendly ministers. The Economics Ministry, still the lead bureaucracy for energy policy, was much more resistant and protective of the traditional utilities, as Dryzek would predict: "patterns

of passive exclusion still tend to prevail in policy areas dominated by powerful economic interests."[37] After the 2013 federal elections the ministry was renamed Ministry for Economics and Energy, reasserting its centrality to the energy transition.

The Greens fell out of the governing coalition in 2005, and subsequent, conservative-led governments have been less friendly to renewables. When the Merkel administration tried to reduce renewable energy subsidies, shift support to the coal industry, and extend the life of Germany's nuclear plants, however, a new wave of protest mobilization arose. A 2010 antinuclear demonstration in Berlin was estimated to have been the largest since the 1980s. Mass demonstrations followed the chancellor's apparent reversal in early 2011 of her commitment to decommissioning Germany's aging nuclear power plants. The Fukushima disaster in Japan shortly thereafter sent tens of thousands more antinuclear activists into the streets. Merkel's positions contributed to the Christian Democrats' loss of two state elections that year to Red/Green coalitions and forced her reluctant government to commit to ending nuclear power in Germany by 2022 and achieving 80 percent renewable energy by 2050.

Thus, grassroots activism forced the federal government onto its current energy path and kept it there, both by making other alternatives politically infeasible and by making inroads into the legislature and Environment Ministry at a key juncture. The Economics Ministry did not really budge, though, and the governing coalition changed to one less favorable to the challengers. For their part, the big utilities were late getting into the game, declining to invest in renewables development and pressuring the government to curtail small-scale wind and solar once these began to take off locally.

My central claim is that renewables advocates have done more than prevent policy rollback. They have created a whole renewables-based infrastructure intimately connected to their ideas about grassroots democracy and community empowerment that is very skeptical of corporatist power. Their networks preceded the feed-in laws and in a sense made them possible. To understand how they formed and why they persist, we now turn to the prominent case of the Freiburg region in Germany's southwestern corner.

Case Study: Network of Innovation in the Upper Rhine Region of Baden-Württemberg

The area around Freiburg is now known as Germany's "Solar Region." It was not always this way. The West German, French, and Swiss governments

planned a massive industrial buildout of the Upper Rhine region between Basel and Mannheim in the 1970s.[38] The region became a center of citizen protest, particularly against nuclear power. The movement against a planned nuclear plant at Wyhl, near Freiburg, included an eight-month-long site occupation beginning in 1975 and a protracted administrative court battle. The protesters encompassed a broad spectrum of the population that defied political stereotypes–from vintners and small farmers to university professors and students. Their actions drew support from all over West Germany and beyond.

There was a strong feeling among the protesters that the principled rejection of nuclear power obligated them to offer alternatives. During the site occupation, some of the participants experimented with solar collectors. An exhibit of their homemade devices, in 1976 near the occupied site, drew more than 12,000 visitors.[39] People began to request solar collectors for their private homes. For many, the successful protest at Wyhl was the inspiration to work for a different energy future in their subsequent careers. Connections forged at Wyhl gave rise to a network of innovation that tied in with the nascent environmental and other citizen movements critical of the state and focused on local change ("think globally, act locally"). This was well before any federal legislative framework for promoting renewables existed–in Dryzek's terms, before the energy transition reached the core of the state. The network grew to the point where it gave the region a new identity that attracted ecology-minded citizens from elsewhere.

The network of innovation for renewables was built from several important components. These are described in more detail below.

Institutions of Counterexpertise—the Eco-Institute

The Institutefor Applied Ecology (Eco-Institute) Freiburg was founded in 1977 by twenty-seven scientifically trained veterans of the Wyhl protest. They noted that the fate of large energy projects was determined in the technical permitting process, and that lay citizens were at a distinct disadvantage in this process. They dedicated the new institute to generating what they termed "counterexpertise" in order to help citizens challenge the claims put forth by government and industry experts:

> 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 ...[40]

The Eco-Institute's young scientists not only produced technical information and testimony for these permitting disputes, they also broadened the energy debate generally by authoring their own expert reports. One of the first of these was entitled *Energy Turning Point.* It made the then-radical proposal that Germany withdraw completely from nuclear energy and showed how it could be done.[41] Government- and industry-funded mainstream science was uniformly on the side of nuclear power, and it was hard for critical scientists to find a research home. The Eco-Institute offered one. Former Eco-Institute CEO Rainer Griesshammer recounts that the relentless attacks from establishment science shook the confidence of the Eco-Institute scientists to the point where they checked their findings three or four times before publishing them.[42] Their prognoses, however, were borne out repeatedly, and with time, the institute's reputation grew. It also benefitted from an informal partnership with the emerging alternative press. Reiner Metzger, Deputy Editor-in-Chief of the newspaper *Die Tageszeitung* (*taz*), said, "After the founding of *taz,* the Eco-Institute was a virtual cornerstone of its reporting: finally there were experts whom the extensive eco-scene trusted."[43] Dissenting viewpoints on energy became much more visible and mainstream in the course of the 1980s, thanks largely to the Eco Institute.

The Eco-Institute saw its fortunes rise along with public concern over nuclear power and climate change. It now employs more than 100 researchers at three locations in Germany. It takes on about 300 projects annually, with clients ranging from private citizens to national and EU governments. While its science has become accepted by mainstream actors, the institute retains its independence and its ties to the oppositional grass roots.

Local Renewables Businesses

The protest at Wyhl inspired experimentation with solar energy technologies. Werner Mildebrath, who displayed his homemade solar collector at the 1976 exhibition mentioned above, received so many requests for solar collectors that he opened his own small business. He eventually won contracts from as far away as Egypt.[44] The burgeoning local demand for solar installations provided an opportunity for ancillary businesses such as carpentry and metalworking firms. This was long before there was any money to be made by feeding power into the grid; the early customers were motivated by conviction, not profit.[45] Wyhl veterans founded other high-visibility businesses that have since become calling cards for the city of Freiburg. One of these is solar architecture. Rolf Disch designed the city's first solar housing development, fronted by a solar-powered commercial development known as the "Sun Ship". Disch also designed the first private plus-

energy home, which serves as a demonstration project and also his private residence.[46] Freiburg and the nearby Black Forest have also become centers for ecotourism, capturing numerous awards for their innovations in this branch. Renewable energy businessman Jan Bresinsky says today, it is the region's small and medium-sized enterprises, many of them family owned, that profit from the energy transition.[47] They are more nimble and innovative than the big firms in a branch where customer orientation and innovation will be highly prized going forward.

Manufacturing

United by their interest in a renewable energy future, individuals in many different branches built an interconnected network that began to attract other pioneers to the Freiburg region. Manfred Volk took part in the Wyhl demonstrations as a student. Committed to promoting renewable energy technologies, he founded Volk Hydropower. His Black Forest factory produces water turbines and other equipment for customers worldwide.[48] Georg Salvamoser moved to Freiburg from Bavaria in order to open a photovoltaic installation firm and network with other solar pioneers in the region. He invested the profits from that business into Freiburg's first solar module manufacturing firm, the Solar Factory, which opened in 1998. The Solar Factory's innovative design made it the first zero-emissions manufacturing plant in Europe.[49]

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. The German government and the traditional utilities had been slow to recognize the commercial potential of renewables. Adolf Goetzberger, a renowned physicist who headed the Fraunhofer Institute for Solid State Physics in Freiburg, became fascinated with the potential for solar energy and lobbied the nonprofit Fraunhofer Society to let him open a solar research institute in 1981. The Fraunhofer Society "occupies a mediating position between the fundamental research of universities and industrial practice," requiring that a certain percentage of its funding come from contracts with industry.[50] The society was skeptical that solar energy could pay its way, but Goetzberger thought the positive climate in the Freiburg area would help applied research find a foothold there. The institute started with eighteen employees. Despite some "cliffhangers" into the 1990s, it became a European leader in development of solar cell technology and eventually thermal conversion, smart grids, and storage technologies. Today, with 1,200 employees, the Fraunhofer Institute for Solar Energy Systems is the largest solar

research institution in Europe. It trains hundreds of students for careers in the solar energy industry and partners with local and regional organizations promoting solar energy technologies.

Goetzberger networked extensively with renewable energy researchers elsewhere in Europe. As the regional network of innovation grew, it began to draw visitors from a wider radius. 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.[51] Led by the Department of Forestry, several faculties of Freiburg University founded a Center for Renewable Energies (ZEE) in 2007, which affiliated with, among others, the Fraunhofer ISE and the Eco-Institute.

Education

Another Wyhl veteran, Olaf Srowig, became director of Freiburg's Richard Fehrenbach Vocational School in 1982 and set about reorienting its mission toward the training of a skilled workforce for the renewable energy economy.[52] The school opened a "solar tower" on the grounds to teach students about the workings and maintenance of solar energy systems. Fehrenbach students are currently working on cutting-edge latent heat storage and solar cooling technologies.[53] 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. The school also provides a skilled workforce for the many small family craft businesses in the region. According to Srowig, 80 percent of these now have renewable energy work as part of their operations. With the region's changing demography, there is an unfilled demand for skilled employees. Family-owned businesses that have been handed down from father to son for generations often have no one to take over the shop. The school helps by supplying people who have not just basic skills, but also the creativity to innovate.

One of the features of the site occupation at Wyhl was the "Community College of the Wyhl Forest." Participants with specific expertise made public presentations at the site. The presentations covered a spectrum from nuclear physics to botany to folk music. Many of the lectures were designed to educate the local public about nuclear power and other energy technologies. The Community College was so popular that it continued long after the site occupation ended, hosting presentations in the surrounding villages for eight years. Later, an organizer of the Community College joined forces with the continuing education program at Freiburg University to give occasional weekend lectures on energy topics. This variant of the "Saturday University" works to inform the population of the entire cross-border Upper

Rhine region about new developments on the energy scene.[54] Freiburg thus offers university education connected to cutting-edge R&D in renewables, vocational education for the regional renewables economy, and continuing education to keep the active public informed of the latest developments.

Political Activism—NGOs and Greens

The protest at Wyhl coincided with the founding of Germany-wide environmental NGOs. BUND, the German Association for Environmental and Nature Protection (*Bund Umwelt- und Naturschutz Deutschland*) was a new kind of group that combined the political mobilization of a citizen initiative with the nature protection emphasis of traditional environmental organizations.[55] Its first managing director, Erhard Schulz, had been a participant in the Community College at Wyhl. He devoted BUND's resources to demonstrating the feasibility of an environmentally friendly local economy. The Eco-Station in Freiburg is perhaps its most popular project. Maintained by the City of Freiburg and run by BUND, it serves as an environmental education center and demonstration project in ecological living.[56] 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 antinuclear 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 conservative Christian Democrats. They decided to try for direct representation by running one of their members for the state legislature. Although he ran under the auspices of one of the smaller political parties, none of his campaign materials mentioned any party affiliation. Instead, he used the label "Citizen Initiative." His convincing win signaled to the group that they could gain local office with candidates connected directly to the antinuclear movement. This was one impetus for the founding of the local Greens.[57]

Networking Organizations

Local solar energy entrepreneurs, many of them Wyhl veterans, decided they needed an energy agency to promote their products and services. Finding no support at higher levels, they cooperated in founding a regis-

tered association, FESA e.V., locally.[58] FESA (Association for the Promotion of Energy and Solar [in the] Freiburg Region) 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."[59]

FESA was a partner in founding the Energy Agency Regio Freiburg, along with the City of Freiburg and some members of the Chamber of Crafts, in 1999. The regional agency acts as a consultant and liaison for renewable energy projects. It is the largest and one of the oldest regional energy agencies in Baden-Württemberg. The agency partners with the nearby Fraunhofer Institute and multiple universities on projects, and roughly half of its thirty employees are students doing internships with the agency. The agency consults on approximately 100 projects a year. Their clients range from individuals to communities to the federal government. CEO Rainer Schüle worked at the Eco-Institute before starting with Regio Freiburg. These agencies have been a critical force for expanding the regional renewables network and keeping local projects alive when more conventionally minded investors and public officials balked at supporting new ideas.

Another type of networking is done by companies created to help small investors participate in the local renewable energy boom, especially with wind turbines. FESA founded a limited liability company, FESA GmbH. It collects small investments and has helped hundreds of investors navigate the permitting and construction processes. Green Electricity Group Freiburg is another such company with a different organizational structure. Its director and principal investor, Andreas Markowsky, says his group tries to offer investment opportunities to those who live in the place where the project will be built, from the landowner (who receives rent) to investors in the turbine. They have a total of 2,500 investors in 200 facilities. They also work with some sixty municipalities. His firm does the management–from organizing the applications to maintenance of the facility–in return for a percentage. Markovsky says citizen demand is "enormously high;" their projects have all sold out now for years.[60] Municipal utilities are also offering citizens opportunities to invest in local renewables projects.

"Plus-energy" Villages

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.[61] The "Schönau Electric-

ity 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. The feed-in law enabled them eventually to sell clean energy nationwide. "Plus-energy villages," which produce more electricity than they use from renewable sources and sell the excess, have become a growing trend throughout Germany. I will profile two of the most well known here.

One township Markovsky's firm works with is Freiamt in the southern Black Forest, where seventy people are waiting to invest in the next wind project. Freiamt is a plus-energy community and a big tourist draw. Its prospects were not always so rosy. Five far-flung villages make up Freiamt, with no real historical community center. This was a deeply rural area of mostly marginal dairy farmers. Traditionally, people from Freiamt were employed as service personnel in the more prosperous towns of the region. Freiamt's political leaders worried about dwindling sources of employment and flight to urban areas. After the first feed-in law of 1990, investors from outside the region began approaching the farmers to lease their land for wind turbines. The locals feared that outsiders would come to control their land and pocket the profits, so they joined together to become energy entrepreneurs. Residents invested in several wind turbines. Some beef and dairy farmers switched to "energy farming" with biomass. They pump excess heat to public buildings and feed electricity into the grid. Many installed solar panels on barns and farmhouse roofs. The mayor says her office has supported the developments, but it was farmers who took the initiative.

Freiamt has experienced a boom in ecotourism that has buoyed the guesthouses and restaurants as well as the farms. The mayor calls it "energy tourism" and credits Freiamt's quick-thinking farmers for starting early, before the second feed-in law made plus-energy villages commonplace. One result that may not be visible to outsiders is a clear improvement in the self-confidence of the citizens here. "Now we are Freiamt and we're proud," she says. "Freiamt cannot go back," she adds.[62]

The township of St. Peter is a plus-energy village in the Upper Black Forest. It produces more than 100 percent of its electricity usage and also pumps residual heat to most of the village, including its famous Benedictine abbey, school, and shopping center. St. Peter has a community energy co-op that uses wood pellet gasification and wood chip combustion from local sources. The idea came from a *Stammtisch* of mostly young, idealistic residents. Wind turbines already existed in the township, and this group

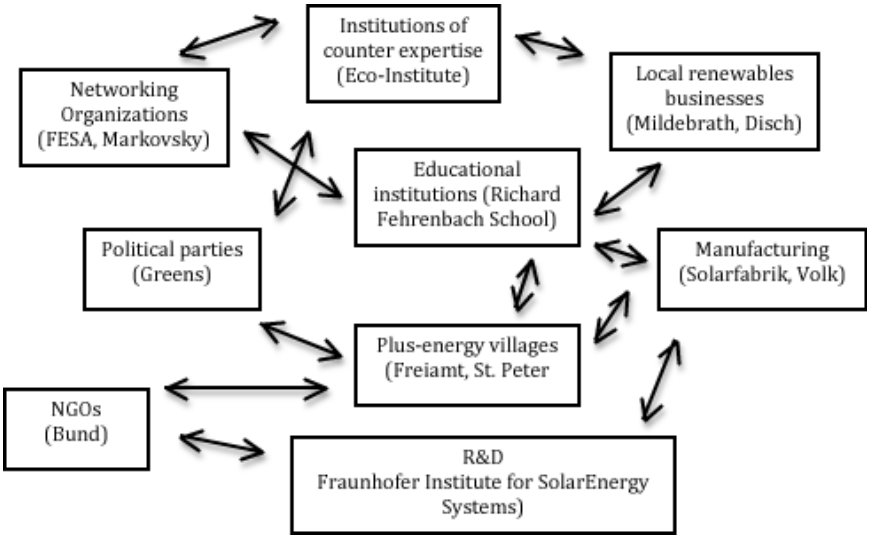
wanted to develop additional renewables-based projects. They hit on the idea of cogeneration of electricity and heat using local resources. Many farms and forestry operations in the area had more scrap wood than they could use and were willing to contribute it regularly. In principle, the group wanted to keep the energy production local–"a step toward world peace is to become independent of oil," says Markus Bohnert, Managing Director of the co-op.[63] Another goal was public participation–the co-op wanted its leadership to be democratic and transparent. They held open meetings and went door-to-door to find investors. Since wood gasification would be more expensive at first than oil, they argued in terms of the environmental virtues of wood rather than price. They found enough takers to lay the pipes for heating village homes.

The wood chip co-op has made the village famous. The co-op sold out its heating capacity and has more demand than it can fulfill. St. Peter has become an energy tourism destination visited by others who want to undertake similar projects in their own municipalities. Bohnert says the local restaurants profit from the increase in tourism, and everyone wants to see the "green *Stammtisch*" where the idea was hatched. Their sister village, St. Märgen, has formed its own co-op and implemented a similar project. One positive aspect is that, through the co-op, neighbors achieve positive change together. Another is the embrace of a progressive technology. These two things combined, says Bohnert, give local citizens "a completely different strength" and create a rallying point for the community. The co-op held its grand opening in the abbey courtyard to convey that the project, like the grand old sanctuary, belongs to the village.

In sum, a dense network of interconnected actors in politics, education, research, farming, and business gave Freiburg the ingredients needed for regional leadership in renewables: cutting-edge research, a skilled workforce, manufacturing and small business. The network of innovation formed well before there was federal support for renewables, and it was motivated in large part by opposition to the core industry and state players. It remains firmly anchored in a cultural milieu that favors local, environmentally friendly action. Figure 2 depicts this regional network.

The Renewable Energy Act of 2000 boosted 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 continued to grow as well. This development took on a life of its own as the region's green reputation grew. Freiburg won numerous "green city" designations and elected one of Germanys first Green mayors. Not all renewables businesses have succeeded, but the bot-

Figure 2: Networks of Innovation in the Freiburg Region



tom-up model of energy investment and innovation is firmly anchored in the population. 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 technologies.[64] 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.

Reform of the Renewable Energy Act: Putting the Genie Back in the Bottle?

Germany's energy transition has empowered citizens nationwide to become entrepreneurs and investors. As of 2013, roughly half of installed renewables capacity was locally owned by individuals and farmers, while only 5 percent was owned by the big utilities. Moreover, renewable energies had created 371, 400 jobs.[65] As the energy transition progresses, however, technological and political issues have arisen that tend to set the decentralized, local model against the model of change from the institutional core. One such issue has to do with the future role of conventional power sources. As a recent *New York Times* article notes, "the big German utilities are warning–or pleading, perhaps–that the revolution cannot be allowed to go forward

without them."[66] But, they are having a hard time operating profitably in the current constellation. Utilities argue that there is too much renewable energy in the grid, flooding it especially during the middle of the day and sending wholesale power prices plummeting. It is not profitable for utilities to power conventional plants up and down to cover for intermittent power from renewables. And their investments in large-scale offshore wind farms, incentivized by the changes to the Renewable Energy Act, are beset by costly technological difficulties.[67] "We were late entering into the renewable energy market–possibly too late," said RWE chief executive Peter Terium recently, by way of explaining the utility giant's $3.8 billion annual loss.[68]

Another issue is rising consumer energy prices and concerns that the costs of the energy transition are falling disproportionately on less well-to-do individuals. The Renewable Energy Act locks in the rates given to renewables producers who feed into the grid. Consumers pay a surcharge on their electricity bills that is supposed to reflect the difference between these rates and electricity wholesale prices.[69] As the latter have declined, partly due to technological innovation, the surcharge has risen. This evokes several socioeconomic justice issues. One is that the law has exempted many industrial customers from the surcharge in order to aid industrial competitiveness. These customers use 25 percent of Germany's power but pay only 2 percent of the surcharge.[70] Another is that urban residents, especially renters, have fewer opportunities to benefit by becoming small producers themselves. Renewable energy is also distributed unevenly among the federal states, benefiting some regions more than others.[71] There is an emerging role for the center in ensuring an even distribution of costs and benefits of the transition.

Finally, conflicts have arisen within the environmentalist community over the effects of renewable energy installations on wildlife and landscapes.[72] This is particularly true of onshore wind projects, which are meeting some resistance even in very pro-renewables areas like the Upper Black Forest. Concerns have also been raised regarding the wildlife effects of water turbines and energy transmission lines. These issues have not significantly dampened public support for the energy transition, which remains at nearly 90 percent, but they have made the public look more critically on its implementation.[73]

Periodic revisions of the act have enabled the government to tinker with the central-local balance and the distribution of costs and benefits of the energy transition. The 2012 revisions shifted support for renewables to large-scale projects, such as offshore wind farms, in addition to temporary increases in support for coal and natural gas extraction more compatible

with the centralized model of energy production. The government has been trying since the 2009 revisions to discourage the continued growth of small-scale solar energy production, arguing that the grid technology will not support it.[74] The feed-in rates paid to small solar producers are also often blamed for the rise in the surcharge, an assertion disputed by the Fraunhofer Institute in Freiburg as well as other expert institutions.[75] Despite these efforts, private installation of solar has continued to overshoot government estimates. The cost has dropped so precipitously that it would nearly be worthwhile to install roof panels without any feed-in payment at all. The 2014 revisions try a new tack, designating "corridors" for development with target limits to increases in solar, onshore wind, and biomass capacity, the forms most commonly invested in locally. For the first time the government will also levy a portion of the surcharge on those who produce solar power for their own use(rooftop solar on family houses is still exempted).

Conclusion

Germany is the largest industrial country to undertake a rapid wholesale shift to renewable energy. We can better understand how this unprecedented development came about by examining the relationship between the state and inside and outside groups. In Dryzek's terms, this study has shown how a passive exclusive state may inadvertently foster change. Partly because of their exclusion from the core of the state, citizen initiative groups of the 1970s developed a wide-ranging critique of the technocratic growth society, which crystallized around anti-nuclear protest. They also developed a new model for a decentralized, eco-friendly, grassroots-democratic society, from which support for renewable energy grew. As renewable energy has become more mainstream, so has this model, and it challenges the corporatist model of state-societal relations. 2013 survey data show that the vast majority of Germans support a rapid, decentralized transition to renewables.[76] A majority are critical of the Merkel government's support for the big energy players despite widespread concerns about costs and fairness. Any recentralization of energy production looks to many like an attack on local communities.

This study supports Dryzek's insight that a passive exclusive state such as Germany can be changed from the outside in the absence of much institutional change at the center. In the German case, the lack of access inspired a vibrant oppositional civil society that, while unable to impinge on the core economic imperative of the state, persistently challenged its legitimation

imperative. The movement's very exclusion from the core of state power, along with the anchoring of the alternative model in German society, kept the potential for grassroots activism alive and gave the push for renewables its community focus. Activists developed a two-pronged pattern of influence in which they infiltrated some federal institutions and mobilized for grassroots protest when necessary. As Dryzek would predict, the Ministry of Economics and Energy still favors a more centralized model and corporate producers but has been forced to take alternatives seriously as their proponents built a network of counter-expertise, activism, and professional organizations that could not be suppressed or ignored.

Like Toke, I would take ecological modernization theory a step further by highlighting the key role played by oppositional groups in technological innovation. As the Freiburg case shows, renewable energies spread through networks of innovation that were not dependent on major support from the center. Renewable energy does now impinge on the state's core economic imperatives, and it has resulted in institutional change, but the response from the center has not been to embrace the innovations made at the periphery as both ecological modernization and institutionalist theorists would expect. This study goes further than Toke in explaining why it is difficult to do so. The technologies favored by the traditional core players and the challengers are embedded in two different models of state-societal relations and economic organization, one centralized and top-down, the other decentralized and bottom-up. The uneasy coexistence of the two competing models, each with its own power base, characterizes German politics today. Reconciling them will be one of the primary challenges for German politics as the energy transition unfolds.

Carol Hager (Ph.D. University of California, San Diego) is Professor of Political Science on the Clowes Professorship in Science and Public Policy at Bryn Mawr College. She chairs the Political Science Department and directs the Center for Social Sciences at Bryn Mawr. She is author of *Technological Democracy: Bureaucracy and Citizenry in the German Energy Debate* (Ann Arbor, 1995) and co-editor (with Mary Alice Haddad) of *NIMBY is Beautiful: Cases of Local Activism and Environmental Innovation Around the World* (New York, 2015), as well as articles in journals such as *German Studies Review* and *International Journal of Urban and Regional Research.* She is interested in the ways in which lay citizens participate in issue areas with high technical content, particularly land use and energy politics. Her current book project (co-edited with Christoph Stefes) is entitled *Energy Transition in Comparative Perspective: Germany's Path to a Sustainable Future* (New York, forthcoming).

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