Expert View from Science

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Why We Need High-tech Politics to Make Renewables a Success Story

Abstract: With the continued growth of renewable energy technologies, major changes are under way in a growing number of energy systems across the globe. Wind, solar, biomass, hydroelectric and geothermal solutions experience an impressive boom and have created a new business sector worth US$243 billion in 2011. This trend is not caused by recent breakthroughs in engineering; in fact most of the technology has been around for some time. The way we organize our energy infrastructure is not primarily a technical matter; it is above all a political decision. The scale-up of renewable energy supplies at the cost of today's fossil-fuel dominated energy infrastructure is a systemic transition from one technology regime to another and thus requires political leadership for setting the targets, guiding institutional change, freeing resources and deciding on the relevant regulations. Today's energy systems are based on well-established routines and – as any other existing societal arrangement – are governed by a certain degree of lock-in: because people are generally happy to do things the way they have done it in the past, they are unlikely to embrace change quickly. These "lock-ins" shape, to a large extent, the speed of change as well as the type of solutions required in order to leave behind what works for today in favor of what we want to work for tomorrow. This article provides an overview of recent developments in the energy systems in Germany, California and Japan. We show that in order to appreciate the dilemma's that arise when creating a more sustainable energy system, we need to understand the local political landscape and how it influences decision-making processes. Looking at the three regions, it becomes evident that the level of political leadership determines much of what technology can do to facilitate innovation in the field of sustainable energy.

Keywords: renewable energy, high-tech, innovation

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With the continued growth of renewable energy technologies, major changes are under way in a growing number of energy systems across the globe. Wind, solar, biomass, hydroelectric and geothermal solutions experience an impressive boom and have created a promising business sector. The 2012 World Energy Outlook report states that "[r]enewables make up 60% of investment in new power plants, led by wind, solar PV [and] hydro" [1]. This trend is not caused by recent breakthroughs in engineering; in fact most of the technology has been around for some time. It is clear that technological expertise has contributed significantly to what is possible today in terms of cost efficiency and electric performance, but the way we organize our energy infrastructure is not primarily a technical matter; it is above all a political decision. The scale-up of renewable energy supplies at the cost of today's fossil-fuel dominated energy infrastructure is a systemic transition from one technology regime to another and thus requires political leadership for setting the targets, guiding institutional change, freeing resources and deciding on the relevant regulations. Today's energy systems are based on well-established routines and – as any other existing societal arrangement – are governed by a certain degree of lock-in: because people are generally happy to do things the way they have done it in the past, they are unlikely to embrace change quickly. These "lock-ins" shape, to a large extent, the speed of change as well as the type of solutions required in order to leave behind what works for today in favor of what we want to work for tomorrow.

Technology and innovative solutions can help introducing these changes, for example against the interests of those who prefer keeping the status quo. Consider the rise of the PC vis-à-vis type-writer manufacturers' interests in keeping the personal computer away from households. On the other hand, technology has its limits, and innovations need politicians (or decision-makers in general) who are willing to take the responsibility for the consequences of something 'new'. Energy systems are a case in point. For a long time, nuclear power generation was considered an acceptable risk by most decision-makers, and there was a firm belief among ruling elites in the ability to control the technology. To some extent, this changed in March 2011. Since the Fukushima catastrophe, political leaders across the globe are increasingly looking for alternatives. Germany, Switzerland and Belgium already decided to phase out their nuclear power supply, and in a recent development, French President Hollande announced to close one of its 58 nuclear plants by 2016, which is part of his election promise to reduce the country's dependency on nuclear (from 75 per cent to 50 per cent) [2]. In other words, Fukushima was the trigger for many to change their view on renewable energy solutions, and boosted the will to look much closer in what renewables can do in order to change today's global energy regime. Capital markets offer an interesting interpretation in this regard: according to Bloomberg New Energy Finance, 2008 was the first year when investment in renewables surpassed investment in fossil fuel technologies; and in 2011, the total investment in renewable energy amounted to US$257 billion, a seventeen per cent increase to 2010 – and a six-fold increase compared to 2004.

Sustainable energy for all: Combining innovative governance with high-tech innovation

Despite these large-scale investments, the current state of affairs still offers a discouraging picture. In 2011, 1.3 billion people still live without electricity, of which 95 per cent live in Sub-Saharan Africa or developing Asia, and 84 per cent live in rural areas [3]. The energy sources available in these regions are far from sustainable, and the expected demand increase in non-OECD countries is set to reinforce this trend. At the same time, most of these countries are unable to invest in research and development so that they could reduce their dependency on foreign fossil fuel imports. One could therefore argue that only if renewable energy technologies are being developed in high-tech economies, sustainable energy has a chance of solving the increasingly urgent global energy dilemma we face today: to secure a sustainable energy supply for a growing world population. This effect can already be observed in the world-wide decline in prices for onshore wind technology (from 2.000 EUR/MW in 1984 to 880 EUR/MW in 2011) [4], and more recently as a result of the major investments in solar PV by Germany, China and the US. In 2013, global market prices for solar PV modules have declined to US$0.74/watt, from US$76.67 in 1977 [5]. What counts for onshore wind and solar PV will likely count for upcoming technologies in the medium-term. The lesson we can draw from this effect: if industrialized nations invest in renewable energy technology, the rest of the world stands to benefit because new technologies become more affordable. In order to get there however, political leadership is required; and some countries clearly have more cloud than others. In the following, we highlight three regions in the world and explain why these should be watched closely when it comes to sustainable energy policies: Germany, California and Japan.

Germany: drawing others in

Germany has long been active in the field of renewable energy, but has only recently become the most cited example of a country committed to a radical turnaround in terms of energy policy: the so-called "Energiewende". Over time, the feed-in-tariff (FIT) system introduced in 1991 (and modified in 2000) created the 3rd largest market for renewables worldwide after US and China. It allows electricity producers to receive a guaranteed and fixed price per produced Kwh for 20 years, offering a high degree of investment security. At the same time, this policy choice has led to doubts whether incentive schemes characterized by high FIT rates are the best way to promote energy innovation (for example, Germany started off with a €0.50 tariff for solar PV in 2000, compared to a household electricity price of ca. €0.14 [6]. Many therefore consider the FIT as a subsidy which distorts the electricity market. Arguably, the biggest problem lies in the fact that instead of increasing the costs for energy externalities (such as environmental degradation, air pollution and CO_2 emissions), it gives a premium to renewable energy sources so that they become competitive vis-a-vis conventional energy sources. Put differently: while conventional energy sources should become less attractive because of the high external costs, renewable energy has to be made more attractive to those investing in energy infrastructure. Another problem is that this scheme is then bankrolled through the energy bills of consumers, and includes major exemptions for the most energy-intensive industries. One year into the Energiewende, this system has initiated a public debate in Germany about fairness: prices for those who consume the most are the lowest. The average household and the smaller businesses have to pay the renewable energy premium which is set by the state. A third problem lies in the fact that many of Germany's fast-growing solar PV companies have thus far been unable to develop business models that do not depend on the FIT payments. A large number of businesses now have little time to adapt to a changing world market. With a declining FIT rate, companies from outside Germany, notably Chinese, have been exploiting their competitive advantage: lower production costs.

Notwithstanding this restructuring process within Germany's solar PV sector, it is generally accepted that the FIT policy triggered a significant share of the innovation that has led to new technologies being developed in Germany and elsewhere, higher efficiency and ultimately, lower costs per energy unit: as a rule of thumb, costs for photovoltaic fall by twenty per cent for each doubling of installed capacity – in which Germany's FIT played an important role. In 2011 and 2012, respectively seven and eight Gigawatt PV power entered the system, and only 0.3 per cent were larger than 1,000 Kilowatt [7]. This decentrality is a major characteristic of Germany's evolving electricity infrastructure: in June 2012, Germany hosted approx. 1.22 million individual PV installations. This major shift towards a larger number of small renewable energy units is hard for others to ignore. In the European electricity market mutual interdependence is high, and Germany's exit from nuclear power in 2011 therefore has significant impacts across the continent. Gas-fired plants, whether they are based in Germany or in the Netherlands, make profits from making electricity available on short-notice, particular during peak hours at lunch time. With a growing share of PV power being fed into the grid, which carries no marginal costs, their business model is becoming increasingly problematic: the sun often shines during lunch time and drives down prices. This effect illustrates very nicely – and there are many other aspects with a cross-border element – that the German Energiewende is gradually creating a new reality for many stakeholders in the European electricity business.

The technological solutions that can shape the new system – a system that includes a growing amount of different renewable energy technologies – now adapt to the political decision. Wind manufacturers are investing in deep-water offshore technologies, as they are required for Germany's territorial waters; R&D in the field of power-to-gas is being scaled up because of the need to store electricity from the North, and energy-intensive industries located in Germany are considering to install their own wind warms. Without the clear political commitment to a non-nuclear power supply by 2022, few of these initiatives would have seen the light of day. The innovations are likely to follow, but the government faces a serious dilemma as it needs to find the right balance between setting a political agenda on the one hand (yes to PV premiums in order to guarantee investment security for those installing a rooftop system for example) and market-distorting regulations on the other (inadequately high FITs that prevent more competitive solutions being developed). For now, the public debate among the private sector, public entities, public opinion and scientific community has led to a rather lively and detailed discourse, in which actors have managed to voice their respective concerns. It brought about a growing awareness about each other's perspectives. While this all bodes well for a broad dialogue, and ultimately for the acceptance of such a massive infrastructure project, it is important for German policy-makers to stick to the overall goals in order to stimulate the required investments in new technologies.

California: the odd one out

In the United States of America, climate-protection and renewable policies differ widely throughout the nation. The state of California is clearly the US renewable energies success story. The state has enacted ambitious policies with a 33 per cent target for renewable energies in 2020, similar to Germany's goals, and established the first cap-and-trade-system in the country. With a population of over 36 million people, California is the eighth largest economy in the world and domestically leads in electricity generation from non-hydroelectric renewable energy sources, including geothermal power, wind power, bio power and solar power. California's rich resource base and its early, sustained support for the renewable energy industry has been successful in attracting and incubating a number of leading renewable energy companies. It is clearly a global hub for renewable energy research and development with a plethora of renowned universities and research institutions that are closely linked to business start-ups as well as investors.

In essence, there are two policy instruments that play a major role in California: the California Renewable Portfolio Standard (RPS), and the Assembly Bill 32 (AB 32). The California RPS sets the targets for electricity generation from renewables, while AB 32 aims to reduce greenhouse gas emissions.

The RPS program requires investor-owned utilities (IOUs), electric service providers, and community choice aggregators to increase procurement from renewable energy resources to 33 per cent of total procurement by 2020. RPS is part of a broader set of greenhouse gas legislation, implemented jointly by the California Public Utilities Commission (CPUC) and the California Energy Commission (CEC). The CEC's responsibilities lie in the certification of renewables for the RPS, the design and implementation of a tracking and verification system to ensure that renewable energy output is counted only once for the purpose of the RPS, and in verifying retail product claims in California or other states. In April 2011, the Senate Bill X1-2 increased the Energy Commission's role with responsibilities specific to publicly owned utilities. It directs the Energy Commission to adopt regulations specifying procedures for enforcement of the RPS for publicly owned utilities, requires the Energy Commission to certify and verify eligible renewable energy resources procured by publicly owned utilities and to monitor their compliance with the RPS [8]. The Public Utilities Commission in turn determines annual procurement targets and enforces compliance, reviewing and approving each IOU's renewable energy procurement plan and reviewing IOU contracts for RPS-eligible energy. It establishes the standard terms and conditions used for eligible renewable energy and calculates market price references for non-renewable energy that serve as benchmarks for the price of renewable energy [9].

The Californian RPS is not the only renewable energies portfolio standard in the country. But it is ambitious, highly effective and enjoys overwhelming public support. Since 2003, 2,871 megawatts (MW) of new renewable capacity have been added for commercial operation under the RPS program. More than 300 MW of new renewable capacity came online in the first two quarters of 2012, and another 2,740 MW is scheduled to come online until the end of 2012. In 2011, California saw the greatest year-to-year increase in commercially operated renewable generation since the beginning of the state's renewable energy scheme. At the same time, public utilities have already far outperformed the requirements: the state's IOUs served 20.6 percent of their electricity with renewable energy in 2011 (up from 17 per cent in 2010). In 2011, the Pacific Gas and Electric Company served 20.1 percent of its retail sales with renewable energy, Southern California Edison with 21.1 percent, and San Diego Gas & Electric with 20.8 percent. The intermediate target values for renewable energies were then clarified in 2012 with the Assembly Bill 2187 (AB 2187). It sets the renewable energy aims at 20 per cent by the end of 2013, 25 per cent by the end of 2016 and 33 per cent by the end of 2020. AB 2187 passed the senate with 36 votes yes and only 1 no, and was approved by California governor Jerry Brown in September 2012 [10].

In addition to the RPS, California has passed the Global Warming Solutions Act under the official name Assembly Bill 32 (AB 32). It is considered the roadmap to a green economy and requires California to develop a portfolio of regulations to reduce emissions to 1990 level by 2020 (–30 per cent). Until 2050 emissions shall be reduced by 80 per cent. In a scoping plan the state identified different market mechanisms and regulations (incentives, voluntary actions, cap-and-trade program) as suitable measures to reach the target. AB 32 was introduced in 2004 for the first time and passed the senate with 23 votes yes and 14 no in 2006 and the assembly with 47 yes and 32 in August of that year. It was signed by then governor Schwarzenegger one month later. The system has only been running since 1st of January 2013 and requires major GHG emitters such as refineries, power plants, industrial facilities and fuel-for-transport distributors to purchase emission certificates. The program covers 85 per cent of California's GHG emissions and will deliver a 15 per cent reduction compared to business-as-usual [11]. The first auction achieved prices of US$10.09/t, which compares to US$7.41/t in the European Emission Trading System ETS [12].

It is interesting to note that similar to Germany, polls indicate that there is strong support for the government measures. The Californian public feels it is important to hold polluters accountable and to invest in clean energy as well as new infrastructure. According to the Los Angeles Times, the cap-and-trade system is generally welcomed: 63 per cent of the voters said the law was needed, agreeing that the state needs to break from "outdated energy policies" and reward companies that produce energy from wind, solar and other renewable sources and to decrease U.S. dependence on foreign oil [13]. With the trading scheme in place, it is now time to see how industrial players respond to the financial incentive to reduce emissions. The applied research landscape across the state suggests that new technologies will find it easier to mature given the financial room that is being created by this policy measure. Coupled with the RPS, the cap-and-trade system could become an important driver of change in the field of renewable energy research and business development in the cleantech sector.

Japan: waiting in the wings

Japan is still recovering from the Fukushima disaster. At the same time, the nuclear fallout resulted in an attitude change: popular opinion at the beginning of 2013 paints the picture of a gradual shift away from nuclear. People are increasingly worried about the risks involved in a business-as-usual scenario. As a result, a major dilemma emerges. Nuclear power is considered a necessity for safeguarding energy security by some, and is seen as an unacceptable risk in the face of valid alternatives by others. In September 2012, former Prime Minister Mr. Yoshihiko Noda pushed ahead with a zero-nuclear agenda and tabled a new energy plan, which included the phase-out of nuclear power by the mid-2030's. The cabinet at the time had originally endorsed the proposal but dropped the deadline, introducing a flexible approach to implementing a more gradual phase-out.

The December 2012 parliamentary elections brought the opposition back into power, with a comfortable majority. The new prime minister from the conservative LDP, Mr. Shinzo Abe, is likely to work towards the re-installment of the nuclear energy regime, and to switch back on a to-be-decided number of nuclear power stations that had been switched off since the nuclear accident in Fukushima. Even though the upper house elections are still to come in June 2013, the new political playing field seems to suggest that a major change in Japan's energy policy is unlikely, and the question remains which road map the new government will follow regarding today's 30 per cent share of nuclear energy. It has however announced that it aims to reduce the country's overall dependence on nuclear.

From a technological perspective, the future of renewables in Japan looks promising. Wind power, solar power, geothermal and biomass-based generation could become major contributors to a less nuclear-dominated electricity supply. Wind introduction potential is up to 50 GW for on- and off-shore by 2050 [14]; and solar PV could bring up 75.2 GW. The future of geothermal power is a much debated issue because of the potential environmental damage to national parks, but could bring up to 23 GW generation capacity. In fact, geothermal energy resources are projected to have the 3rd largest capacity in the world [15]. Biomass estimates are much harder to establish but particularly waste-to-energy is considered to have a significantly higher potential than today's installed capacity of 3 GW [16].

Given this potential of alternative sources of energy, greater diversification would be a feasible step for Japan in order to avoid a growing resentment against nuclear power (consider for example another Fukushima-like incident in the near future and the potential popular response to it). At the beginning of 2013 however, Japan's political elite is inclined to continue business-as-usual, and drop any political attempt from 2012 to invest in renewables. The share of renewables (excluding hydropower) in national primary energy supply stood at less than two per cent in March 2012 and is significantly lower than in other OECD countries. For example, wind energy in Japan counts for 0.01 per cent of total installed capacity in 2011 [17], in comparison to 28.3 per cent in Denmark [18]. As the new government is set to reconfirm the need for a continuation of nuclear power, much of the potential will likely go unused.

Despite these developments, renewable energy might come in through the back door. Japan is one of the leading renewable energy nations in the world and ranks 3rd in terms of solar PV installed capacity [19]. In addition, the recent feed-in-tariff, which was introduced by the last government in July 2012, is currently the most profitable renewable scheme in the world. International investors are keen to move into the new niche and Japan could quickly become an attractive business opportunities for renewable energy companies [20].As a consequence, the new Japanese FIT can serve as an important catalyst for an emerging domestic renewable energy industry and could tap the potential of a green economy. A number of recent initiatives illustrate that there is movement from 'below'. Softbank President Masayoshi Son, the richest business person in Japan inaugurated one of Japan's largest solar power plants in Kyoto on the day the FIT was announced; a number of other large companies quickly responded to the nuclear catastrophe by investing in alternative energy. Kyocera Co., a Kyoto-based electronic and ceramics manufacturer, is planning to start a solar power plant of 70 MW capacity in Kagoshima Prefecture (Southern Japan) [21]; and Lawson, one of the biggest convenience store operators in Japan, decided to equip 2,000 of its 10,000 stores with solar power panels under the FIT scheme [22].

The year 2013 therefore holds an ambiguous promise for technology and renewable energy innovation in Japan. On the one hand, the political struggle between the advocates of nuclear electricity and the pro-renewable movement is only starting to be played out. On the other hand, the FIT offers an interesting incentive to invest in existing technologies, and might contribute to greater cost-efficiency for example in wind and solar energy solutions. For a longer-term positive effect on R&D in the renewables business however, the absence of political commitment is unlikely to make Japan a leading business location for renewable technologies.

Looking ahead: towards a global contract for sustainability

Given the massive energy demand increase in non-OECD countries, the success of renewables will not be measured by the installed capacity in the Western world. In 2012, the world's population has reached seven billion, 50 per cent of which 50 live in energy-intensive urban regions. The United Nations estimates that by 2030, the world will host 8.3 billion inhabitants and 9.3 billion by 2050. By that time, urbanization will be around 67 per cent. In other words: the world faces a growing urban energy challenge in the Global South. A global energy supply therefore calls for more readily available – and the continuous innovation of – renewable energy technologies.

The developments in Germany, California and Japan make clear that political commitment can make the difference between business-as-usual on the one hand and stimulating the required technological innovation on the other. Looking at the energy landscape, renewable energy technology is only at the beginning of its development. Much more can be done in terms of cost-efficiency and establishing new technologies. Think of storage innovation, tidal energy or floating wind turbines. Market forces alone, however, will not secure an adequate level of (financial) commitment to invest in these trajectories. Representing the most advanced economies in the world and with a prominent track record in high-tech innovation, political commitment in Germany, California and Japan would therefore have a significant effect on research and development across the globe.

Already today, renewable technologies are increasingly affordable for countries in the developing world. Thailand, Morocco and Kenya for example have announced large-scale renewable energy programs. Small island states are keen to become independent from costly fossil fuel imports, and less prosperous countries are increasingly interested to introducing sustainable energy solutions. At the time of writing however, political leaders in the Global South face serious financial constraints and remain cautious to invest public money in renewables. They view high-tech economies in the lead to developing those technologies, so that they reach marketability. Realizing such a 'global contract for sustainability' requires a clear commitment. Only if the political leadership in high-tech economies commits to sustainable energy, marketability for the rest of the world becomes a feasible option.

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