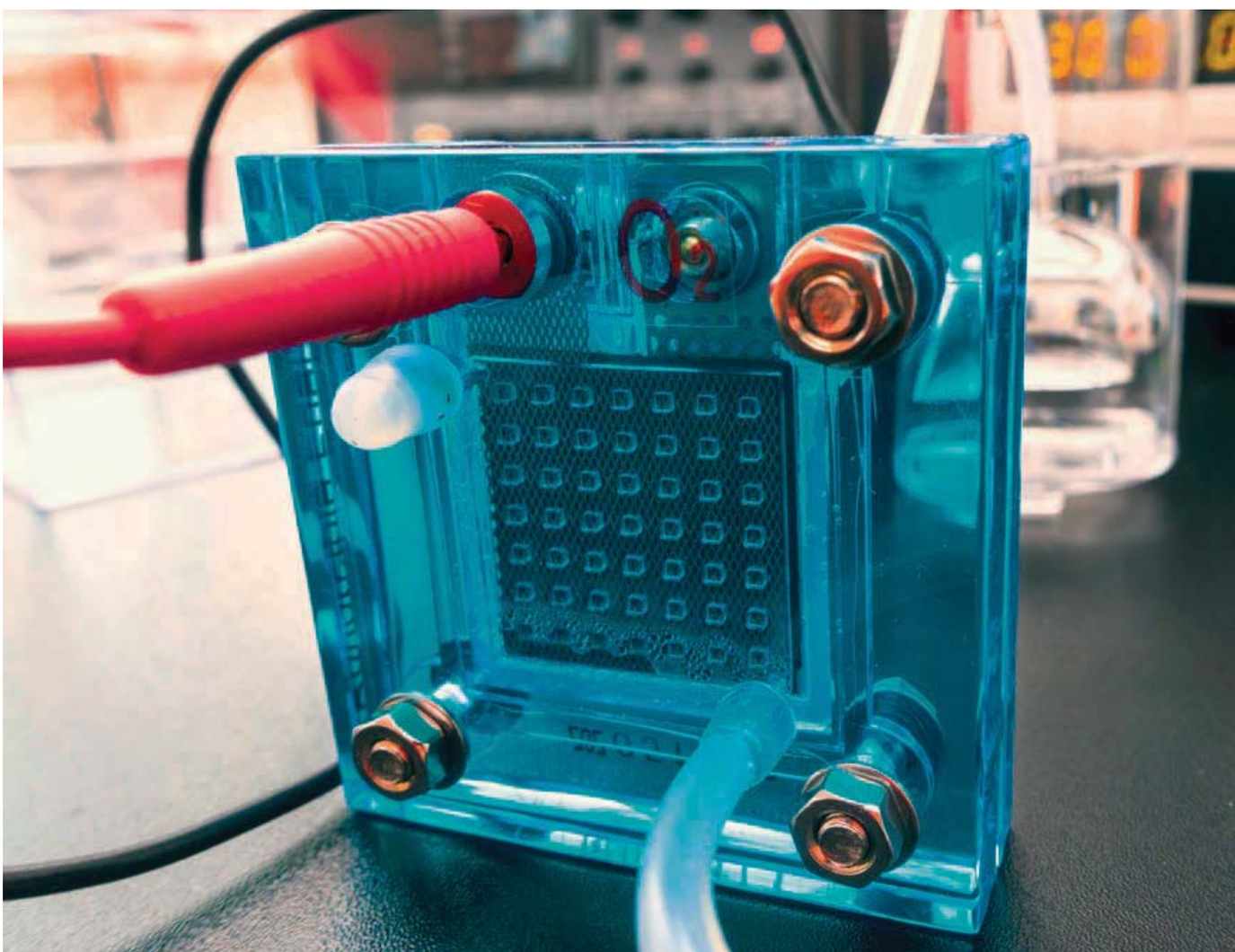
"Leading the Way with Our Technical Capabilities"

An Interview with Professor Clemens Hoffmann and Professor Ulrich Wagner

The interview was conducted by Dr. Claus Hecking

Professor Hoffmann, Professor Wagner, the expansion of renewable energy is progressing more rapidly than anyone expected: in 2015 nearly one-third of Germany's kilowatt hours of electricity came from renewable sources such as wind farms and solar parks, biomass and hydroelectric plants. Environmental activists are delighted. How about you?

Prof. Ulrich Wagner: This could not have been conceived of even in our wildest dreams. It is the beginning of a radical shift in our energy system: renewables will soon be Germany's most important electricity source. At certain times, for example Sunday mornings when electricity usage is low, and when weather conditions are good, the available wind and solar energy are already sufficient to meet the demand of the entire country. But not all the time; the fluctuations in supply can be extreme. If it is dark or cloudy and there is no wind



blowing, not much solar and wind energy can be produced. We then have to rely on gas, coal, or nuclear power plants to meet demand.

According to the plans drawn up by Federal Environment Minister Barbara Hendricks, Germany will switch off its last coal power plant by 2050. By that time our electricity supply is to come almost entirely from renewable energy sources. Is this possible, given such fluctuations in supply?
Prof. Clemens Hoffmann: The fluctuations in generation are indeed inherent to a renewable-based energy system. In the case of solar energy, this comes from the alternations between day and night and the changing cloud cover; in the case of wind energy, from the alternation between periods of strong wind and periods of calm. In order to deal with this, we have continued to improve the integration of the system. This will increase the flexibility of load-balancing power stations and of future consumption, and thus allow supply and demand to be more closely adapted to the fluctuations in generation. In the end this will result in a stable energy supply.

That sounds like a lot of effort. Is it even practical to aim for 100% renewables in the electricity sector?
Prof. Wagner: The technological ability to meet German electricity needs using renewables is theoretically already there. But there are certain economic limits. If we were to build enough plants to ensure the provision of Germany's electricity needs even on a cloudy, windless winter day, we would have an extreme capacity surplus the rest of the time. This is ecologically questionable, too, for the production of photovoltaic units or wind turbines requires enormous amounts of resources. The optimal ratio would perhaps be closer to around 70% renewables, with the remainder covered by gas-powered power plants, which have low carbon dioxide emissions compared to coal. The money that would be saved by doing this can be better invested in the building and transportation sector—these are areas where we still have a long way to go.
Prof. Hoffmann: The 100%-renewable scenarios aren't actually terribly expensive. We believe that the occasions when there is not enough power in the system will only account for some 10% of the entire annual electricity needs. At the same time, we expect that the return efficiency of large-scale energy storage can be increased in the future to 40%. This means that 40% of the original energy remains after the process of capturing electrical energy in a storage medium such as hydrogen and later converting it back into electricity. In other words, an electricity deficit of 10% requires two-and-a-half times as much stored energy in order to ensure that there will always be enough. So the entire renewable generation capacity only needs to be 25% more than the normal values; that is, we must build a capacity of 125%. Of course, the costs of storage technologies have to be added to the calculation, but we consider it vital that Germany will someday be able to meet all its electricity needs using renewable sources. If we do not prove that complete decarbonization is possible, we will not be able to convince the rest of the world that this is the right path.

At present, however, the federal government itself is curbing the expansion of renewable energies. It has implemented a "deployment corridor"—that is, the share of renewables in the electrical supply is not supposed to exceed certain thresholds: in 2025, for example, not more than 45%.
Prof. Wagner: This policy corrects a development that resulted from the success of measures introduced to encourage renewable use. The fixed support tariffs for wind and solar electricity in the Renewable Energy Act (Erneuerbare-Energien-Gesetz, EEG) resulted in high installation figures and drove forward the technological development. However, this led to a significant increase in the total costs of these subsidies—costs that were appreciable for the consumer. Politicians decided that the electricity surcharge could not continue to increase in this way, so they hit the brakes.
Prof. Hoffmann: I think this approach is a catastrophe. In order to successfully bring about a complete *Energiewende* over the next three-and-a-half decades, we have to expand capacity in solar, onshore and offshore wind power by about 8 to 10 gigawatts (GW) each, per year. This is technically and financially feasible. Currently,

1 *A variety of technologies can be used to convert energy to other forms: for example, fuel cells transform chemical energy into electricity.*
Photo: science photo / Shutterstock.com

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however, we are increasing photovoltaic capacity by only about 1 GW and wind by 2 GW annually. At this rate, we will need until the end of the century to achieve our *Energiewende*.

On the other hand, nothing prohibits citizens from installing wind turbines or photovoltaic units if they choose. They just have to do without the government-guaranteed tariff for their green electricity.
Prof. Hoffmann: The production costs are around €0.08 per kilowatt hour; the wholesale price of electricity is about €0.05. This difference has to be covered somehow, but it will not result in substantial changes in the EEG surcharge. But compared with the construction of a new coal-fired plant, renewable power installations are certainly financially viable already. They are even better value when compared with a new nuclear power plant.
Prof. Wagner: So now the expansion of renewable energy is being reined in. And yet it would be much more sensible to accelerate the adoption of renewable electricity in other sectors—for example, heating. That's where we're struggling. We are saving money in the wrong place.

Politicians also claim that the limits are necessary because the infrastructure is inadequate. Andreas Kuhlmann, head of the semi-public German Energy Agency, commented recently that "the expansion of renewable energy is happening five years sooner than planned, but the expansion of the grid is happening five years later instead."
Prof. Wagner: I doubt that we are only five years behind with the grids. We are going to end up with a major problem there. Very soon the extent of the grids will no longer be sufficient for our needs.
Prof. Hoffmann: We must continue to extend the grids, no question about it. But it makes me suspicious when I get the impression that people are just looking for another argument to restrict the continued expansion of renewable energies.

When the federal government decided definitively in 2011 to decommission all Germany's nuclear power plants by 2022 and shut down several reactors immediately, there were warnings that this would result in major blackouts. And yet this largely failed to materialize—why?
Prof. Wagner: Ten years ago there was already talk about how we could end up with power shortages. This never happened; instead we ended up with an efficiency gap. We continue to operate too many older, less efficient power stations. There are still a great number of these around, in particular lignite-fired power plants.

Is the absence of power outages also a reflection of the skill of our engineers at managing the power grids?
Prof. Hoffmann: We train these people. We manage this system well. That's something we can be proud of. Germany is leading the world here. The number of outages here has actually fallen since 2011 to an average of only 16 minutes per year for each end user. It certainly does not seem as though the *Energiewende* is threatening our comfort and convenience in this respect.
Prof. Wagner: However, there are already some tight spots. The frequency of redispatches is becoming a cause for concern.

Redispatches? What are they?
Prof. Wagner: Redispatches are times when the grid operator discovers that consumers are using significantly more or less electricity than had been predicted, and has to quickly buy more electricity from neighbouring grids or get rid of the excess. Both processes can be quite expensive. Ten years ago, when renewables did not make up as large a share of our supply as now, there were on average 100 to 200 redispatch cases annually. In 2014 there were already around 8,000, and for 2015 we predict there will be about 12,000. The costs could total up to a billion Euros by 2016. They are paid for by the user in the form of higher electricity grid fees.

One of the main problems for the system is regional distribution. A substantial proportion of renewable electricity comes from wind, which is most prevalent in northern and eastern Germany. But many of the large industrial facilities are in the south. How do we get the electricity to where it is needed?
Prof. Wagner: As the German Energy Agency stated in an analysis in 2010, we need three major north-south transmission lines. But then the expansion of the grid was postponed for several years—largely because of resistance from the Bavarian state government and from the many citizens' groups there. Those disagreements have now been solved, but now there is a new discussion about whether the transmission lines should be built through Lower Bavaria or the Upper Palatinate. Either option would ease the burden on the grid. If politicians continue endlessly debating whether there might be some other, better solution, this is, in my opinion, a waste of time. We need to start building now.

Even though hundreds of citizens—particularly in Bavaria—who live along the planned power line routes oppose the project?
Prof. Hoffmann: We all have to be completely clear about something: Why did we decide that the *Energiewende* was necessary? If people reflect deeply on this and weigh the pros and cons, local acceptance for the *Energiewende* will increase. For this reason, I think the initiative of the Deutsches Museum is an important way of educating citizens about the *Energiewende* and encouraging discussion. But I can also understand those who are pro-

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2 *Dr. Hecking (centre) in conversation with Prof. Wagner (right) and Prof. Hoffmann, who participated via video conference (left).* Photo: Deutsches Museum

testing. The landscape around them will be changed, and some of their properties will lose value. However, so far the residents have no reason to think they will benefit in any way from the transmission line. These acceptance issues must be solved by arranging for those along the route to receive some kind of financially measurable compensation.

Prof. Wagner: I have gathered from many discussions that people do not feel they are being listened to, in fact they feel excluded. People should be given the possibility to participate in such projects, maybe even to profit financially from them. That will not solve all the problems, but many of them.

How important is it to expand the transnational electricity grid across Europe?

Prof. Hoffmann: Very important—for a variety of reasons. First, the fluctuations in input are highly dependent on weather. And in Europe these are heavily dependent on high- and low-pressure areas. This means that when there are storms in one place, it is calm and windless somewhere else. Here the sun is shining; over there it is cloudy. These weather systems can be up to five hundred kilometres across. Which means that if we run a power line across distances of this magnitude, it is possible to balance out differences in the input of wind or solar electricity. Second, it is possible to link up the grid to countries that have large storage capacities. German electricity supply companies are already using pumped storage plants in Austria, Luxembourg, and Switzerland. There are also plans for a major undersea cable to Norway, which, thanks to its large hydroelectric power stations, has many times the storage capacity of Germany.

Prof. Wagner: Transnational grids can also distribute demand more evenly, simply because of the time differences between different longitudes. The midday peak, when the demand for electricity is particularly high, occurs at different times in a grid that stretches across borders and time zones.

In summer 2015, the federal government decided to maintain so-called reserve power plants. A number of coal-fired plants have been taken out of service but remain on stand-by in case electricity shortages do occur. More than 1.6 billion euros in premiums to the operators will be paid for by consumers. Is this a sensible plan?

Prof. Hoffmann: I consider it to be necessary. In the future, when we will rely on an even higher proportion of renewable sources to produce our energy, we will need a load-balancing infrastructure, ideally a mix of large and small gas power plants. These plants are part of a structure for ensuring the security of our electricity supply, just like the electrical grid, and their operators must similarly be compensated.

Prof. Wagner: I do not see any way to avoid payments for keeping such reserve power plants on standby, either. But it makes me pretty uncomfortable, as it runs counter to all market economy principles. It is a situation that has to have a time limit.

3 *German consumers are paying the operators of coal-fired power plants 1.6 billion euros to keep the plants in stand-by as reserve capacity.*
Photo: Reuters / Wolfgang Rattay

Which can only happen if we can find better ways to store electricity than we have had until now. What technologies do you think are the most promising?
Prof. Wagner: At present, conventional pumped storage is by far the best. This involves using excess electricity to pump water to a reservoir at a higher elevation. When electricity is needed, the water is released again, powering a hydroelectric turbine as it falls. The costs are low, the technology is proven. Unfortunately, the options for building new pumped storage facilities here in Germany is extremely limited. In terms of current knowledge and costs, perhaps the next best option is power-to-gas—that is, the conversion of electricity into gaseous energy sources such as hydrogen and methane. Unfortunately, during this process nearly half the original energy is lost. On the plus side, existing natural gas pipelines and storage facilities can be used for the transport and storage of methane. Hydrogen would be ideal for use in transport systems as a replacement for petroleum-based fuels.
Prof. Hoffmann: At present, we do not necessarily need all that much storage capacity in order to continue to expand wind and solar energy. If necessary, fossil-fuel-based reserve power plants are on hand to cover any deficit. At the same time, we reduce our carbon dioxide emissions proportionately to our production of wind and solar energy. Every gigawatt hour that we produce in this way is a gigawatt hour not produced using coal or natural gas. So the lack of large-scale storage technologies should certainly not be regarded as a reason to stop the expansion of renewables. But there is also no doubt that if we want to someday have 100% renewable energy, it will not be possible without more storage, and we have to start developing that now.

What storage technologies are you currently researching?
Prof. Hoffmann: Underwater pump storage facilities, among others. This involves installing hollow concrete spheres some 30 metres in diameter on the sea floor, taking advantage of the high pressure at this depth. Using excess energy, a turbine pumps water out through an opening in the tank. When power is needed, the seawater is let back in, driving the same turbine. This technology is particularly attractive for offshore wind farms as a way of balancing fluctuations in wind energy.
Prof. Wagner: Let us not forget about batteries, which offer a lot of possibilities for household applications in particular. Today quite small storage batteries with a capacity equal to four to six car batteries can significantly increase the level of self-sufficiency of a building that is equipped with rooftop photovoltaic units.

In the electricity sector the progress towards the Energiewende *looks very good so far. But what about other sectors such as heating and transport?*
Prof. Wagner: Here there is still an enormous amount of work to be done. The contribution of renewable energies to the provision of on-site heating is only about

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10% of the total. Even though for buildings in particular there are many technologies already available and no further away than the nearest home improvement store. By replacing windows or with strategic use of insulation it is possible to save a lot of energy and money. And in millions of households it is still the case that in the evening the heating boiler switches into cooler night-time mode, but the thermostats in the house are still turned on and attempt to maintain the daytime temperature, even though they are not supposed to. This waste can be easily prevented with smart thermostats, costing only twenty or thirty euros.

Prof. Hoffmann: The heating sector is the biggest emitter of greenhouse gases—and it is the one that would be easiest to convert to being CO_2-free, since most heating usage requires only low temperatures. Household heating only has to reach 20 or 21°C. Heat pumps have great potential here. They essentially draw on solar energy, namely heat that has been absorbed by the Earth. Using a heat pump, I can raise that heat to the temperature needed in the house. At the Fraunhofer Energy Alliance we have been able to show that the primary energy usage for heating can be reduced by 90%.

What is preventing this from happening in practice?

Prof. Wagner: For one thing, the tenant-landlord issue. To the landlord, it does not matter whether the appliances operate efficiently because it is the tenant who pays the costs.

Prof. Hoffmann: But the biggest problem is really the building itself, because the energy costs are low in comparison to the construction costs of the building. Thus, if I start to make serious changes to the shell of the building—new windows, insulation, panel heating—it quickly gets expensive. The drilling and installation of a heat pump is only a small part of this.

Prof. Wagner: Discussions about this subject shouldn't revolve only around the savings in energy costs. It's much better to point out increases in the value of the building, the improvement in living quality, noise reduction due to air-tight windows, or an aesthetic improvement to the building. The energy savings from replacing an old two-pane window with a three-pane one mean that with current energy prices, it will take a good 40 or 50 years for it to pay for itself. But there's a lot to say for having an attractive new window that blocks out noise from the street and reduces heat loss.

Let's turn to transport. Renewable energy sources make up less than 6% of this sector. Biofuels are highly controversial and electromobility just isn't getting anywhere. The prospects seem fairly bleak, don't you think?

Prof. Wagner: I don't see it that way at all. In transport, there are two main paths we can take. First, there's direct use of electricity in battery-powered vehicles, with the limits that come with this: a range of about 150 kilometres, a battery charging time of several hours. But in other respects, electric vehicles are already quite practical for everyday use. In addition, they can potentially serve an important function of storing surplus wind or solar energy. Second, I have high hopes for fuel cells that use synthetic hydrogen created by means of electricity from renewable energy sources. Here, limitations on travel distance are not as much of a problem. However, the power yield is also much lower than simply charging batteries with electricity and then driving off without any additional energy conversion.

So far, however, sales of electric vehicles in Germany have been quite sluggish. How can they be made more attractive to motorists?

Prof. Hoffmann: The break-even point for electric cars will arrive very soon. I drive an electric car myself. And my driving habits are fairly typical for an employee in Germany: ten kilometres to work and ten back again. Everything goes without a hitch. As is often the case with new technologies, initially many people underestimate the growth of the market. But I am convinced that in the next few years the electric vehicle market will take off…

Prof. Wagner: …Especially since the environmental footprint of electric cars is improving all the time. I expect that by 2020 there will be some 250,000 electric vehicles driving around Germany.

But at present it is still hard to find charging stations in many places. Does the government need to fund the expansion of this infrastructure?

Prof. Wagner: Not at all. People greatly overestimate the number of charging stations that are actually needed. We have a 1:10 ratio of charging stations to vehicles, and according to our calculations, there won't be any shortages as long as vehicles have an operating range of 150 to 200 kilometres. However, care must be given to the strategic positioning of these electric filling stations. For example, in public parking lots, airports or train stations—and especially at workplaces, so that the vehicle can be charging during the day while we sit at our desks.

Prof. Hoffmann: And charging during the day, during working hours, correlates precisely with the period when electricity production from photovoltaic units is at its peak.

Fuel prices have fallen to their lowest point for many years. Won't cheap petrol make the electric car less attractive?

Prof. Hoffmann: Well, it certainly doesn't help. But there are a lot of other incentives for buying an electric car. They are a pleasure to drive, the acceleration is unparalleled. And with an electric car you never need to go to the petrol station any more.

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4 *In absolute numbers, China has already overtaken Germany in the expansion of renewable energy.*
Photo: picture alliance / Photoshot

You both sound optimistic that the Energiewende *in Germany will be successful. What else still needs to happen?*
Prof. Hoffmann: The key factors are optimism, education, and political accountability. The energy industry is making investments that will only pay off after many years. This requires legal security and confidence that regulatory conditions that have been stipulated will be adhered to.
Prof. Wagner: We also need a comprehensive master plan that doesn't simply concentrate on the electricity sector but also includes the heating, building, and transport sectors. What absolutely cannot be allowed to happen is that the government in some way backs down from the goal of decarbonization.

How do the prospects for an energy transition look beyond our borders?
Prof. Hoffmann: Our immediate neighbours have joined us in the club of those willing and prepared: Denmark, Norway, Switzerland, Austria. But when we look to the east it becomes more difficult. In Poland, for example, they say "you in Germany can afford the energy transition, we can't". They disregard the fact that renewable energies are already economically competitive with fossil fuels.

5 *In the transport sector, renewable energies currently have a share of less than 6%; biofuels are highly controversial, and electromobility isn't making much progress.*
Photo: J. Lekavicius / Shutterstock.com

And beyond Europe?
Prof. Hoffmann: In the USA, the energy transition is driven not so much by ideology as by economics. Now that the break-even points have been reached, the foundation for enormous growth is there. In absolute numbers, China has already surpassed us in the expansion of renewable energy capacity. However, Japan is not pursuing an energy transition, even after Fukushima, and in the Arab world and in Africa there is still much too little being done. The situation in South America is quite varied, and Australia is one of the worst coal nations.

Nonetheless, representatives of 195 nations adopted a major climate agreement at the Paris Climate Change Conference in late 2015.
Prof. Hoffmann: But what will really happen if it is ratified and the resolutions are implemented? In many countries, there is often still no society-wide consensus on the necessity of sustainable energy policies as there is in Germany.
Prof. Wagner: I agree with this assessment. It is therefore all the more important that in Germany we continue to lead the way with our technical capabilities, and that we show other nations that an energy transition is possible.

◆ The physicist **Prof. Dr. Clemens Hoffmann** has been Director of the Fraunhofer Institute for Wind Energy and Energy System Technology in Kassel since 2010. Previously he played a leading role in expanding the renewable energy division of Siemens.

◆ Electrical engineer **Prof. Dr.-Ing. Ulrich Wagner** is Professor for Energy Economy and Application Technology at TU Munich. In addition to his research, from 2010 to 2015 he was on the executive board of the German Aerospace Center in Cologne, responsible for energy and transport.

Challenges

The Energy Transition as a Social Process

The Energy Transition Will Not Be Possible without Public Support

Why Citizens Must Be Involved in the Planning of the *Energiewende*

by Ortwin Renn

Public acceptance of measures or plans for an energy transition is dependent on four main factors: recognition of their necessity; a net positive balance of benefits over risks; the assurance that they as citizens will retain some personal agency; and the possibility of emotional identification with the project. It is not essential that all four conditions are met in their entirety, but approval, or at least tolerance, can only be expected if the people directly affected have a sense that all four have been met to a certain degree. Energy policymakers must therefore work to improve the preconditions for acceptance by creating the appropriate policy environment, by communicating to specific target groups, and above all by providing more opportunities for citizens to participate in public planning.

Societal Acceptance of the *Energiewende*

With the decision to phase out nuclear energy and to significantly cut down greenhouse gas emissions, Germany has set itself a Herculean task: bringing about a reduction in the share of fossil fuels in the energy supply from 80% today to less than 20% in 2050. The changes this will entail require substantial investment, organizational skill, willingness to cooperate, and innovative political initiatives. All this will be difficult enough, but in addition, it will only succeed if energy consumers and people who live close to the new infrastructures and facilities are actively involved. In surveys, 86% of respondents indicated that they were in favour of the expansion of these, 31% said that expansion should proceed at the same pace, and 55% even thought it should be speeded up. Only 12% said that fewer renewable energy facilities should be constructed.[1] At the same time, however, there has come to be a widespread belief that this transition can be achieved by politics and industry alone—all while maintaining the

same reliability of energy services, at reasonable prices, and without additional environmental impacts. Once it becomes clear, however, that the *Energiewende* requires changes which will involve additional costs and which can easily lead to an unequal distribution of burdens and benefits, this enthusiasm will quickly turn into disappointment and scepticism. The initial reactions to increases in electricity costs and the resistance to the upgrading of the grid have already made this clear.
In the years to come, a new wave of acceptance problems is virtually guaranteed. Whenever new power lines are installed, when wind turbines are built, when preparations for new "smart" models of electromobility and power supply require infrastructural alterations that involve small restrictions of consumer autonomy, resistance can be expected from the people affected.

1 *Pinwheels are an appealing symbol of a climate-friendly, renewable energy source.*
Photo: aodaodaodaod / Shutterstock.com

Requirements for Acceptance

In the case of large-scale projects, acceptance does not necessarily require favourability towards or endorsement of the planned project. Most infrastructure projects are not embraced enthusiastically. As a rule, it is sufficient for the political implementation of plans if those affected tolerate the presence in their lives of the necessary measures and facilities. However, for the vitality of the discussion and the initiation of learning processes in the community, it is of key importance that there are some who view the project in a positive light, as well as citizens who are actively engaged in supporting the planned measures. In order for acceptance of a substantial change in the living environment of the community, four conditions must be fulfilled:[2]

1. *Orientation and understanding:* If the measure is recognized as being necessary, and if there is support for the goals and the means of accomplishing them, then acceptance is more likely. But in order for people to get a clear idea of what the plans mean for them, they need information about the available options and about the planning process. Everyone wants to know what they can expect from the plans in the future and how they will be affected. This includes whether there are alternative options available, and if so, why those options were not chosen. Likewise, citizens want the arguments justifying decisions to be transparent and understandable.

2. *Agency, or self-efficacy:* People tend to reject changes in their lives if they feel that their freedom of choice and their control over the life they are accustomed to could be adversely affected. For example, people feel that any interference with the way they use household appliances or consumer electronics as a consequence of a smart-grid system (such as shutting off appliances when grid demand is too high) is an unacceptable restriction of their autonomy. To have to temporarily relinquish control over your electric car so that it can be used to help balance out grid fluctuations is also considered by most citizens to be an unacceptable intrusion into their private sphere. The more a particular measure gives the impression that it restricts the exercise of freedom, the more likely it is that there will be a lack of acceptance for it.
However, the agency argument also applies to the decision-making process itself. Only here the argument is the opposite: if individuals have the impression that their own capacity to change or even prevent an unwanted major project is not sufficient to have any political effect, then the measures are tolerated out of a sense of futility. Only when they believe that their own actions are capable of influencing the execution of the plan do people turn to politically effective forms

2 *The dancing electrical pylon "Zauberlehrling" (Sorcerer's Apprentice) was part of the public art exhibition Emscherkunst.*
Photo: Tuxyso / Wikimedia Commons / CC-BY-SA 3.0

of withholding assent. This can result in a paradoxical situation: the more opportunities people are given to get involved in the planning process as a result of official concessions or offers to participate, the more faith they acquire in their own self-efficacy, and the more the planning authorities have to reckon with effective public resistance. However, this should not be interpreted as an excuse for intimidating the local population or for an authoritarian imposition of a pre-selected plan. Fatalism destroys faith in government and leads to disenchantment with politics. Therefore, it is in the interests of planning authorities to strengthen the sense of self-efficacy of the affected citizens.

3 *Protesters in Brandenburg call for speeding up the energy transition.*
Photo: dpa

3. *A net positive balance of risks and benefits:* The more benefits people can expect from the planned measures for themselves and for those groups and individuals they care about, the more likely it is that the measures will be accepted. A higher likelihood of acceptance is also to be expected if the measures benefit everybody. In all communications, it is important for residents to learn whether they or those close to them will gain a net benefit from the project. Without information about the pros and cons, it is of course difficult to assess whether a proposal is desirable or not.
Both components—risk and benefit—must be given equal consideration in the evaluation of a project. As a rule, people try to avoid cognitive dissonance—that is, conflicting arguments or contradictions. Accordingly, empirical studies have shown that most people associate high risk with small benefits, and conversely, large benefits with low risk.[3] So as soon as an energy source is considered by the public to be risky or dangerous, its benefits to the community are automatically downgraded. The perception of risk is thus an important factor in determining the acceptability of any measure.

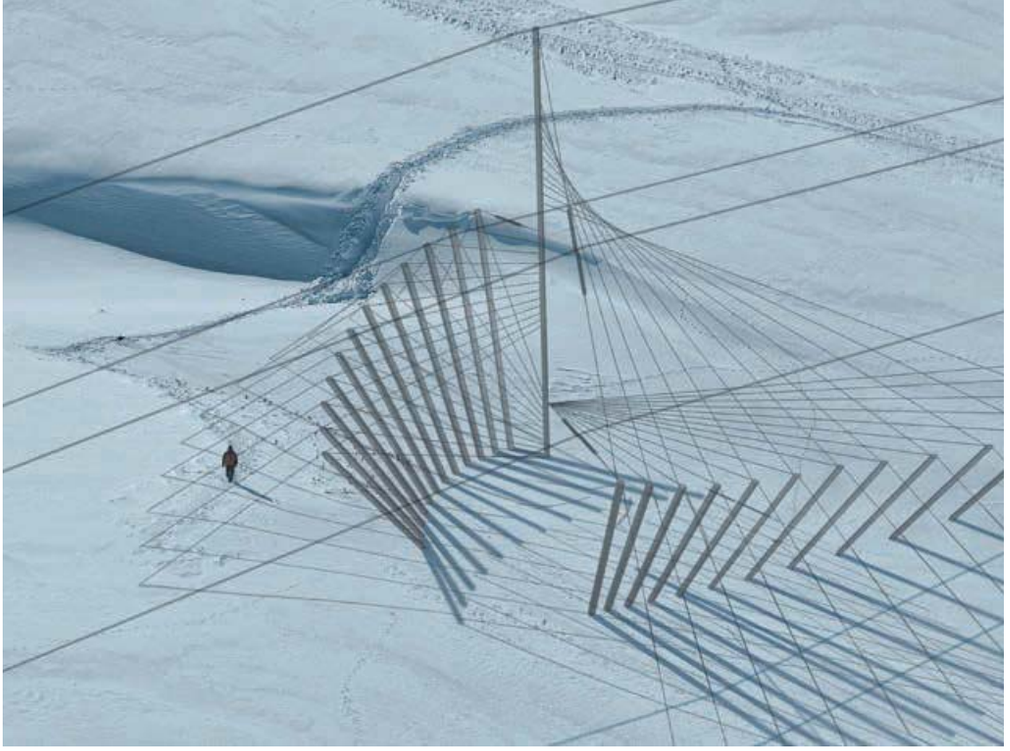
4. *Identification:* The more it is possible to emotionally identify with a project, the greater the willingness to accept it. When planning a new project, it is particularly important to provide information that helps residents to understand the significance of the proposal for the future development of the local area and to assess how well it fits with their own and outsiders' views of their

social and cultural world. In particular, new operational and ownership models (such as cooperatives, distributed share certificates, profit-sharing, etc.) are worth mentioning as a way of fostering identification with the project through emotional connections to property or to common goods. Likewise, having faith in the leading actors involved makes it easier to identify with the planned changes in the local community.

It is essential to design information and communication measures with these four aspects in mind if one wants to encourage acceptance of a proposed measure. A high degree of acceptance can only be expected if positive identification is possible and if can be clearly demonstrated the shared benefits of the planned project.

Combining Communication and Participation

The efficacy of communication in encouraging acceptance is limited, however. Especially in the case of projects that entail hardship for residents, and for which the communal benefits are still the subject of debate, it is almost impossible to improve the level of acceptance solely by means of information and communication, even if it is carried out interactively, in the form of a dialogue. In addition, large-scale changes tend to be seen as an imposition or intrusion from the outside rather than an enrichment for the community. In such cases, the cards are stacked against those with responsibility for communication.
Consequently, it is advisable to create opportunities for those who will be affected to participate in the planning so that they can look at the various options for themselves and decide to what degree the four criteria for acceptance are met.[4] A participatory perspective alters the political decision-making process. Communication means informing those affected about a decision that has already been made in favour of a particular option in the hope that they will accept, or at least tolerate, it. Participation, by contrast, takes as its starting point an open-ended process of consensus-building and entrusts the citizens involved in this process to develop new options within a legally defined framework and evaluate existing ones on the basis of their own ideas and judgement. When those affected by decisions become decision-makers themselves, then identification is generated by the process in and of itself.[5]



4 *To increase public acceptance for pylons, some projects propose making them more aesthetically appealing and adapting them to fit in with the landscape.*
Photo: Centipede Snow Field, Copyright 2015, Choi + Shine Architects

Summary

An energy transition can only succeed if social structures, decision-making processes and developments are taken into consideration from the very beginning. For sufficient consideration to be given to such processes of social change, the public has to be involved early on in the definition and analysis of the problem and the path towards a decision. For the only way that the energy transition will be perceived as a task that involves all of society—and the only way it can succeed—is if citizens are involved from the start in the process of making it a reality.

1 TNS Emnid Umfrage. Die Deutschen wollen die Energiewende. www.check24.de/strom-gas/news/umfrage-deutsche-wollen-energiewende-60364/ (accessed 10.1.2017).
2 A breakdown of motivations similar to the model used here can be found in Fiske, Susan T. Social Beings: Core Motives in Social Psychology. Hoboken (NJ): 2010, pp. 89–92. She lists the following basic motivations: understanding, controlling, and self-enhancing. However, she does not mention benefit, which is undoubtedly an important motivation. On collective actions compare Zomeren, Martijn van; Postmes, Tom; Spears, Russell. Toward an Integrative Social Identity Model of Collective Action: A Quantitative Research Synthesis of Three Socio-Psychological Perspectives. In: Psychological Bulletin 134 (2008), pp. 504–535.
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