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Research article

Does politics matter? Explaining swings in wind power installations

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Abstract: This is a social science article on the politics of wind power, and on whether or not politics actually matters. While it may seem obvious that politics actually does, I argue that the arguments that we encounter about wind power very often are about economics, technology or geography, arguments that have something deterministic to them, and which leaves politics a lesser factor. Against this, I argue that while these arguments may go a long way toward explaining the general upward trajectory of wind power, they do a bad job of explaining swings in wind power installations, why some countries are more successful at wind power in general, and why within countries, you typically have periods of both stops and starts. For this, we need a political explanation. Of these, there are many, but from the vantage point of political economy, I suggest a focus on vested interests, among other reasons because this is an explanation that can be used to analyze both democracies and non-democracies, and both presidential and parliamentarian systems. Methodologically, the study is a qualitative comparative case-study of five countries (US, Denmark, Japan, Germany, China) employing a combination of John Stuart Mill's comparative methods and process-tracing. The main finding is that if you want to explain swings in wind power installations, you need to focus on the political system, and in particular on the interest politics that goes on behind the scenes. While economic, technological, or geographic explanations all provide useful amounts of understanding, neither explanation can explain swings. There is only one explanation that remains constant and important in every one of the five cases. Economics, technology and geography play different roles in different contexts to different extents. Politics on the other hand always plays a role.

Keywords: wind power installations; politics; vested interests; swings; development trajectories

1. Introduction

Does politics matter? And in this case, does it matter with respect to wind power? To a political scientist the question sounds almost banal. In our field, we are raised to believe in the importance of politics and political processes. Of course politics matters! However, if you consult economists, they will talk about getting prices right–wind power will expand fast once it is competitive. Others, both in the social and the natural sciences, resort to arguments centering on geography, or resource endowments: countries with unresolved energy problems and/or an abundance of renewable resources will have more ambitious renewable energy policies. And engineers like to think that once the technologies have become sophisticated enough, the world will realize that wind power presents a more desirable solution than fossil fuels and nuclear and that this will lead to mass installations of wind energy. In other words, there are theoretical takes that seriously downplays the role of politics, and instead suggests that wind power can be explained by recourse to variables outside of the realm of politics.

But what this also means is that these approaches essentially emphasize development *trajectories* rather than swings. In other words, the emphasis is on variables where the variable value either rarely changes (such as with resource endowments) or where it develops steadily in one direction (gradually falling wind power costs, technological progress). If we focus on aggregate figures, this makes sense. Wind power installations have grown at a rapid and steady pace, from 17 GW in 2000 to nearly 487 GW in 2016 [1]. This growth reflects steadily falling costs and improving technologies. Which lends credence to arguments that as soon as wind power is cost competitive with fossil fuels, or as soon as the technologies are sophisticated enough, investors will rush in and channel their money into wind power over fossil fuels. And voila, within a foreseeable future, the world's energy problems will be solved and an energy transformation achieved.

But if we break down aggregate figures and look at the national level, for so many countries what emerges is an image less of irresistible growth than of periods of growth punctuated by periods of stagnation–starts and stops. These, I argue, are indications that politics matters. They are not starts and stops that can be explained by changes in resource endowments (these are rare in any case), by wind energy becoming more or less cost-competitive (which happens, but if so, we would expect most countries to experience similar fluctuations in installations, which is not the case), or by a technological breakthrough or a lack of technological progress (which also happens, but again, then we would expect most countries to experience similar levels of progress, which they do not). Granted, the international economy, to mention one general factor, is not unimportant. Investments in renewable energy worldwide dropped significantly after the financial crisis (e.g. [2]). But this article is not about explaining swings that happened simultaneously in all countries. Rather, it is about explaining swings that happened independently of each other in five very important wind power countries. The countries are the US, Japan, Denmark, Germany and China, and what I try to do, is to explain the swings by linking them to domestic political changes, using vested interests as a theoretical angle, in the process showing how the swings have had major impacts on the development of wind power in these countries.

Focusing on swings obviously does not mean discarding other explanations. Wind power becoming more competitive–because prices fall or because new technologies appear–and resource constraints–as in some countries desperately needing renewable energy for energy security reasons whereas others are so richly endowed for instance in waterpower that there is hardly any incentive

for wind power–are obviously important. It is also obvious that these explanations sometimes go together. Technological breakthroughs may entice politicians to more enthusiastically embrace wind, whereas developments such as the fracking revolution in the US has made petroleum relatively more competitive, and thus put pressure on politicians to shift their attention from wind back toward petroleum. Still, what we see in a number of countries are swings that cannot easily be explained by factors outside of the political system. My attempt at an explanation focuses on how changes to the political environment can lead to changes in interest coalitions, changes in the power relationships between different actors, changes in public opinion, and new windows of opportunity.

Empirically, this article to a major extent draws on my book from 2015 [3], but in addition to updating and expanding on this material, I shift the attention more specifically toward the actual swings and the stories behind these.

I have chosen to structure the article around a number of graphs. Granted, graphs never speak for themselves. But they can be good at illustrating trajectories, as well as breaks in those trajectories. My job is to provide the explanation for those breaks. There is obviously no such thing as one objective selection of graphs. This is my selection, and the choice has been made because I think that these are graphs that make it obvious to the reader that there is something here that needs to be explained, a story to be told. They are not graphs showing smooth upwards developments or trajectories. Instead, they suggest to the reader that there are stops as well as starts that need to be explained.

This is also a selection of countries that are all important wind power countries. Thus, on the one hand they are obvious cases in the sense that they are cases where there is quite a lot of energy and wind power politics to explain. On the other hand, it constitutes a bias in the sense of privileging cases where politics has been important over cases where other explanations, such as cost-effectiveness or resource endowments may have greater explanatory power.[1] However, with the exception of Japan, they are also countries where quite a lot of wind power has been installed. Which means that even in countries that can count themselves as wind power successes, developments have been far from smooth. Again, instead there have been stops and starts, and again, these can best be understood by politics. I am not claiming that politics trumps every other explanation in every single case. I do however claim that the swings must be understood primarily as driven by politics.

2. Theory and Methodology

Behind the rather banal question, does politics matter, lies a more serious issue. What is it that drives wind power policy? Is it primarily driven by market forces, by technological progress, by resource endowments, in other words factors that are primarily outside of the political process, or rather by a political logic? Of course, in real life, the answer is a resounding all of the above–it is obvious that renewable energy becoming more cost-competitive increases its chances, it is obvious that better technologies do the same, and it also makes sense for countries that are resource-rich to be less interested in renewables, such as wind. But is it the case that these are more important than

[1] It could for instance be argued that Norway is a case where resource endowments (a wealth of hydropower) in combination with a strong focus on cost-effectiveness as the foundation of energy policy provides very small incentives to pursue wind power (even if a closer reading of the Norwegian case reveals that there is a lot of politics involved as well) (e.g. [3]).

political processes internal to countries, and often characterized by local contexts, party political histories and experiences, interest group strength, lobbying, etc.? A look at aggregate installation statistics for renewable energy reveals a strong and largely unbroken upward trend for wind power. But broken down to individual countries, what we see instead is a history more of starts and stops. Thus, what I argue is that whereas factors outside of politics can account for long-term trends, for the starts and stops, we need to look at the political system.

If the long-term trend is one of remarkable overall growth, does it even matter that national histories are littered with cases of starts and stops? In 2011, wind power accounted for 2.3% of electricity production, rising gradually to 3.7% in 2015 [2,4]. In 2000, the world had installed 17 GW of wind power, by 2016 rising to 487 GW [1]. In other words, regardless of national ups and downs, the case could be made that the overall trend is what is important. Such views however, fail to take into account that a large proportion of the wind power capacity that is being installed every year falls on a relatively small share of countries. For four years in a row (2013–2016) China has accounted for 40–45% of the world's total installations. Thus, to a considerable extent, worldwide growth is driven by Chinese growth and Chinese wind power policy, and not because wind power is more cost competitive in China or technologically more advanced than in other countries. Thus, if we want to know why some countries have been more successful than others with respect to wind power, we need to look for explanations at the country level, rather than the aggregate level. And as we shall see, there has been lots of variation within and between countries. The IEA [5] states quite clearly that policy uncertainty persists in too many countries, slowing down investments. It also states that we are moving towards a two-speed world. One is Asia, which is rapidly taking the lead in terms of installations, but where this only accounts for a modest share of what is also a very fast rise in electricity demand. The other consists of the EU, Japan and the US, where renewable generation is increasing at a slower pace, but where this growth is actually outpacing growth in electricity demand.

Again, to suggest that politics matters may seem banal. However, even a very brief look at the discourse of renewable energy tells us that a large part of it is focused on the extent to which renewable energy, whether wind or solar, can compete on price with fossil fuels, or when it will happen, the assumption being that once cost competitiveness is achieved, investments will soar. The Economist [6] states that instead of being politically relevant, economists prefer to be theoretically correct, excluding politics from their models. "Many economists shy away from such questions, happy to treat politics, like physics, as something that is economically important but fundamentally the business of other fields".

Cost competitiveness is a focus also of the UN [7], the IEA [8,9], and of a host of other institutions and organizations (e.g. [10,11]). Yao et al. [12] asks when wind energy will achieve grid parity in China, the answer being a combination of technologies and economics. Jensen and Undeland [13] emphasize that while there is no convergence toward a single winner when it comes to wind power technology, and that it is very hard to predict the technologies of the next decade, technological progress has been rapid, lowering the cost-of-energy greatly, and that one thing is for certain, namely that only technologies that keep lowering the cost-of-energy will prevail. The Danish Wind Industry Association [14] suggests grid parity for Danish offshore wind between 2020 and 2025. Focusing on resource endowments, Eikeland and Sæverud [15] conclude that the ambitiousness of a country's renewable energy policies mirrors the seriousness of its energy problems. This is the obvious energy-security perspective. Countries with unsolved energy problems (and/or more abundant renewable resources) have more ambitious renewable energy

policies. Politics is a lesser factor. It is the structural conditions circumscribing the country that determines its wind power stance. It is also a perspective lobbied for and supported by petroleum industries worldwide. The world will be overwhelmingly energized by fossil fuels for the foreseeable future (the share of fossil fuels in global final energy consumption has only dropped by two percentage points from 80.4% in 2004 to 78.3% in 2014 [2,16]). Thus, energy policy worldwide will be constrained by the resources that we as a planet have at our disposal, and no policy initiative can bypass the hard geographic reality that renewable energy will remain a bit-player for decades still to come. In all these approaches, politics is a lesser factor.

Against this, I argue that politics makes a major difference, and that this can be seen most clearly by looking at and trying to explain the swings that different countries have experienced in their wind power installations.

Obviously many different approaches could be taken when theorizing about the political system. The suggestion that I make here is therefore not the only conceivable one, but it is my suggestion that we look more closely at decision-making and interest coalition building within the state. More specifically, I suggest looking at how vested interests within the state often have the power and the influence to significantly alter policy-making, and that swings in wind power installations from year to year can often be explained by the vulnerability of politics to vested interest pressures. Sometimes, it could be as simple as another political party coming into power with different policy ideas, in which case the swing in installations can be explained by a political swing, but very often political processes are more complex, involving interest organizations, institutions, bureaucracies, industry, academia and other research institutions, public opinion, and so on. While obviously acknowledging the changes that may happen as the result of an election, the focus on vested interests is something that enables me to look not just at democracies, but also non-democracies (in this article China), the basic assumption being that there is no reason to think that interest group politics and battles do not exist in non-democracies. The most important point still remains to illustrate how politics sometimes changes rather rapidly, and that despite long-term trajectories of falling costs and increasing cost competitiveness, these changes are of major importance.

Needless to say, scholars have provided numerous interpretations on the vested interest theme. The notion that industries seek to utilize the state for regulations and institutions to their own benefit, rather than the economy as a whole, can be found with Stigler's [17] classic article on regulatory capture. Industries use their political influence to control entry into their own industry, as well as control the rise of industries producing substitutes for their own goods. Others have focused on the institutional fit of the system. Institutionalists tell us that institutions create stability. They are the rules of the game, acting as bulwarks against radical change [18,19,20]. Institutional change tends to happen at a far more glacial pace than technological change, a point described as early as in Ayres' [21] work on institutional lags. New and upcoming industries frequently have different requirements than established ones. A national system of political economy may be a good fit for one type of technologies and industries, but a distinctly bad one for others (e.g. [22–25]).

Central to my explanation is the notion of structural change. An energy transformation away from fossil fuels toward renewable energy (wind power up until now the most important type of renewable energy) would most likely represent the biggest structural change to the planet's energy system in at least a century. However, structural change is difficult, for the simple reason that it creates both winners and losers. Technological change harms those with assets tied in with the old technology, and what has been widely documented, is that throughout history, resistance against new

technology from the losers has been widespread (e.g. [26]).Very often, the losers are old industries that have had ample time to organize and accumulate political influence. This influence is typically used to secure for itself beneficial regulations and institutions, and to influence policy so that it goes in its favor. Over time, a successful industry will have built a formidable political support network that it can draw on whenever it feels threatened, and it can most likely also mobilize news media to get powerful actors to rally behind it. For politicians, it is often "safer" to support the old and trusted industries than the new and vulnerable ones (especially in election years). For this reason, it is very easy for a society to be locked into economic practices and institutions congruent with the needs and requirements of old and established industrial actors. As an industry grows prosperous, it normally also becomes politically influential, and it often becomes a force against change to the system that it has benefited from. It becomes a vested interest with a stake in the preservation of the system. These vested interests resist change, and it can be very difficult to convince a society that what has worked well in the past may not work in an unknown future [23]. In the energy sector, this problem is widespread, and has been so for centuries, among other reasons because it contains some of the world's biggest (and politically most influential) industrial giants. These are industries that countries have sunk major amounts of investments into, and where large and costly infrastructures have been built over periods of many decades. In other words, countries have maneuvered themselves into a structural and institutional lock-in. Unruh [25] talks about techno-institutional complexes (TICs)–large technological systems embedded through feedback loops between technological infrastructure and institutions. Once locked in, they are exceedingly hard to replace, because so many powerful interests have invested in the perpetuation of the system.

In times of structural change, when wholescale industries are under threat because of competition from new and rival industries, the political economy will typically see vested interest battles between the old, fending for itself and fighting for its profits and its employment and trying to create entry-barriers that are large enough that it can perpetuate its existence, and the new and upcoming, but still vulnerable industries–the potential industries of the future. These often need protection and support as they are fighting against industrial giants both within and outside of the country. Wind power can very easily be seen as one of several such new industries, fighting against established energy giants, whether these be oil, gas, coal or nuclear.

Thus, a new industry, such as wind power, may easily find itself constrained by vested interests using their influence to sway policy in their favor. And the longer the system (in this case the energy system) has gone without any major shake-ups, the larger the problem will typically have become. Mancur Olson [20] tells us that in a political or economic system where no major shocks ever happen, inefficiencies will accumulate. When there are no shocks to the system, rigidities silt up, making the system ever more resistant to change and ever more sclerotic. It becomes one in which vested interests can prevent change and block new industries from rising to prosperity.

Is this a period of structural change? In one way, only the future can tell. If vested interests are able to block structural change, then obviously no structural change will happen. But throughout history, there have been a number of such periods, major industrial change happening empirically with 50–60 year intervals (e.g. [22]), giving rise to what Joseph Schumpeter [27] labeled "waves of creative destruction". What we are facing today is the potential phase-out of fossil fuels and the possible phase-in of renewable energy, wind power the most important of these. Again, this is potentially the biggest structural change to the energy system in at least a century. Thus, when wind power rises, it is against a backdrop where 9 of the 10 largest companies in the world are based on

fossil fuels or resource extraction in one way or another.[2] Paraphrasing Unruh [25], we live in a world where a carbon-based techno-institutional complex (TIC) is controlling the energy market place. There is a strong institutional bias in favor of the present energy structure, based on fossil fuels (and sometimes nuclear) and on big, centralized energy utilities distributing electric power to a vast number of industries and households. TICs are large technological systems embedded through feedback loops between technological infrastructure and institutions. Once locked in, they are not easily replaced. Today's petroleum companies are the biggest industrial giants on the planet, part of a TIC that perpetuates a fossil-fuel based infrastructure, exacerbated by government subsidies and institutions, resulting in what Unruh calls a 'carbon lock-in'.

Thus, there is more to the success of wind power than cost-competitiveness, technological breakthroughs or beneficial resource endowments. Even if all of these favor wind, success is no guarantee. Instead, wind power also needs to confront political obstacles, and these are often the most difficult, because they are rooted in a different rationale, one that has to do with interest coalitions, bargaining, institutions, re-election calculations among political actors and windows of opportunity. How then, do we expect that wind power has been affected by rising in the shadows of far bigger energy political actors? The main corollary of the argument is that in countries where vested interests are weaker and/or political decision-makers have more autonomy to shape economic-political decisions unimpeded by interest groups, wind power stands a greater chance of succeeding, as these would be countries where the political cost of going against powerful vested interests is smaller. In other words, the stronger the vested interests–in particular incumbent energy interests–are, the more likely they are to have their interests represented with political decision-makers in the government, in the parliament, in the bureaucracy, as well as in the media, in academia, etc. This provides influence to directly affect political decisions through lobbying and by influencing the institutional framework so that it is biased in their direction, as well as using the media and experts in academia to shape the political agenda and public opinion. Thus, the stronger the vested interest, the more likely they are to be able to block legislation that goes against them, get legislation in their favor, shape the institutional system in their favor, shape the concession systems in their favor, and so on.

I am not going to spend too much space on methodology, and the article does not have very ambitious methodological pretensions. A few words are still necessary. I am using John Stuart Mill's comparative methods of agreement and difference in combination with process tracing. The method of agreement analyzes dissimilar cases and tries to find crucial similarities between them, whereas the method of difference analyses similar cases looking to find crucial differences between them. In analyzing five countries and suggesting that vested interests is the cause behind all the swings, I utilize the method of agreement. The method of difference is however a far stronger method, in that it can logically make inferences both about $X \rightarrow Y$ and $-X \rightarrow -Y$. The countries all vary to certain extents, among other things because between them they host a number of instances of both starts and stops, in other words examples both of success and of fiasco within the same case. This makes it possible also to use the method of difference, which allows us to be far more confident in the generalizability of our findings. Finally, process tracing complements the comparative method. Without it, the comparative method would essentially remain a method for finding co-variations,

[2] Of the world's ten largest companies (total revenue), five are fossil fuel providers, one is an electricity company, two are carmakers, and one is a mining company [28].

without providing us with an n large enough for statistical testing. Specifying the predicted causal mechanism and tracing it in the different cases, is what ensures that we can reliably make descriptive inferences, or in other words, remove the noise from what is systematic about the case.

What I explain in this article–the dependent variable–is wind power installations, but as we will see for instance in the China case, this is an imperfect variable, and sometimes, it is beneficial to supplement it with other measures of wind power performance, such as electricity generation from wind power.[3] The main independent variable is politics, as described above operationalized as changes in the vested interest structure. It is obviously not the only way of conceptualizing politics, and the main point here is to show the importance of politics rather than to highlight a particular manner in which politics must by necessity work. It is hard to *a priori* determine the relevant vested interests of a society or the relevant policy areas and issues that these interests influence. Also, vested interest structures consist of more than just concrete interest groups seeking to influence concrete issues.[4] Very often, it is the existence of an entire vested interest structure, entrenched for instance in institutions or the government bureaucracy that makes structural change (i.e. wind power installations on a large scale) so hard to accomplish.

It is however possible to be somewhat more concrete. While unable to make extremely strong *a priori* statements about what the vested interest structure looks like in any given country–there is a heavy inductive component to this–we can make some informed guesses. We can for instance single out actors within the energy sector as among the most obvious candidates. Wind power most often rivals incumbents within oil, gas, coal and nuclear. These are actors that have interests that often go against those of wind power (after all, a renewable energy transformation might lead to the bankruptcy of these industries), and they very often have a lot of influence, through the direct access to politicians, media, by sponsoring industry-friendly research, or through the institutionalization of their interests for instance in the bureaucracy. The utility sector has typically also been among the vested interests resisting renewable energy in general and wind power in particular, for the reason that renewable energy is intermittent and because renewables tend to disrupt the business model of the traditional utility companies. Quite often, the utilities also have strong political connections, as well as connections to coal and nuclear. When it comes to industry, it is harder to make informed guesses, but in several countries, energy-intensive industries have lobbied against renewables because of a fear of increased electricity prices. Then again, in other countries energy policy and climate policy have gone together with industrial policy, creating a cluster of interests in favor of renewable energy. This cluster has often included research institutes, even if a country's research sector may also be biased in the direction of the country's most important industrial interests. Within the government bureaucracy, ministries of environment tend to fight on the behalf of renewable energy, whereas ministries of finance often operate according to an economic logic tending toward a preference for market mechanisms and against expensive support systems for renewables, and ministries of energy often have close connections with incumbent energy actors. As part of their institutional apparatus, countries typically also have concession systems for wind power, and often times a bias for or against wind can be found here. Some countries make it a lot harder to install

[3] Which is however also a flawed operationalization, as electricity generation among other things depends on how windy a year has been. This may vary substantially from year to year.

[4] Concrete interest groups are part of the structure, but it also consists of the institutions that have sprung up around the main vested interests and of the routines or rules of thumb that these operate according to.

wind power and a lot easier to appeal against wind power concessions than others. In the final analysis however, it is important to stress that there are major variations between countries in all these areas, and that while we may single out fruitful candidates for analysis, we ultimately need to do the empirical legwork before we can draw any conclusions.

What I try to show in this article through five small case studies, is that in several very interesting wind power countries, politics has been more important to explaining the success (or failure) of wind power than non-political variables. Non-political variables may explain why the conditions for wind power keep steadily improving. Resource endowments can explain why certain countries are more predisposed toward wind than others. But the swings, and ultimately the success or failure of wind power in each and every country, is politically determined.

The short version is as follows: The US is the world's largest economy and an example of the unpredictability and volatility that wind power faces in countries with weakly institutionalized support systems and strong lobby organizations. Denmark is maybe the paradigmatic wind power country in Europe, but one where we often forget that there actually have been major policy swings. Germany is the other major European renewable success story, but one that is currently going through a policy swing, the severity of which we will only know in a few years. Japan was the initial solar power leader in the world, then fell ever more behind before the Fukushima disaster triggered the greatest re-think in Japanese energy policy for four decades. This re-think and political realignment had a positive impact on renewables, but only on solar, not wind. China is the wind power powerhouse of the world, but there is a major discrepancy between installation and generation figures, the former being highly impressive, and the latter really not.

These five countries obviously do not constitute the only possible selection of countries, but the graphs that I present all showcase that there is something in their development that needs to be explained. They all neatly illustrate the point, from different angles, with different policy configurations, different vested interests, political alliances, and different energy vulnerabilities showing that politics has been crucial to explaining the swings in very different contexts.

3. Results

3.1. USA

Trying to find a pattern to US wind power installations based on this graph, is no easy task. There was the California Wind Rush in the 1980s–the result of state, not federal, policies. There were boom years in 1999, 2001 and 2003, followed by busts in 2000, 2002 and 2004. There was a period of healthy growth between 2005 and 2012, then a major bust again in 2013, followed by reasonably strong growth since 2014.

Thus, what the US case primarily shows is instability. This is rooted in the lack of institutionalization of wind power policy. And this lack of institutionalization, in combination with a system of governance that has lots of veto points (checks and balances) has made for violent policy swings as well as provided fertile ground for vested interests to exploit these veto points. Thus, the

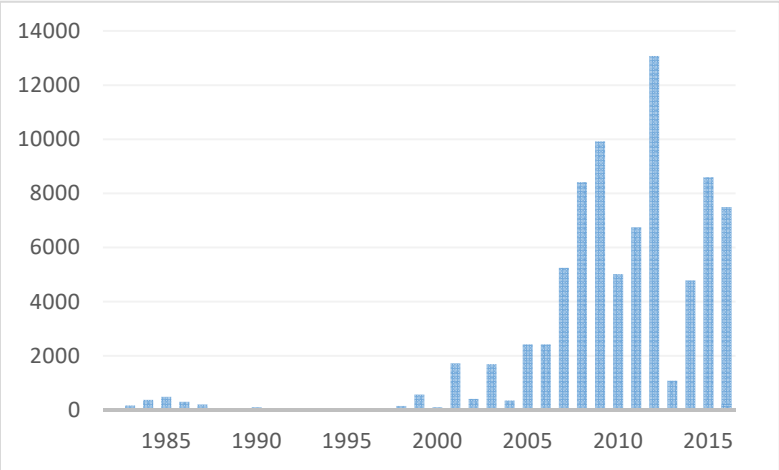

Figure 1. USA, annual wind power installations (MW). Sources: [1,29].

US is one of the countries where it is the easiest to see that politics not just matters, but is absolutely crucial. Which brings us back to the graph. What it hides is a policy environment for wind power that has been anything but stable. Belief in renewables in the US was great in the 1970s, but completely unrealistic expectations about its progress led to a falling out of love with wind and to an entire US wind industry going bankrupt [30]. Below the federal level, the first US wind power boom was the 1980s California Wind Rush, driven to a large extent by Californian subsidies. When that subsided, very little happened until the late 1990s, when Texas seized the initiative. But more importantly, and linked to federal policies rather than state-wise initiatives, the past 15 years have seen violent swings in annual installed capacity. Thus, in 2000, 2002, 2004 and 2013, installations fell by 80–90% from the previous year. The 2013 bust was particularly bad, following a 2012 record year, when the US installed more wind power than any other country and more than ever before or since. Installations dropped by more than 90% and US company GE Wind, which in 2012 was the world market leader with a market share of 15.5% in 2013 slumped to 6.6%. Employment in wind power dropped from 81,000 in 2012 to 51,000 in 2013, before rising back to 88,000 in 2015. Danish wind power giant Vestas cut its share of US jobs by a fifth. It is a policy environment that has led to short-term planning and to a lack of investments [2,31,32,33].

The reason for this volatility is that the main federal support vehicle for wind power is the production tax credit (PTC), and the PTC is subject to regular renewal and subsequent political infighting. It was instituted by President George H. W. Bush in 1992 and expired in 1999, and since then has had to be reinstated, often on a yearly basis, and thus routinely subject to Congressional tugs-of-war, which has led it to expire on numerous occasions, triggering dramatic booms and subsequent busts.

The contrast to the boom and bust-cycles was the more stable policy framework between 2005 and 2009, which saw annual installations quadruple. While President George W. Bush was more known for supporting coal and biofuels, his “the US is addicted to oil” State of the Union address in 2006 ushered in a short period of stability for renewables [34], with energy-security concerns guaranteeing stability and the Republicans in Senate and House not challenging the president. Thus, between 2005 and 2007 the PTC was part of the Energy Policy Act. With the presidency of Barack Obama, stability again gave way to infighting. Thus, in 2008, there was strong evidence of coal

interests lobbying hard for coal and against the PTC, the PTC being perceived as "part of a transformation toward a less fossil-based economy" [35]. With the coal lobby having major sway over US energy policy, Democrats from "high-carbon" states happily joined the Republicans in opposing the PTC. It was only at the 11th hour, and after it had been removed from a general energy bill and instead included into a Wall Street bail-out package to counter the financial crisis that it eventually went through. This was a three-year extension, after which it was again allowed to expire in 2012, and in 2014 party politics again blocked the extension of the PTC preserving the limbo of US wind until December 2015, when it was extended for a full five years during which it will gradually be phased out [30,35,36,37].

The many veto points in the US system makes lobbying easier than in most countries, especially since wind power is so weakly institutionalized to begin with. Legislation can be blocked both in the House, the Senate and by the president, with the Senate particularly important. This is for two reasons. First, the ever greater prevalence of filibustering in the Senate means that a 60–40 majority is often needed rather than 51–49. It is extremely rare for any of the parties to have such a majority, thus bills that have passed comfortably in the House can very easily be blocked by the Senate. Second, as the Senate has two Senators per state irrespective of the population of the state, each Senator has a lot of potential influence. A number of US states have very influential coal interests, and on certain issues, such as for coal, Senators often serve as much as representatives of their state as of their country. It leaves plenty of room for vested interests to lobby "their" local Senator. And lobby they do. Between 2003 and 2006 fossil fuel lobbyists spent $58 million on state-level campaigns, whereas renewable energy lobbyists could muster no more than $500,000 [38]. Especially for coal-producing states, of which there are quite a few, there has been both widespread and successful lobbying activity. It is very hard to drive anything that might have detrimental impacts on the coal industry through the legislature, which is one reason why the PTC has been targeted. And while the coal industry has tended to fund Republican congressional and presidential candidates more heavily than Democratic ones,[5] when it comes to coal, Democrats from major coal states will frequently side with Republicans [37,39,40].

The current five-year extension brings some sorely needed stability to US wind power, but in a country where renewable energy is not institutionalized and heavily subject to lobbying and infighting, these are exactly the policy outcomes we should expect. In the US, this becomes more severe because of the many opportunities that exist for energy lobbying, and the many veto points in the system. It is a system that invites vested interest battles, which typically favors the established industries and not the newcomers. President Obama eventually tired of the opposition that he faced on energy policy, and ever more chose to bypass regular political channels by using the bureaucracy to regulate emissions rather than pass legislation. Thus, the Environmental Protection Agency (EPA) in 2014 instituted a plan by which each state was mandated to cut its power sector emissions by a certain percentage, something that the EPA has the mandate to do, since it is in charge of regulating emissions of gases that are harmful to the American people. This was a plan that in all likelihood would hit coal harder than any other source of energy, and Republicans were lamenting what they have frequently been referring to as President Obama's war on coal, taking the plan to the courts.

[5] Then the largest private-sector coal company in the world, Peabody Energy in 2000 for instance allocated 98% of its election campaign donations to Republican candidates [39].

While the EPA Clean Power Plan could have major impact on emissions from the US power sector, the fact that it takes the form of bureaucratic legislation rather than a legal bill also means that it is far more vulnerable to change. In other words, the lack of institutionalization means that a new incoming president will announce a new head of the EPA, and President Donald Trump chose Scott Pruitt, who is a known climate skeptic and a friend of the coal industry. With the new president vowing to restore the fortunes of coal and terminate the Clean Power Plan, it will be interesting to see if this will result in another dip in the fortunes of wind power, and to the administration falling under the influence of the coal industry once again. Granted, wind power policy in the US has been as much about state initiatives as much as about federal policy. And it could of course be that from now on individual states will take the lead. Still, with the new president, the US might be facing another policy swing, one where coal lobbies are again being allowed to flourish, and where there is scant evidence that wind power will receive favorable treatment by the state.

3.2. Denmark

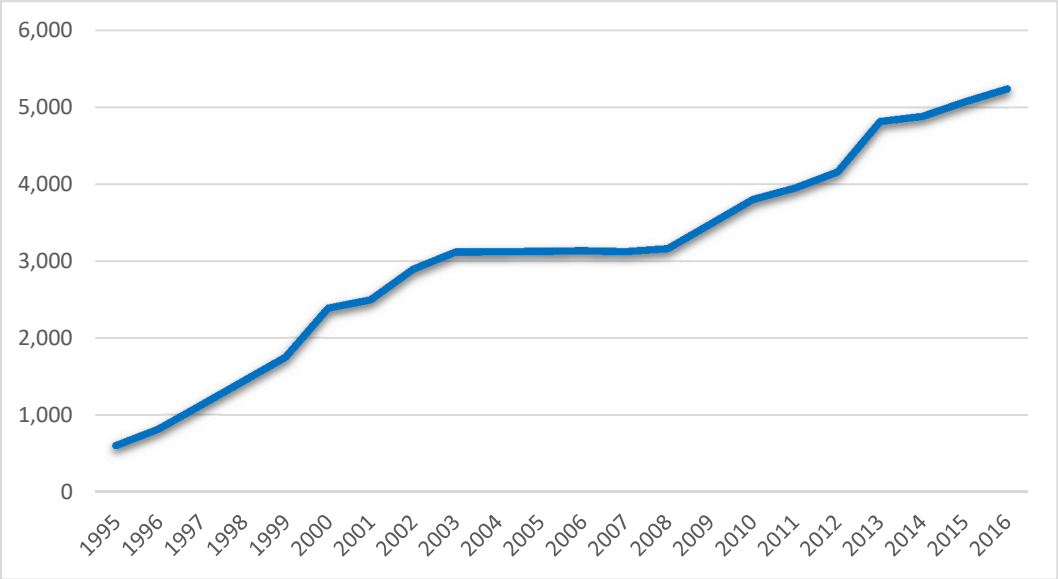

Figure 2. Denmark, cumulative installed wind power capacity, 1995–2016 (MW). Source: [41].

The Danish context is very different from the US, and the above graph shows cumulative installations of wind power in Denmark over the past 20 years. With currently a little over 5 GW of installed capacity, 14 TWh of wind-generated electricity and a world record 42.1% of electricity from wind power as of 2015, Denmark is maybe the paradigmatic wind power country in the world. No country has a relatively larger wind power sector, and for most of the past 20 years, Danish company Vestas has been the world's market leader.[6]

However, looking at the graph, it is immediately evident that there has been at least one very significant bump in the road. 1995 was the year installations started picking up (earlier, the Danish

[6] Since 1999, only in two years did Vestas slip down from the number one spot: 2012, when GE Wind profited from a temporary US boom, and 2015, when Chinese company Goldwind profited from an enormous domestic market [2].

wind industry had been enjoying major exports in conjunction with the California Wind Rush, but by 1995 the rush was long gone). Then they hit a more or less complete brake in 2003, with a net figure of only 5 MW being installed between 2003 and 2007–a year that even saw an overall reduction in capacity–before 2009 represented a kind of return to normalcy.[7] Sovacool [42] may have complemented Denmark on 25 years of policy stability, and on balance, Danish wind power policies have been a success. Still, his description is only partially correct. Thus, what accounts for the dramatic swing that resulted in an almost complete standstill between 2003 and 2008?

Part of this story is taken from Eikeland and Inderberg [43], who provide a very telling overview of the policy developments that occurred in Denmark at the time. The 2003 swing really started in 2001, as a new government came into power, but because of projects that were already in the finalization phase of their implementation, it took until 2003 before installations came to a halt [44]. The new and more market-oriented administration of Anders Fogh Rasmussen sought to streamline energy policy along cost-effectiveness lines, and wanted to scrap the Feed-in tariff (FIT) in favor of a Renewable Portfolio Standard (RPS). In desiring this, he also followed the recommendations of the EU. Energy policy would no longer be thought of in terms of environmental or climate policy. Instead, he wanted to rein in what he perceived of as an ever more influential Ministry of the Environment. Thus, in 2001 energy policy was moved to the Ministry of Economics and Industry, a move away from wind power and toward "old industry". The idea was that if wind power could compete on price, it would triumph, and if not, the Danish government would not subsidize what was after all one of the biggest Danish export industries. This led to one of the least generous support systems for wind power in Europe.

What is however interesting is the reaction that these policies created in Denmark. Denmark has two quite strong wind organizations that are well coordinated and able to draw upon major support groups in the parliament. Thus, when the government made energy and climate policy more market-based, this met with massive resistance and pressure from the wind power industry, among other things arguing hard that part of Denmark's climate commitment should be met through wind power. It argued that no EU country offered lower average prices for wind power and that with the old regime Denmark would now be producing one-third rather than one-fifth of its electricity from wind [45,46,47].[8] And in this, wind power had allies, not just in the opposition parties, but in the Association of Small- and Medium-sized Enterprises, and from a number of large industrial corporations where several CEOs openly denounced the new energy policies as reactionary [43].

Thus, already by 2005, the Fogh Rasmussen administration was starting to shift its emphasis back toward wind. In addition to pressure from Danish wind power actors, there was the quite obvious concern that one of the most important Danish industries might suffer, not just Vestas. There were also energy-security concerns: President George W. Bush had recently proclaimed that the US was addicted to oil and was very impressed with how Denmark (among other things through wind power) had managed to grow its economy by 50% in 20–25 years without increasing its energy consumption. Thus, as Fogh Rasmussen in 2006 was invited to Camp David, he was taken aback by

[7] The present government may in turn represent a return to the five years of standstill between 2003 and 2008, but it is still too early to know for sure. Installation figures for 2015 and 2016 are steady, but not particularly impressive.

[8] The wind power share of electricity production also stood at more or less a standstill, increasing marginally from 18.5% in 2004 to 19.1% in 2008. In contrast, since 2008 it has soared and set a new record in 2015 at 42.1%. In 2016 it was slightly down, to 37.6% because of 2016 being one of the least windy years in recent times [48].

President Bush's interest for Danish wind power policies that distinctly belonged to his predecessors. In Britain and Germany, heads of government Tony Blair and Angela Merkel were equally worried about where the energy of tomorrow would come from (beyond less than democratic sources such as the Middle East and Russia, which had recently closed its supply of gas to the Ukraine) in a world with soaring Chinese energy demand and rising oil prices. They all influenced the Danish government, by providing an image of a future where energy would become ever more precarious. And what was also important was the personal influence of new Environmental Minister Connie Hedegaard, who very actively sought to put climate change and renewable energy back on the political agenda [43,49,50].

2008 saw a cross-political bargain staking out a more ambitious renewable policy course once again. It reinstated a FIT (2009), with wind power support increased from a lowly DKK0.10 to a more reasonable DKK0.25/kWh (€0.013–0.033/kWh). This was reinforced by two new political documents aiming to reduce the dependency on fossil fuels and increasing wind power's share of energy production, culminating with the Renewable Energy Act. And the institutional responsibility for wind was changed as from 2007 it moved to a new Department of Climate and Energy [43–46, 51,52]. Sovacool [42] gives the renewable energy lobby much credit for these changes.

To summarize, a more market-oriented government spurred on by the EU changing its rhetorical course, ground wind power policies to a screeching halt, which triggered major counter pressure from a number of Danish actors, within industry, academia and politics. This was an example of a vested interest dynamic working in the opposite way than in most other countries. What we see very often are vested interest coalitions consisting of utility companies, nuclear and fossil fuels fighting to perpetuate the existing energy structure, at the expense of upcoming energy actors, such as wind and solar. But in Denmark, wind power was already a central part of the energy structure, not on the periphery as in so many other countries. To the extent that Denmark has vested energy interests, it could easily be argued that these are wind power interests. The energy political equilibrium is one that has wind at the core, and while Fogh Rasmussen wrested policy away from this equilibrium, this only lasted for a few years before the vested interests of Danish energy managed to swing policy back towards "normal". It happened not exclusively because of wind power in Denmark being influential, but in combination with changes to the external policy-environment, leading the Fogh Rasmussen administration to reassess its policies, as industrial policy and energy-security policy concerns trumped the administration's cost-effectiveness arguments about the inability of wind to compete on price with other energy providers. Thus, politics most certainly mattered. It explains the stop–the complete halt in installations for five years–and the re-start–vested interests forcing politics back toward something along the lines of a default.

All this comes with a disclaimer: As in the US, Denmark has recently experienced another political change, along the lines of the 2001 one. In 2015 Lars Løkke Rasmussen became PM of an administration that has branded the term "Green Realism", meaning more environment for less money, attained by more cost-effective means than in the past. It is a considerably more market-oriented administration than its predecessor. This among other things has led to uncertainties as to whether or not Danish climate commitments will be upheld. At COP21 in Paris in December 2015, the Climate Action Network bestowed upon Denmark the dubious honor of the "fossil-of-the-day" award, given to a country that has abandoned former progressive climate policies. To the extent that there are changes to energy policy, they are away from wind power, with spending cuts for renewables and tax relief for energy intensive industry [53–56]. At present it is too early to tell what

the consequences for wind power of this latest swing will be (installations are still steady if not spectacular, but in 2001, because of projects that were in the pipeline, it took two full years before installations came to a halt), and the extent to which wind power interests will again be able to sway policies back in the favor of wind.

3.3. Japan

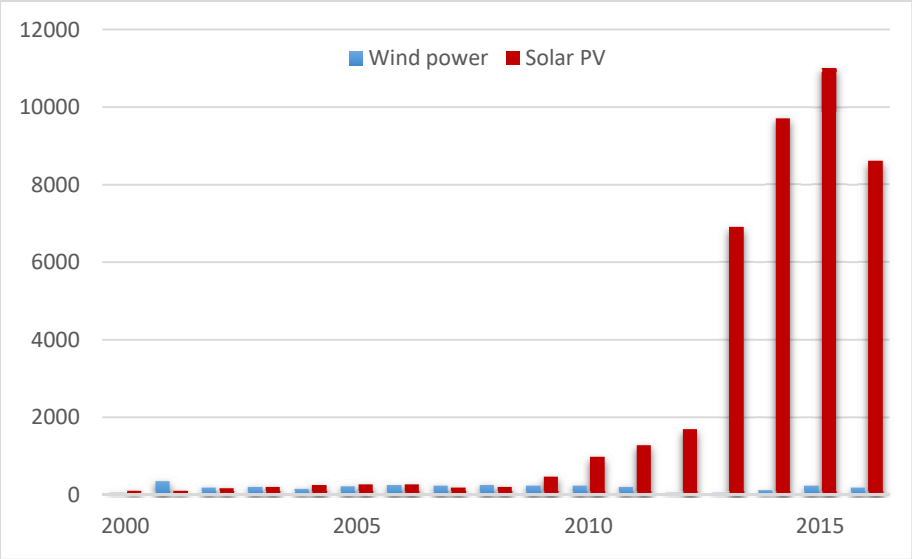

Figure 3. Japan, annual wind power and solar PV installations, 2000–2016 (MW). Sources: [1,2,31,57].

The Japanese story heavily involves an external shock, namely that of the tsunami and nuclear disaster at Fukushima in 2011. It is also one that cannot be told without focusing almost as much on solar as on wind, as it is very evident that wind has had to fight not just against vested interests in the shape of utility companies and nuclear power, but in many ways also against solar, which has been a rival renewable energy source as much as a support.

After four decades of energy policy gridlock, Fukushima has led to the first major re-think of Japanese energy policy since the 1970s oil crises. Since 2011, Japan has become one of the largest solar PV markets in the world, with the second largest capacity (after China and on par with the US). It still accounts for no more than approximately 4% of the electricity supply, but as can be seen from Figure 3 above, the change has been dramatic. What is however also evident, is that the shock has only benefited solar and not wind, where installation figures remain stagnant. In fact, as witnessed, as late as 2008, wind power installations were higher than solar installations. Today, solar installs 50 times more capacity a year than wind. Thus, Japanese renewable energy has definitely experienced a swing since Fukushima, but it has affected wind and solar very differently. What needs to be explained then, is why wind power is still at pre-Fukushima levels, whereas solar has increased annual installations 50-fold.

The swing in fortunes for solar owes much to this external shock, but it has worked through mechanisms familiar to political scientists. Japan is widely known for the strength of its vested interests, which in the energy sector has typically meant the utility companies and nuclear

power (e.g. [3,58]). Stability has been ensured by a Ministry of Economy, Trade and Industry (METI) that has heavily favored nuclear (which in 2011 stood at 26% of the electricity supply) and by very influential utility companies (that have also been heavily pro-nuclear). The utilities have often ridiculed wind power, but solar as well, as "insignificant boutique power sources" [59]. Since Fukushima, vested interests have very much softened on solar, but remained tough on wind. But both solar and wind have seen the support system improve dramatically, primarily in the form of a generous FIT. A weakening of the Japanese vested energy interests is crucial to understanding the FIT. But as Figure 3 tells us, this FIT has not led to a revival in wind power installations.

Whereas wind has never been big in Japan–it stands at a paltry 3.2 GW compared for instance to 50 GW of wind power in Germany and 43 GW of solar in Japan)–solar has a lot of history. Japan led the world in installations until 2005, and as late as 2004 it controlled more than 50% of the world market.

A policy swing is partially responsible for Japan losing its leadership in solar power, as the solar subsidy was phased out at more or less exactly the same time as the world market took off. But policy swings also led to the renewed rise of Japanese solar, and it happened in two spurts. First, a FIT was introduced in 2009–but only for solar and not wind–annual solar installations increasing from 2009 onwards, doubling in 2010, and nearly doubling again by 2012. The second and most dramatic spurt happened as a consequence of a new and more comprehensive FIT. The 2011 FIT was both more generous and for all kinds of renewables (even if solar still received preferential treatment). But with the exception of a brief upswing in 2015, wind is still very much stagnant.

There is a lot of policy behind the two solar spurts. The original success of solar and the urge for the most important government bureaucracy, METI (previously MITI) to keep justifying its existence by pointing to industrial success stories of its own creation, made it vital to ensure renewed favorable terms for solar. In addition, Japan hosted the 2008 G8 summit and pride and prestige factored in, Japan feeling pressured to come up with a policy achievement. Iida [60] is adamant that these were important reasons why Japan in 2009 re-introduced the subsidy. But the 2009 FIT also coincided with another policy swing, namely the election of the Democratic Party of Japan (DPJ), coming into power vowing to introduce a FIT for all renewables, breaking up the Japanese vested interest structure, often referred to as an iron triangle of business interests, the bureaucracy and the Liberal Democratic Party (LDP). Political and bureaucratic infighting, in particular METI's very deliberate attempt at pre-empting what it saw as the DPJ encroaching on "its" policy prerogative, however led to METI coming up with its own very much watered-down FIT alternative (among other things reserving the FIT for solar only), heavily influenced by the utilities. METI won the battle with the DPJ, and its proposal ended up being very close to the final 2009 FIT. As can be seen by Figure 3, the result was still a major increase in solar installations, but predictably no change for wind, where the DPJ caved in to strong METI opposition.

The second spurt was a direct consequence of Fukushima. It could obviously be argued that losing the entire nuclear electricity generation capacity overnight changed the Japanese resource situation to such an extent that the only sensible solution would be a fast phase-in of renewable energy. This is one example that different explanations often overlap. But Fukushima also led to a weakening of vested interests, particularly of the utility companies and their up until then very close relationship with METI, and this is what made it possible for Japanese energy policy to change.

Fukushima made the extremely close, almost incestuous, relationship between the regulatory authorities and the nuclear power plants clear for everyone to see, and this created political windows

of opportunity that gave politicians leverage to push major policy changes through. But introducing a FIT was still not easy, and it did not go through until PM Naoto Kan of the DPJ in 2011 let his resignation as PM be contingent on the Diet establishing a generous FIT for all renewables, something which would have been fought tooth and nail and probably successfully so by the utilities and METI pre-Fukushima. Instead, METI now went from sympathetic to solar and dismissive about wind to celebrating renewable energy as one of three pillars of Japan's future energy policy (in addition to nuclear and energy efficiency). This however also puts the difference in performance between solar PV and wind in stark relief. It has led to PV installations increasing from a little over 2 GW in 2009 to 43 GW by 2016, whereas over the same time period total wind power installations only increased from 2 GW to 3, with even a fall in annual installations every year between 2008 and 2013. In no year after Fukushima has installations been higher than before Fukushima. The policy swing is there for anyone to see in terms of the rhetoric surrounding renewable energy (i.e. solar), but wind power is still stagnant.

Why has the policy change had so little impact? While Fukushima weakened vested energy interests, the difference between wind and solar is evidence of still existing vested interest power in Japan. This difference has a lot to do with the reluctance of the utilities to install wind power. Solar is typically installed on private rooftops, of houses that are already connected to the grid. This is something that the utilities were forced to accept through government-backed test programs in the late 1980s, and the utilities have (although often hesitantly) since then accepted solar as part of the energy mix. Wind turbines however, are free-standing installations, whose connection costs the utilities are often very reluctant to pay, as they are then essentially paying for a competitor to be allowed onto "their" grid. The argument also goes that wind turbines, being so much larger than individual rooftop solar panels contribute much more to intermittency problems and that wind turbines are typically set up far away from people, where the grid lines are the weakest (e.g. Moe, 2012).

Some of these arguments are partially valid. The Japanese grid is more vulnerable than the European. Japan cannot draw on other countries for electricity in times of emergency, which is accentuated by the fact that its grid is even divided into two, using 60 Hz in the southwest and 50 Hz in the north, and by the fact that until very recently, the electricity market was controlled by 10 regional monopolies with only weak interlinkages. (This has also changed because of Fukushima: By 2020, Japan will have a fully deregulated electricity market where generation and transmission are split between different companies, highly suggestive of how weakened the utility companies have become.) Thus, in times of crises (such as an earthquake or a nuclear meltdown), not only could Japan not draw on electricity from another country, but there were major constraints on how much electricity it could draw on from other regions. These are legitimate concerns, even if the weak interlinkages between regions was also overplayed and used as an excuse to shut wind power out. The lack of priority access to the grid for renewable energy (unlike for instance in Germany or Denmark, where utilities are obliged by law to accept whatever quantities of renewable energy are produced), has meant that wind power could be physically shut out in a way that solar never could. Finally, solar had the institutional support of METI, which thought of solar as one if its successes. No such institutional support ever existed for wind, which means that it has been far easier for the utilities to resist wind, even today with generous FITs for both solar and wind. Unbundling of transmission and generation will have positive consequences for wind, but without priority access to the grid, wind will keep growing far more slowly. This is reflected in Japan's renewable energy goals:

By 2030 Japan will have installed 65 GW from solar, but only 10 GW from wind, accounting for only 1.7% of the electricity share [61].[9] Finally, Japanese wind power projects undergo a very lengthy and costly environmental impact assessment (EIA) process. This means that there is a lack of predictability to the framework conditions of wind power that is not experienced by solar, leaving far fewer investors willing to promote wind power, and which also tells us that for the policy to be equally beneficial to wind and solar, more is needed than just generous FITs. Rather, there are structural conditions that disfavor wind and that has made it far easier for the utilities to fight wind than solar.

How big has the policy swing been, and how permanent is it? These are crucial questions, and they are hard to answer. The FIT has led to massive solar installations. On the other hand, Asano [62] has argued that the FIT is too generous, leading primarily to Japan subsidizing imports from China instead of boosting the Japanese economy. The FIT has come down quite a lot since 2011, but it is still generous, and figures from Vosse [63] show that the number of solar imports increased from only 15% in 2010 to 56% in 2013 and are likely to rise further. There are also doubts as to for how much longer the solar expansion can go on (installations were down in 2016 and are likely to fall somewhat further in 2017) before serious gridline updates are necessary, something which is already leading to resistance from the utilities. This is bad news for wind. Solar was always the insider of the two, and if the utilities are now resisting even the insider, then the outsider that is wind power will struggle even more. There is also little doubt that the "nuclear village" is seeking to claw power and influence back. Thus, nuclear power plants are being slowly phased back in again,[10] and the utility companies are trying to circumvent the scheduled unbundling.

While this means that Japan's energy future has not unambiguously changed, Fukushima caused a major shift, significantly weakening some of Japan's strongest vested interests. The shock created a new energy political reality, and it created a window of opportunity for new policy to such an extent that the support for solar is now far better institutionalized than pre-Fukushima. This is a major achievement, but at the same time, one that has so far left wind power by the wayside. Also, the policy window will not necessarily be open forever, and the old Japanese energy interests will not by necessity remain weakened forever. What is however beyond doubt is that Fukushima caused the biggest re-think of Japanese energy policy since at least the 1970s, even if this re-think led to very different results for the two main types of renewable energy.

3.4. Germany

[9] Also, at the pace that Japan is currently installing solar power, the 65 GW target will be reached probably as early as 2020. Thus, at current rates, the difference by 2030 will be far greater than 65 GW vs. 10.

[10] In 2014, the Japan Business Federation (Keidanren), the Japan Chamber of Commerce and Industry and the Japan Association of Corporate Executives (Keizai Doyukai) in writing urged the Industry Minister for an early restart of the nuclear plants. In 2015, the Institute of Energy Economics, Japan (IEEJ) also urged Japan to start phasing nuclear back in, stating that present policies cost Japan ¥3.6 trillion ($30 billion) a year from imported fuel. As of now, only two reactors have been restarted (Sendai 1&2), whereas Takahama 3&4 were up and running for a short while before being shut down again following a court injunction. Ikata 3 became operative again in the fall of 2016 [64].

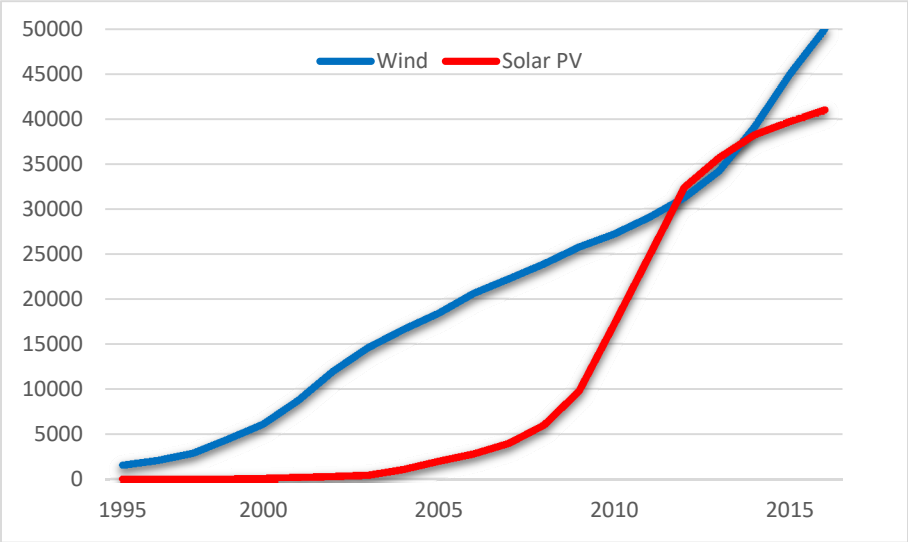

Figure 4. Cumulative wind power and solar PV installations, 1995–2016 (MW). Sources: [2,61,65,66,67].

The above figure for Germany compares cumulative installations in wind power and solar PV for the past 20 years. Here as well, there are important swings, but in many ways, for most of the years showed in this graph, policy was stable. The 1990 introduction of a precursor to the FIT, the electricity feed-in law, constituted a major policy swing, but after that, what the graph basically tells us is what we should also expect based on market logic. Once the FIT was established, wind power, which was far cheaper than solar power was installed in far greater quantities–in 2000, Germany had 6 GW of wind power and leading the world, but only 76 MW of solar–but as the cost of solar dramatically sank, solar installations rapidly rose. Whereas wind power was installed at a relatively steady pace of 2–3 GW a year, the influx of cheap Chinese solar from 2007–2008 onward, led to Germany becoming by far the biggest PV market in the world, with installation figures in the 7GW region in 2009, 2010 and 2011. With generous FITs, this however made the German system ever more expensive, peaking at an estimated €24 billion in subsidies in 2016 [68]. Reductions to the FIT (for both wind and solar) made little difference, and at the end of 2012, total solar installations actually superseded wind power installations. Up until 2013–2014, wind and solar were installed roughly as could be expected based on market perspectives. Wind was cheaper to begin with, but as solar rapidly fell in price, solar installations went through the roof.

Instead, the German renewable swing happened in 2014. Besides escalating costs, a main problem with German renewable installations was that they ever more ran ahead of gridline expansions. Gridline expansion has been slow, and typically the prerogative of the utility companies, which have taken huge economic losses over the past few years because of the rapid influx of renewable energy.[11] Up until 2009 this was not a major problem, but from then on, growth primarily in solar meant that the electricity system had an ever harder time phasing such amounts of renewable energy onto the grid. Thus, the policy change that happened was one whereby the FIT will be phased

[11] RWE lost €2.8 billion in 2013 alone, its worst loss in more than 60 years [69], a direct consequence of Germany pursuing renewable energy. E.ON, which is the biggest of the utilities, has also been affected. Between 2010 and 2013 its electricity generation fell by 38% as a result of the influx of renewable energy [70].

out altogether before the end of 2017 and substituted with a tendering system, where wind and solar are capped at 2.5 GW a year (off-shore wind being exempted) each. The consequence has been for solar installations to plummet, from 7.6 in 2012 to only 1.5 GW of installations in 2016. For wind power, the result has been a different one. In fact, 2015 was a record year with 6 GW of installations. This is partly because the 2.5 GW onshore wind target was overshot by 1.2 GW, but also because offshore wind is exempt from the target, and installed a record 2.2 GW. Another reason is that capacity is now being rushed in before the FIT is abandoned [61].

Thus, the swing can to a considerable extent be explained by legitimate problems stemming from rapid renewable energy phase-in, such as a lack of coordination between renewables and gridlines, and ever higher costs. It was however also the consequence of lobbying from the utilities and the energy-intensive German industries, which have long suffered because of some of the highest electricity prices in Europe–a consequence of the FIT. In Germany, the political consensus, as well as the backing in the populace, on renewable energy had been strong for over a decade. In fact, two attempts by the utility companies at bringing the FIT in front of the EU court failed.[12] The fact that the Social Democratic Party (SPD) backed renewable energy despite traditionally being pro-coal and the Christian-Democratic Union (CDU) despite traditionally being pro-nuclear made for a very solid renewable energy interest coalition. It was also what Patt [75] calls a "clumsy solution"–a solution that is not perfect for any actor, but one that is highly sufferable for a multitude of actors. In Germany, renewable energy was climate policy, energy policy and industrial policy at once. However, with the influx of cheap Chinese solar, the industrial argument weakened. Germany has major wind power companies (Siemens, Enercon), but its solar industry, which at its height accounted for nearly 20% of the world market is now down to 2%. This has severely weakened the industrial argument for renewables, and the interest coalition at the heart of the renewable expansion could far more easily be overpowered by the energy-intensive industry lobbies. Here, they also found support from parts of the bureaucracy. The utilities have typically been backed by the Department of industry and energy (BMWi), which has routinely advocated cost-effective solutions such as green certificates, and resisting FITs. And so, while politicians for years consistently went against the utilities to back renewable energy, the bureaucracy has by no means been anti-utility, the arguably most important government ministry very much speaking on its behalf. And with the 2017 scheduled phase-out of the FIT, the viewpoint of the BMWi and the utilities won through, as Germany is moving to more market-based instruments.

The above has been accentuated by gridline problems. The rapid renewable phase-in requires gridline expansions, as most of the wind power is installed in the north and most of the solar in the south, and north-south connections are weak. The north has an oversupply of renewable energy, and the south an undersupply. Thus, major grid connections between north and south are essential, but have met with large amounts of local public and political resistance. Only one connection from the

[12] In 1996, the utilities filed a complaint to DG Competition (the part of the European Commission that deals with competition law) that the feed-in law violated state aid rules. As a result, feed-in rates were to be lowered. This, however, failed in the Bundestag, with many CDU/CSU MPs prepared to vote against their own government. In the end, rates remained unchanged. Compatibility with EU rules, more specifically state aid charges, came up again in 2002. However, in 2001, The European Court of Justice had already declared that the EEG does not constitute state aid, and so DG Competition withdrew its objection [71–74].

east to the south was scheduled for 2016 and on average, grid planning and construction takes 10 years [76–79].

How severe the German swing will end up being is still unclear. Most renewable energy goals have been maintained, but we are certainly witnessing a change toward more market-driven policies. The renewable energy coalition that seemed to have become strong enough to withstand vested interest pressure in particular from coal and utilities was not strong enough once the world changed: The rapid installation of solar power created its own backlash (both in terms of cost and in terms of gridline problems), which happened to coincide with the demise of the German solar industry. In Japan a policy window opened with Fukushima. In Germany, Fukushima led to the phase-out of German nuclear, but it did not open any further windows for renewable energy. Rather, as installations were running ahead of gridline expansion, the windows were being closed instead, and the solution to the gridline problem is yet to be found. It remains to be seen what the consequences of the shift to tendering will be. Chances are that it will lead to a slow-down in installations, but do far less for gridline expansion.

3.5. China

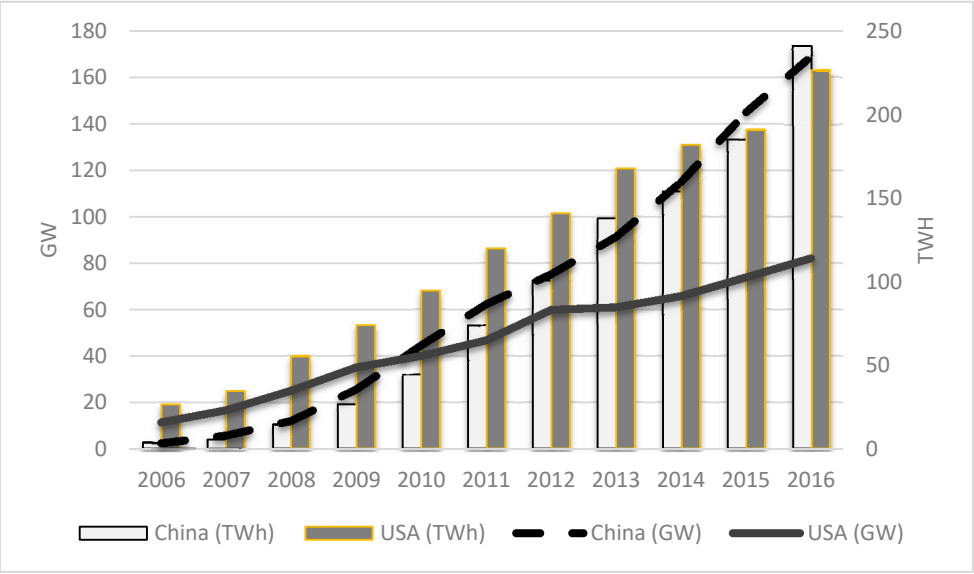

Figure 5. China and the US. Installed wind power capacity (GW) vs. electricity generation from wind (TWh). Sources: [2,80,81,82].

Most likely, the above figure needs to be studied slightly more carefully than the others before the reader notices anything extraordinary. At first glance, what can be observed is a steady increase in Chinese installations (along a somewhat less steady US increase) as well as a very steady increase in electricity generation in both countries. However, looking more closely at the figure reveals a striking anomaly. As late as 2015, China, with an installed capacity almost twice that of the US (145 GW vs. 74 GW), generated less electricity from its wind turbines than the US did from its (185 TWh vs. 191 TWh). Only in 2016, with a capacity of 169 GW to the US 82, did Chinese electricity generation from wind edge ahead of that of the US (241 vs. 226 TWh). Granted, part of the explanation has to do with a higher level of technological sophistication and better quality control

in US wind turbines than in Chinese. US equipment has fewer reliability problems, shorter down-times, and a higher operating efficiency. There have been quality problems even with major Chinese manufacturers such as Sinovel, Mingyang, and Goldwind, and a concern with a shortage of human capital [83,84,85].

However, the main reason for the gap between installations and generation is political, and with a heavy vested interest component. First, China should be saluted for installing more wind power than any other country by far. For the past few years, Chinese installations have accounted for 40–45% of world totals. This is due among other things to a very concerted and persistent effort from the leadership in Beijing to promote wind. During the financial crisis, wind power was even among a select group of industries singled out as locomotives to create economic activity and get China through the crisis. This also means that the initiatives on the part of the Chinese leadership were not first and foremost driven by concerns for the environment. Wind power policy started out as industrial policy, with an eye to energy security. China has purposefully sought to develop wind power as an industry that it considers strategically important. Historically, the industrial development idea always outranked the notion of green development, and it is only over the past few years that it has also become part of an air pollution and carbon emissions strategy [86–89].

Then, if the leadership champions wind power in a one-party state, why do electricity generation figures fall persistently behind? Again, this was originally an industrial strategy. Building a new industry was more important than generating electricity [88]. Thus, the incentive structure favored installations over generation. However, the other part of the answer is that while policy-making is centralized, implementation is local, and locally vested interests, primarily in the shape of grid and utility companies and the coal industry, have considerable influence, the relationship between politics and economics often being very intimate. This has had a number of unfortunate consequences for wind power. First, the utilities are obliged by law to connect wind power to the grid, and the grid company has to bear the financial losses from this. However, there are "few regulations and instructions on how to connect wind power to the grid" [90], and "it is commonplace for grid enterprises to refuse or delay building or expanding grids to connect to renewable power plants" [91]. "…until the effective lack of regulation…is rectified this mandate [to purchase electricity from renewables] will remain meaningless" [92]. There have been no reported cases of penalties on grid companies for refusing to connect. According to gtm: [93] "for years, wind producers in China have had trouble connecting to the grid". State Grid operators have deliberately delayed connecting wind farms in remote areas and cut back on purchases, as their profit margins on renewables lag behind that of coal-generated electricity. Wind power is essentially fighting with coal for access to the grid [93,94].

State Grid, which is the biggest utility company in the world, has held back on purchases of wind power because of intermittency concerns. Building infrastructure is costly, most wind turbines are located far away, and wind is costlier than coal, thus wind power reduces the operating profits, leaving grid companies no profit incentive to expand the grid. What this means is that the grid companies and the transmission infrastructure may easily be the biggest barrier against wind power [87,91,92,95,96].

This is made worse by a second point, namely that the focus on installations over generation has led to significant off-grid capacity (probably around 15%) and/or capacity located in areas far away from a well-functioning grid-system. Between 2003 and 2011 90% of the wind farms were approved by local governments, which perceived of wind power as an easy way to boost the local economy.

This led to applications being granted very quickly, to rapid growth in installations, but to many problems regarding lack of coordination and low quality [87,92,97]. One particularly striking example is from Jilin province in the northeast where the nearest city was 300 km away from the wind farm, and the nearest 220 kV line 150 km away [85]. This means that curtailment is a major problem, that is, wind power output exceeding the capacity of the grid to transmit the electricity, which is thus essentially spilled. In China overall, in the first half of 2016 curtailment for wind power was 21%, and in particularly windy and less populated regions, such as Inner Mongolia–China's leading wind power region–it was as much as 30% [98].

As witnessed by the above, vested interest power locally and collusion between local government on the one hand and utilities and coal on the other has led to the Chinese wind power offensive being far less effective than one might imagine based on aggregate installation figures, bringing us to the third point. Local governments typically allocate generation quotas to the power plants. However, thermal plants increase local revenues more than wind power, which is the weaker player. Thus, thermal power companies will lobby for increased generation quotas at the expense of the allocation left for renewables. And on days when the power load is low, the thermal generation quota is the one that gets prioritized, leaving less room for renewable power generation. This essentially sets a guaranteed floor for coal generation. It would take major policy change for the prospects of renewable energy to improve, and such a change would explicitly go at the expense of coal. In its battle to preserve the status quo, coal would also have numerous provincial governments on its side. One solution would be to sell surplus renewable power to other provinces. However, there is strong competition between provinces, resulting in very little electric power trade. Accepting wind power from elsewhere is seen as undermining local economic growth. Thus, while growth in wind power is strong and solidly backed by the central government, at the local level we do not have to scratch far beneath the surface to find serious vested interest battles. Also, while coal consumption in China is now going down, suggesting that the power of the coal industry is decreasing, it is still true that the total coal power generating capacity is expanding (up by 7.8% in 2015). And since China's power demand is no longer increasing (up by only 0.5% in 2015), the battle for access to the grid between different carriers of energy will be getting ever more competitive [98,99,100].

Granted, the central government in Beijing is aware of most of these problems. Measures have been taken to reduce curtailment, although so far with modest success, and off-grid capacity is on the way down. Market-mechanisms are gradually being introduced in the hope that this will reduce the disconnect between installations and generation, and the central government is seeking to reduce China's dependence on coal (coal consumption may have peaked in 2013, and 28 out of 33 provinces have received orders to suspend (13) or delay (15) the approval of new coal-fired power plants) [101,102].

The Chinese case is obviously also far more complex than what I have space for here. Still, what we can say with a lot of certainty is that vested interests at the local level is to a significant extent countering national policies, explaining the discrepancy between installations and generation. This all said and done, there is little doubt that wind power in China has been a success. Looking more closely into the Chinese case however reveals how below the surface, there are problems that still need resolving, and that some of the biggest ones are political in nature.

4. Discussion and Conclusions

What do we observe? First of all, despite all being major renewable energy countries, their wind power policies are quite different. China, Denmark and Germany have on the whole been far more pro-wind than the US and Japan, but Germany is now turning from its previously successful (but expensive) FIT to tendering, whereas Denmark may be in the early phase of another backlash, akin to the one that happened between 2001 and 2008.

Also, their economies are quite different. Japan is heavily dependent on energy imports. Denmark is largely self-sufficient because of petroleum extraction. The US has become largely self-sufficient after it started escalating shale gas and–oil extraction. Germany used to have lots of coal and nuclear, but nuclear is being phased out, and coal distinctly feels like the fuel of yesteryear (even if phasing out nuclear ironically makes Germany more dependent on its coal). Finally, China is the only developing country of the five, and with a rapidly increasing energy demand over the past couple of decades, China has had a hard time meeting this demand through domestic sources.

They have all experienced different policy swings. This is in and of itself not strange. Policy swings happen, and it would be more surprising if none ever occurred. The swings have been prompted by different developments. In Japan it is easy to point to an external shock (Fukushima), as the trigger. In Denmark, the swings seem more prompted by domestic political change than by the external environment, even though the reversal to "normal" in part was prompted by external factors such as Bush (and Blair and Merkel) lauding Danish policies and providing a different global energy-security context for Denmark to place itself within. In the US as well, changes seem to be triggered less by external shocks (even if energy-security became a bigger focus during the George W. Bush presidency, possibly as a response to 9/11). The German policy swing seems to be a consequence more of a political realization of problems within the economic and technological framework requiring changes to the support system in combination with China flooding the solar market and killing off the German solar industry. China is probably the country where policy swings seems the least fitting description. Here, it is rather the story of a disconnect between central and local, a case of stable policies with a sometimes lukewarm execution in the provinces.

So, what do they all have in common? At the heart of these swings were changes in the interest coalitions enabling new windows of opportunity to actually being exploited, either giving established vested energy interests more leverage than they used to have or weakening them. In Germany, rising economic costs and technological problems, in combination with the misfortunes of the German solar industry gave the German energy-intensive industries far more lobbying power, and the advocates of renewable energy fewer arguments. And while politicians from both the two main political parties CDU and the SPD seem to have had more or less the same change of heart with respect to the FIT (urged on by the BMWi), wind power certainly fought against it. Was the swing driven primarily by politicians or by vested interests? It is hard to say, but what is certainly true, is that a new policy environment gave rise to a reassessment of the situation, to a clear weakening of the renewable energy coalition, and to the industrial coalition finally winning through with arguments that it had until then unsuccessfully advocated for more than a decade.

The US is also a case of policy swings and vested interests cohabiting. While the presidencies of George W. Bush and Barack Obama ushered in different wind power policies, the many veto points in the US political system means that vested interest actors can influence policy on a number

of levels. And it is very evident that they have done this, with both coal and biofuels typically being prioritized by President Bush over wind. Looking at the PTC for wind, what we see are periods of tenuous stability interspersed with dramatic breaks. And these breaks have happened reasonably often, in addition to there often being the imminent danger of a break, yielding an investment climate characterized by unpredictability. As mentioned above, the lack of institutionalization of US renewable energy policy has given vested interests a lot of influence in causing swings, and with the PTC it has happened over and over again, irrespective of the political persuasions of the president.

In the Danish case, the swing was caused by a different political party coming to power, and instantly carrying out different wind power policies. No external agent, bar possibly the EU, which advocated a somewhat similar shift in policy, can be blamed for the swing. What was more remarkable in this case was the reaction that this triggered from the wind power coalition, comprising not just the wind power lobbies, but other industries and industrial leaders, politicians, research organizations and academia, and prominent singular individuals in the Danish polity. And this coalition was strong enough to push policies back toward what we may consider "normal" Danish wind power policies. In this, it was helped by changes to the external environment, mainly with respect to the energy-security attitudes and influence of senior world leaders and allies, but there is very little doubt that the Fogh Rasmussen administration felt the pressure that was exerted against it by domestic actors. It resulted in a speedy wind power re-think. Again, a special interest coalition was at the heart of the process, although this time one in which renewable energy was itself powerful enough to strongly contribute to swaying policy back to something akin to normalcy.

In Japan, the external shock is there for everyone to see. The shock severely weakened the existing energy coalition and created a window for energy policy changes. This window was taken, and while it is not obvious that it will remain open for all eternity, the weakening of Japanese vested interests, triggered by an external shock was crucial for any policy swing to happen. Here, however, the window of opportunity, has so far benefited solar and not wind, revealing that in Japan, not only is it a case of renewable energy having to rise against the might of the nuclear lobby and the electric utilities. But also, it is evident that amongst the renewable energies, wind has far less government support to rely on than solar.

Which leaves China, which is by most accounts a major success story, but where if we start scratching beneath the surface, it is easy to see that there is a major discrepancy between the installation figures, which are extremely impressive, and electricity generation figures, which are far less so. The clue to understanding this is that implementation is local, and at the local level there is a lot of maneuvering space for vested interests, irrespective of the enthusiasm with which the central government in Beijing is fronting wind power.

Can we discard all the other explanations in favor of politics? Obviously not: My argument is that politics is important to understanding swings, but other explanations may still work well at explaining development trajectories. Looking at the graph of annual US installations, it makes little sense to try to explain these variations in terms of resource endowments or technology.[13] Granted, resource arguments are routinely invoked, but to the extent that they can explain policy swings, it is because of the political influence of resource-based interest groups, not because resource

[13] With maybe one exception. In his second term, George W. Bush focused strongly on energy-security. While US resource endowments did not objectively change, the emphasis did, as in a far stronger ambition to become energy independent.

endowments have themselves changed. How about market explanations? The policy shift between for instance presidents Jimmy Carter and Ronald Reagan is quite marked. Carter was a strong believer in renewable energy (at a stage where future projections for renewable energy in the US were wildly and naively optimistic), whereas to Reagan this was an expensive sidetrack when winning the cold war was all that mattered. Thus, Reagan's eight years in the White House led to the killing off of most of the US wind power sector [30]. But this is too far back in time to explain the violent fluctuations over the past 20 years. Here, lobbying activity in a political system with numerous veto points seems far more fruitful, in other words a political explanation.

Geography can sometimes be influential, and in Denmark it was an important background condition. As oil prices increased following the two 1970s oil crises, Denmark was left with few options. Scarce in coal and with hardly any potential for hydropower, the main alternatives were large-scale energy imports, nuclear and renewable energy. With nuclear ever more a political taboo, resource endowments can explain why Denmark more than most countries was preconditioned to making forays into wind power. However, since then Denmark has started extracting oil. Thus, in terms of resource endowments, Denmark is no longer energy-scarce, and the need for wind power no longer equally great. But it is very hard to see that this has had any impact on Denmark's wind power efforts. It is also very hard to see that technological breakthroughs or problems can explain either the stop or the re-start to Danish wind power policies. If anything, the halt in installations happened because Fogh Rasmussen thought that Danish wind power was technologically advanced enough to stand on its own two feet, and not the other way around. It could be argued that Fogh Rasmussen's rejection of previous Danish wind power policies was because of market thinking, and cost-effectiveness arguments were certainly important. But again, the halt in Danish wind power is because of a political swing–the explanation is political–and has very little to do with either the cost curves of wind power or its technological development. And the re-start is even less motivated by market-based or technological reasoning.

In Japan, market incentives certainly cannot explain why solar power for so long has been systematically preferred over wind power, even if wind power has been consistently cheaper. Geography can explain some of this: Japan is so densely populated that it is harder to find prime land for wind turbines than for solar panels. Whereas solar panels can be mounted on individual houses, wind power typically is set up in windy and mountainous locations away from city centers. Beyond that, from a resource endowment perspective, few countries should be more eagerly pursuing wind power than Japan. Japan is very resource scarce, and Fukushima only made this worse. But not only was wind power a complete outsider before Fukushima, it has hardly experienced any upturn in performance after Fukushima either. Thus, the overwhelming reason why solar has so persistently been preferred over wind is political and rooted in vested interests. And without the serious weakening of the existing energy interest coalition, the result of Fukushima would have been for nuclear to be phased back in as rapidly as possible, with little change even to solar. Now, renewable energy has instead gone from energy political window-dressing to one of three official pillars of energy policy.

In Germany, economic explanations along the lines of getting the price right can explain some of the background, i.e. why wind power dominated solar for so long, and why solar rapidly caught up with wind once Chinese over-supply led to prices for solar plummeting. One could also argue that the lack of cost-effectiveness in the German system, as seen in the soaring costs of the FIT and the high electricity prices, eventually brought it down. But the changes in the German support system

since 2014 are still very much the result of vested interest battles and a new-found consensus between the main two political parties as to the necessity of making changes. Also, these changes happened *because* costs came down, not the other way around. In other words, if our main explanations is one of wind power becoming ever more attractive as costs come down, then the German case is sobering, and it tells us that success can actually be self-defeating. In Germany, the success was so rapid that it bumped up against one systemic constraint, namely that the installations ran ahead of grid expansion. It also bumped up against a financial constraint: As wind power (and in particular solar) became more cost-effective and installation costs came down, installations increased. But this made the FIT ever more expensive (and also led to very high electricity prices). In other words, costs coming down destabilized the infrastructure and the support system rather than leading to exponential growth in wind power. This does however suggest that there is a technological component, and that among other things a lack of technological progress in energy storage is one reason why wind power installations are now bumping up against technological constraints. Did geography matter? In terms of resource endowments, these changed in the sense that in the aftermath of Fukushima Germany, like Japan, decided to phase out nuclear energy. But this has *increased* the need for wind power, not reduced it, and therefore cannot explain the changes that have happened since 2014. Instead, what the phase-out of nuclear has inadvertently created is a new lease of life for coal.

It could be argued that resource endowments have been a factor in China, in the sense that this is a country that because of a rapidly rising demand for energy has had major unresolved energy problems, something which would normally increase the eagerness to pursue wind power. But the root of the problem in Chinese wind power, the lack of coordination between the central government and the provinces, has little to do with geography, and is mostly about vested interests. It could of course be argued that the fact that wind power resources are located in faraway places with little population makes it hard to transmit the electricity to the population centers on the eastern seaboard, and this is certainly true. What is however also true, is that an emphasis on installation over generation enabled the provinces to pursue policies that led exactly to this outcome. Technological catch-up is probably also part of the reason for Chinese success, but again, reports of low quality manufacturing and sub-standard maintenance suggests vested interest problems rather than obsolete technologies. It is also very hard to see that concerns along the lines of getting the price right have been particularly important. Rather, the Chinese political economy is characterized more by command and control than market incentives, and it is the lack of market incentives that have allowed vested interests to play such a major part in the Chinese provinces.

In other words, what we see is that a host of different explanations are important in our different cases. Geography seems to have been most important in Denmark, but also had some effect in China. Getting the price right-type explanations make a lot of sense for Germany pre-2014. For both Denmark and the US, there are examples of new administrations coming in with more market-oriented policies than their predecessors, but these are still political explanations, and the more or less constant swings in US installations are unrelated to economic explanations. Economic explanations also fail to explain why wind power has been consistently losing to solar power in Japan, and it can explain very little of the upswing for solar since Fukushima. Finally, technology arguments may explain part of the German story, as the rapid phase-in of in particular solar challenges the capacity of the grid itself, a problem that can only be solved by upgrading the grid, making it technologically better and smarter, or through technological breakthroughs in energy

storage. In Japan, similar arguments may explain why in the future solar power may meet with resistance (and wind power even more so), as the Japanese grid is likely to suffer similar problems as the German, but technology arguments can hardly explain why after Fukushima wind power is still largely left behind.

What we however also see, is that there is only one explanation that remains constant and important in every one of these cases, irrespective of whether the country is a democracy or a one-party state, presidential or parliamentarian. Economics, technology and geography may be important background factors, but they vary from case to case. Politics however, always plays a role. The influence of vested interests is strong and persistent in all of the cases, irrespective of other conditions. This makes sense in many ways. Politics is the framework within which markets operate, within which technologies develop, and within which resource endowments are understood and interpreted. Thus, if it is swings that we want to explain, these can ultimately only be explained by honing in on the workings of the political systems. The interest group game differs from country to country because the political constellations are different in every country. This makes comparative case-studies an extremely important methodological tool. But the patterns of interest group politics, regulated by government, as the main cause behind swings in installations, is something that every country has in common. And these are lessons and conclusions that should be applicable not just to wind power, but to other sources of energy as well, both renewable or non-renewable.

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Conflict of Interest

The author declares no conflicts of interest in this paper.

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