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What drives investment in wind energy? A comparative study of China and the European Union

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ABSTRACT

Although the expansion of new renewable energy has been dependent on support in state policies, the research literature has scant focus on the political motivations for implementing policies to stimulate such development. The growth of wind power is an illustrative case of renewables expansion, as this is the most mature of the new renewable technologies. What can explain the rapid development of wind power production capacity in the EU and in China, despite their very different political systems and basic preconditions? Applying the method of *most-different systems design* in combination with document studies and interviewing, this article demonstrates how large-scale investments in wind power have come about through a specific set of political motivations backed by strong governmental support policies with similar main aims: security of energy supply, creating future-oriented industries and employment, and reducing greenhouse gas emissions and local pollution. These three factors together, broadly perceived, might also explain the political motivations that drive large investment in new renewable energy sources elsewhere.[1]

1. Introduction

Transforming the world's energy systems to sustainable standards will require large-scale investment in renewable energy production [75, pp. 27–28]. Today wind power technology is regarded as the most mature of the new technologies in renewables, with the potential to cover more than 20% of global electricity demand by 2050 [74, p. 539]. Investment in wind power production may be taken as an illustrative case for examining what drives investment in renewable energy. Wind energy costs have decreased substantially in recent years, with grid parity[2] being achieved in a growing number of markets, among them Argentina, Brazil, Italy, Portugal and the UK (see [119,142, p. 11; 77]. The People's Republic of China (hereafter China) and the European Union (hereafter EU) have enormous potential for increased production of wind power, given their long windy coastal expanses, large mountainous areas and plains with high winds [47,100]. Both have made considerable investments in new renewable energy[3]—wind power, bio power and solar power in particular—in the past decade. Several studies have investigated the expansion of wind power production in Europe or in China (see [90,9,140,125,154,155,86,43,96]), including the effects of various support mechanisms [91,17]. Lema et al. [87] focus on competition and cooperation between the wind industries in Europe and China, whereas Lema et al. [88] discuss the impact of China's wind industry on the global wind industry. Analysing key participants' motivations for wind energy *innovation* in China, Urban et al. [138] conclude that important drivers are concerns about energy security and economic growth, and more recently also climate change. These findings are confirmed by Boyd's [14] document analysis of the political ideas driving renewables investment in China.

Still, few studies have to our knowledge conducted causal comparative analyses to reveal what has spurred the large-scale development of wind energy production in the EU and in China. The field of energy studies has few comparative studies and inter-

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[2] Defined as operation costs per unit of electricity production when all present and future costs are included, based on the lifetime cost: i.e. the costs of capital, finance, maintenance and operation.

[3] New renewable energy includes wind, solar, bio and geothermal energy, but excludes large-scale hydro power and bio energy in the form of firewood, as hydro power has existed much longer on a commercial scale than the other renewable energy sources and wood has been used since ancient times.

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disciplinary studies, or studies conducted by political scientists and innovation scholars [131, pp. 12,13,19,20]. This comparative interdisciplinary study addresses the overarching question of what types of politics can make policies on phasing in renewable energy achievable (see discussion of Sovacool, [131, p. 21]). Moreover, as pointed out by Aguirre and Ibikunle [1,p. 375] there are few empirical studies of what influences renewables deployment, particularly worldwide. Several authors argue that political drivers are probably central in promoting renewable energy (e.g. [122, p. 13]), but studies on global samples of such political drivers have been inconclusive. Some argue that climate concerns are important [1, pp. 381–2], others that they do not matter [101, p. 6883]; some studies hold that energy security is a key concern (ibid), others that is not a major determinant [1, p. 382]. In a commentary article, Jacobs [78, p. 30] emphasizes energy security, climate concerns and job creation as key drivers behind renewables investment worldwide. As Schaffer and Bernauer [126, p. 25] note, qualitative case studies are useful for demonstrating whether decision-makers take structural factors into consideration in deciding about renewables support policies. Thus we ask: What political motivations may explain why the EU and China, despite their enormous differences, have had similar large-scale expansion of wind power capacity in the past decade? We find that a combination of three predominant political motivations has been crucial in driving the implementation of policies necessary to stimulate growth in wind energy capacity: security of energy supply, creating future-oriented industries and employment, and reducing greenhouse gas (GHG) emissions and local pollution.

These motivations will probably be the same as or similar to those that drive new investments in renewables in general, as politicians tend to seek to satisfy broader societal targets when they create and implement policies on renewables. Moreover, with the comparative method of *most-different systems design*, there is a high likelihood that the results can be generalized to other countries and regions. As renewable energy production has often been more expensive than technologies for producing e.g. coal and nuclear power, it has required various types of governmental support for deployment and innovation—like access to cheap loans, laws granting access to the electricity grid, and research and development (R&D) funding. Here we focus on the political motivations behind the creation of such policies in the EU (perceived as one entity + its member states) and China. Building more wind power installations does not necessarily translate into stimulating innovation in wind-turbine technology, but the two factors are interconnected: a domestic market for wind power can nourish a domestic industry with considerable potential for learning and ultimately innovation [90,91]. Such innovation can drive system costs further down, facilitating large-scale deployment and thereby energy-system transformation by becoming a cost-competitive 'default' technology. Support mechanisms are arguably essential for the early stages of a technology, to help it avoid the technological 'valley of death' and become commercial.

2. Method and data

We draw on historical comparative analysis and the *most-different systems design*. This design singles out for comparison cases that have similar outcomes on the dependent variable, but different values on all independent variables of relevance to the outcome except, ideally, for one or very few. Similar values on that single (or small set of) independent variable(s) should be able to shed light on or even explain the similarities in outcome. This method is useful for minimizing the number of possible causes, since independent variables where the cases score differently can be eliminated as single causal factors (although they may still be involved in multivariate causation) [58, p. 143]. We hold that since wind energy technology has needed various types of stimulating measures to expand, and energy policy is a heavily regulated field, the motivations of political leaders have been central for expansion of production capacity. These motivations can be measured from primary and secondary sources like interviews, public policy documents, reports, speeches and academic literature.

The EU and China have been chosen as cases of comparison, for several reasons. By definition, the EU is different from a nation-state — but as a political system/organization, it has strong federal features that make it comparable to national (not only federal) entities elsewhere. The EU is a relevant study object as regards wind power for various reasons: first, its member states have initiated large-scale investment in wind energy and have also fostered the leading manufacturers of wind energy equipment [60]. Second, the EU as a political organization is relevant because it is an organization where overarching climate and energy policies binding on the member states are created. Third, the EU has gained greater authority in the field of climate and energy (see [8]), although the ultimate power for making most decisions still rests with the member states. Recent expansion of wind- generation capacity in the EU is both a consequence of EU policies like the renewables requirements set for member states by the Renewables Directive (Directive 2008/28/EC) [25] and of national ambitions, as the EU as such has no land, no legislative authority and also no funding for constructing wind farms. Thus, focusing on both the EU and its member states is justified in terms of causality here.

Several factors make China a pertinent case for investigation. First, since 2010, it is the country with the world's largest installed capacity for wind power production [64], although the EU, regarded as one unit, still ranks first. Second, Chinese wind energy equipment manufacturers now rank among the world's largest [81,63, pp. 38,44; 123, p. 71]. Third, for relevant comparison of the development and deployment of a technology until recently deemed expensive compared to traditional energy sources, the cases selected for study should have a considerable potential for large-scale use of this technology. Both China and the EU have ample wind resources [100] and have the world's largest installed capacities [64]. Thus they can serve as useful objects of study, influential cases particularly suited for shedding light on causal relationships of wider relevance (see [58, p. 108]).

The scope for generalization in the present study is potentially global: the causal relationship under scrutiny is in this type of design deemed valid across different regime types and levels of development. If we can isolate an operative cause of wind power expansion in both the EU (e.g. EU policies + EU28 policies) and China, that cause might be expected to apply to other political systems at national and international regional levels where there is high potential for renewable energy. There is, however, as George and Bennett [57, pp. 155–156] note, an inherent weakness with most-different case designs: cases with the same outcome might be discovered that do not have the same value on the variable(s) that survived the elimination procedure in the initial analysis. Therefore, in the discussion and conclusion section we assess whether the structural factors leading to the political motivations identified exist in other countries with large wind potentials and capacity for growth. We combine most-different systems design with causal analysis of influential cases using other case-study methods such as interviewing and document analysis to enable process tracing, as recommended by George and Bennett [57, pp. 156–160]. This also meets the criticism of Gerring ([58, pp. 140–142]): that the most-different systems design method does not provide sufficient grounds for causal analysis in itself.

We focus on the period from around 1980 until 2015. In those years, modern wind-turbine industries were established in European countries and in China and, reaching technological maturity,