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Which Way Does the Wind Blow? Analysing the State Context for Renewable Energy Deployment in the United States

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ABSTRACT

Wind power is an important low-carbon technology and the most rapidly growing renewable energy technology in the US, but there is significant state-by-state variation in wind power distribution. This variation cannot be explained solely by wind resource patterns or US state policy and points to the importance of both local and central governance. We outline the national context for wind deployment in the US and then explore the sub-national, state-level factors shaping wind deployment patterns. We probe the socio-political context across four US states by integrating multiple research methods. Through comparative state-level analysis of the energy system, energy policy, public discourse as represented in the media and state-level, energy policy stakeholders' perceptions we examine variation in the context for wind deployment in Massachusetts, Minnesota, Montana and Texas. Our results demonstrate that different patterns of wind deployment and different debates about wind power have emerged in each locale. Participants across the different states appear to frame the risks and benefits of wind power in significantly different ways. We discuss the impact of risks and benefit frames on energy policy outcomes. The comparative assessment highlights the complex interplay between central and local governance and explores the significant socio-political variation between states. The study contributes to the understanding of energy technology deployment processes, decision-making and energy policy outcomes. Copyright © 2014 John Wiley & Sons, Ltd and ERP Environment.

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Introduction

Shifting away from high-carbon energy systems towards an energy infrastructure that emits little or no carbon is essential to stabilize atmospheric concentrations of CO_2 (Pacala and Socolow, 2004; Holdren, 2006; Intergovernmental Panel of Climate Change, 2007). Investments in energy infrastructure technology made today will impact emissions rates for decades to come (Pacala and Socolow, 2004; Gallagher *et al.*, 2006). Wind power is a critical energy supply technology with potential to contribute to substantial greenhouse gas reductions in the electricity sector. In addition to its climate mitigation potential, wind is the fastest growing energy resource in the United States (US), accounting for 42% of all installed electric capacity additions in 2008 (Wiser and Bolinger, 2009).

There is a need to stimulate the continued rapid uptake of low-carbon energy technologies, but historically, diffusion of emerging energy technologies has been uncertain (Sagar and Gallagher, 2004; Neuhoff, 2005; Stephens and van der Zwaan, 2005) and its geographical distribution unequal (Pasqualetti, 2000; Strachan and Lal, 2004; Astrand and Neij, 2006; Bard, 2006; Meyer, 2007; Toke *et al.*, 2008; R. Blum, 2009, personal communication). Many obstacles to the widespread deployment of emerging energy technologies are apparent, but their interaction is not well understood. Research exploring the challenges of energy technology diffusion has generally focused on economic and technical aspects at the national level (Isoard and Soria, 2001; Nakicenovic, 2002; Nemet and Kammen, 2007; Scherhaufer, 2008) or compared outcomes in different countries (Dutilleux and Gabriel, 2008). By contrast, the local socio-political context into which new technologies must be integrated is often overlooked and its relevance underestimated (Engel and Saleska, 2005). The US provides a unique opportunity to understand local aspects of energy technology deployment: While federal energy policies affect all states, US electric transmission grids are regionalized, and states have significant say in approving and regulating energy infrastructure as well as participating in energy markets. Socio-political aspects at the state level include diverse institutions and actors, regulations and laws, as well as business interests and other economic factors. These actors and institutions are influenced by varying perceptions and levels of awareness about the risks, benefits and costs of emerging energy technologies. The interplay between federal policies, state policies and regional electricity markets provides a rich context for examining the intersection of multi-level governance and renewable energy policy.

This research explores the question of how the socio-political context for wind deployment differs in selected states in the US. This research question is addressed comparatively by combining and comparing media analysis of state-level newspapers with interviews of state-level energy stakeholders. The framing of wind in the print media in each state is compared through content analysis of state-level newspaper coverage of wind power. In addition, in semi-structured interviews, state-level energy policy stakeholders were asked to explain their perceptions of wind power within their unique state context. This mixed-methods approach is used to characterize the socio-political context for wind power across four very different state policy contexts (Minnesota, Massachusetts, Montana and Texas).[1] It contributes to improved understanding of state-level variation in energy technology innovation and the discourses and social processes associated with emerging energy technologies.

Rationale and Case Study Selection

In 2009, a record amount of wind power was installed across the US, and new capacity additions passed the 10 000-MW mark for the first time (AWEA, 2010).[2] Wind development in the US has followed a 'boom and bust' cycle, driven in some part by the passage, renewal and expiration cycle of a centralized national policy at the federal level called the Production Tax Credit (PTC). For the first 10 years of a wind installation's operation, this subsidy provides a tax credit of roughly 2.0 cents/kWh. The US Congress let the PTC lapse three times, in 1999, 2001 and 2003, and this coincides

[1]Both Montana and Texas are generally considered conservative states. Within mainstream US conservative ideology, climate change has become viewed as a fabricated issue and remains quite controversial.
[2]Preliminary data for 2010 indicate a slow-down in new wind energy development associated with the deep economic recession (AWEA, 2010).

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with sharp drops in new wind power development in these years (Wilson and Stephens, 2009). Unless renewed by Congress, it is set to expire at the end of 2013.

While temporal variation in new wind development seems tied to subsidies at the federal level, drivers for spatial variation of wind power are less clear. Patterns of wind turbine distribution are far from uniform across the country. As of 2009, six states (Texas, Iowa, California, Washington, Oregon and Minnesota) were home to more than 60% of the country's wind capacity installations, and Texas alone housed more than 9700 of the nation's 35 000-MW wind power. In turn, the Great Plains states of Nebraska, North Dakota and South Dakota produced very little wind power, despite their excellent wind resource. The states that have experienced the most wind deployment do not necessarily have the best wind resource, highlighting the crucial importance of states in driving wind. Furthermore, the presence of state policies supporting wind power is not perfectly aligned with having more wind power in the state. Neither energy policy nor the distribution of wind resources fully explains state variation in development patterns of this technology. Multiple other factors also seem to be influencing wind deployment patterns; this research aims to explore these factors in an attempt to facilitate more effective coordination and alignment between multi-level governance joining national and state-level energy technology policy and initiatives.

State-level processes, institutions and organizations strongly influence electricity generation and consumption across the US (Rabe, 2004). Although federal energy policies outline broad directions for the US energy system, many policy and regulatory actions with direct influence on the electric energy system happen at the state level. Electricity grids in the US are regionalized, meaning that state institutions (e.g. Departments of Energy or Public Utility Commissions) and regional coordinating organizations (e.g. independent system operators) are very influential. Energy regulation is largely in the domain of the states rather than at the national level, and broad energy objectives are decided and implemented at the state level. State legislatures have authority to pass statutes that influence the organization of the electric power industry, impact the relative use of different energy sources or efficiency and conservation, target local economic development and set environmental goals. Permitting of new generation and transmission facilities is the responsibility of state public utility commissions, which in conjunction with other agencies also monitor compliance with environmental regulations (Sautter and Twaite, 2009). Finally, they determine electric power rates in the 27 traditionally regulated states.

Given the lack of a coordinated national climate policy in the US, state-level renewable energy and climate change policies have been extremely important. The states have served as laboratories of climate change policy for the electric energy sector (Rabe, 2008). At the national level, no policy currently exists that directly targets carbon emission reduction from the electricity sector, nor is there a national energy efficiency policy or a centralized renewable energy mandate. Although federally driven emissions quotas and allowance trading systems exist for SO_2 and NO_x, no unified system exists as yet for carbon emissions. However, other federal policies and incentives for low-carbon energy do exist (e.g. the previously mentioned PTC), but not consistently (Garud and Karnøe, 2003).

In contrast, more than half of all states have already implemented energy efficiency and/or renewable energy mandates, and 35 states have or are developing state climate action plans (Pollak, Meyer, *et al.*, 2011). All in all, this experimentation has produced considerable variation across states in sustainable energy and carbon mitigation policies, particularly where renewable targets and accompanying market mechanisms are concerned (Rabe, 2006; Holt and Wiser, 2007; Fischlein *et al.*, 2009; AWEA, 2010). While in some states these policies have been associated with more renewable power development, in others that has not been the case, and the overall effectiveness of policies at the state level is disputed (Menz and Vachon, 2006; Carley, 2009).

The scale of wind power deployment required to make a dent in carbon emissions is large. Although wind deployment has been growing rapidly in the past few years – particularly in some states – advancement of wind could be furthered with greater coordination among states and between the state and federal level. This research recognizes this potential and focuses on illuminating the drivers of state-level variation to assist in coordinating policy for the further advancement of low-carbon energy technologies. A highly complex context surrounds state-level decisions, policy and discourse that impact energy technology development. Understanding this context is critical to maximizing alignment between centralized and state efforts to advance emerging energy technologies.

Stephens *et al.* (2008) have proposed an integrated research framework, the SPEED (Socio-Political Evaluation of Energy Deployment) framework, to facilitate a nuanced understanding of the sociological complexities of energy technology deployment at the sub-national level. The SPEED framework provides a structure to explore interactions among regulatory, legal, political, economic and social factors influencing deployment. The framework encourages

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multiple approaches to exploring these socio-political factors, including policy review (Wilson and Stephens, 2009), media analysis (Stephens *et al.*, 2009), and stakeholder interviews (Fischlein *et al.*, 2010). The present study integrates the results of media analysis and stakeholder interviews to compare how stakeholders characterize and the media portrays opportunities and challenges of wind technology. We selected four states whose contexts for wind deployment are very different. We followed a case selection method that includes both positive and negative outcomes of interest (Mahoney and Goertz, 2004; Seawright and Gerring, 2008), namely states that show strong deployment of wind power, and those that do not.

Figure 1 shows wind capacity for all US states, including our case study states. We contrast these outcomes with the presence of policies relevant to energy technology development in the state. This variation enables a comparative assessment of the context in states where policy has been more or less effective and in states where other socio-political factors are important. Massachusetts, Minnesota, Montana and Texas exhibit variation in two important dimensions: (1) technology deployment and (2) policy status relevant to wind. Texas, Montana and Minnesota each have a large onshore wind resource potential while Massachusetts has a smaller, but still sizeable resource. Texas and Massachusetts also have an offshore wind resource. Each state has a different history with wind development. An important number of policies relevant to wind technology deployment are in place in both Massachusetts and Minnesota, whereas Texas and Montana have fewer such policies. Montana and Massachusetts have relatively little installed wind power in relation to their resource, but the wind energy sector is large and growing in Minnesota and Texas.

Texas has a significant wind resource, particularly in the Panhandle area, and wind capacity is growing faster here than in any other US state (Wiser and Bolinger, 2008). At 9727 MW installed wind capacity in September 2010, it is the largest producer of wind energy in the US (AWEA, 2010). Electricity prices are relatively high compared with other US states, which has helped wind power's competitiveness with other power sources. Minnesota also has a strong wind resource, especially in the south-western part of the state, along the Buffalo Ridge. With an installed capacity of 1818 MW as of September 2010, Minnesota is the fifth largest wind power producer in the nation

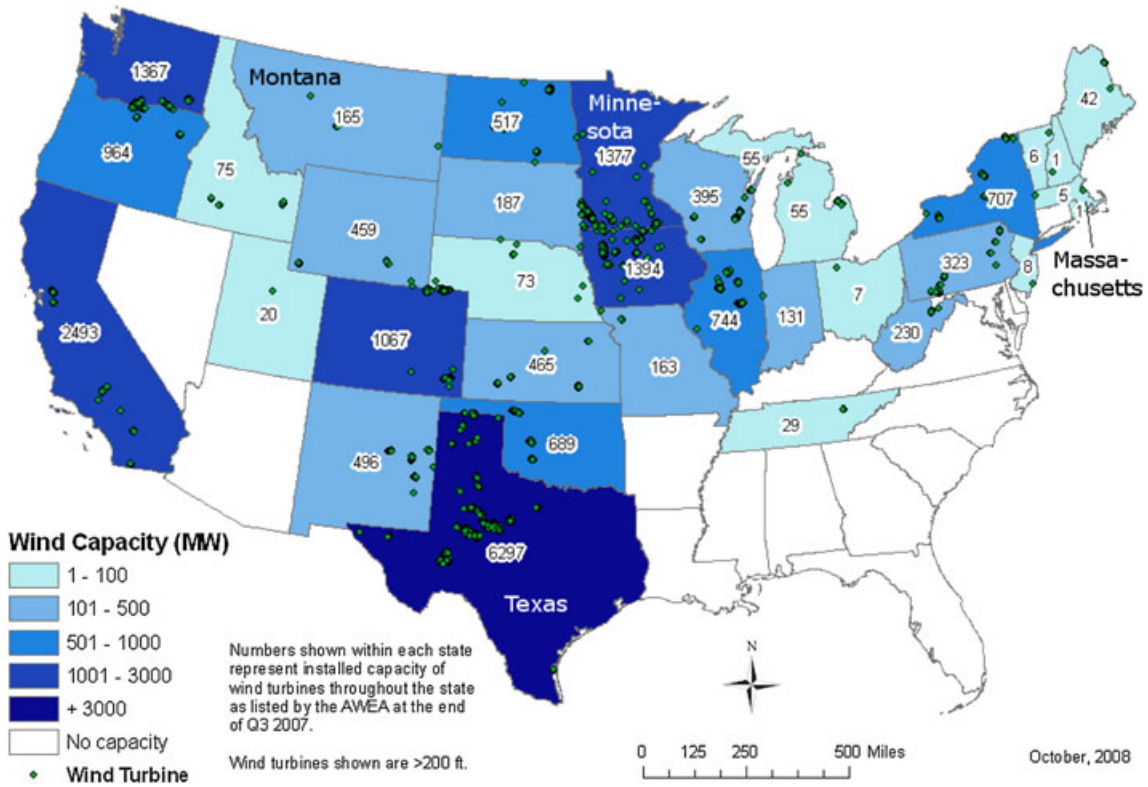

Figure 1. Wind capacity (MW) and wind turbines for 2008 across the United States, including the four case study states. Source: (AWEA, 2010)

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	MA	MN	MT	TX
Population, 2008 (millions)[1]	6.5	5.2	1.0	23.3
Population growth, 2000–2008[1]	2.3%	6.1%	7.2%	16.7%
Land area (sq. miles)[1]	7800	79 600	144 600	261 800
Persons per sq. miles, 2000[1]	810	62	6.2	80
Electricity consumption per capita (MWh), 2007[1,3]	8.8	13.1	14.1	16.1
Cost of electricity (cent/kWh), 2007[3]	15.2	7.4	7.1	10.1
HHH-Index (>1000 = highly concentrated)[3]	1984	2747	775	3879
Total electric power industry CO_2 emissions (million metric tons), 2007[3]	25 539	37 706	20 013	255 092
Carbon intensity of electricity (metric tons CO_2/MWh)[1,3]	0.47	0.88	0.91	0.73
Installed wind turbine capacity in MW (and ranking among US states), 2010[2]	17 (33rd)	1818 (4th)	385 (21st)	9727 (1st)
Renewable percentage of fuel mix (excluding large hydro), capacity/generation 2007[4]	<0.05/0	8.8/4.8	2.7/1.7	4.4/2.2
Wind energy price ($/MWh)[5]	48	30	29	27
Policies and bills affecting wind deployment 1995–2008, highlighting salience to state legislature, not effectiveness	14	50	6	14

Table 1. Indicators for energy system and policy context in Massachusetts, Minnesota, Montana and Texas. Sources: [1]US Census Bureau (2008) [2]American Wind Energy Association (AWEA) (2010), [3]EIA (2009a), [4]EIA (2009b), [5]Bohn and Lant (2009) The HHH-Index of concentration, or the Herfindahl–Hirschman index, provides a calculation of the size of individual companies in relation to the industry, measuring the concentration of a particular industrial sector

(AWEA, 2010). Of all US states, Minnesota has the second highest penetration of wind power in the electricity system, with wind generation providing 4.8% of all electrical power in 2007, more than twice as much as in Texas (EIA, 2009b). Initial increases in wind capacity have been driven mainly by an agreement between the state and Xcel Energy, the power company that supplies 50% of Minnesota's electricity, over the storage of nuclear waste that involved a commitment to wind production. Wind deployment in Minnesota has also been supported by a commitment to community-based wind projects and a state-level renewable portfolio standard. Montana has just begun to utilize its large resource, with only 385-MW capacity developed to date (AWEA, 2010). Much discussion of wind power development in Montana has focused on transmission, because as an electricity exporter Montana could potentially satisfy demand in nearby states that are ramping up their renewable goals.

In contrast, wind resources in Massachusetts and Montana have not been extensively developed. Of the four states, Massachusetts has the least installed wind power, currently only 17 MW (AWEA, 2010). Most of the wind resource is located offshore.[3] The Cape Wind Project, which is to become the nation's first offshore wind farm, has 'faced tremendous political, social and legal challenges' (Phadke, 2010: 1) and was lodged in a lengthy permitting process as local residents opposed the project on aesthetic, environmental and economic grounds (Kempton *et al.*, 2005). The project has since received clearance from all local, state and federal reviews as of 2012.

A more detailed discussion of state differences in wind power deployment can help contextualize the results of this study (Stephens *et al.*, 2009; Wilson and Stephens, 2009; Fischlein *et al.*, 2010). Each of the case study states has a unique energy system (Table 1). In Massachusetts, the policy and energy context for wind deployment *appears* promising; the state is an electricity importer with high energy prices, carbon constraints and a renewable portfolio standard (RPS), but the low-growth of energy demand, the high cost of offshore wind and the political controversy surrounding development of wind resources have stalled wind power development. The controversial Cape Wind Project has dominated public discourse, but opposition to wind projects has not been limited to that project; opposition

[3]Offshore wind power is generally estimated to be 2–3 times more costly to develop than onshore resources (personal communication with R. Blum, R. (2009).

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to onshore wind projects in the western part of the state has also emerged. In contrast, in both Minnesota and Texas, wind energy development is proceeding at a record-breaking pace. Minnesota, like Massachusetts, is an electricity importer, with carbon constraints and an RPS, but Minnesota is still a regulated electricity market, and wind deployment was driven initially by regulatory requirements placed on the state's largest utility and requirements for community-wind development. The high carbon intensity of Minnesota's electricity sector makes low-carbon wind deployment particularly attractive for reducing greenhouse gas emissions. Texas' strong energy-industry history and rapid demographic growth results in a tendency for energy technology discourse to focus more on the business perspective with comparatively little risk discourse. The relatively high electricity prices and restructured competitive electricity market could be seen as driving wind deployment and supporting the generally positive, economics-orientated discourse. Montana wind development is nascent. As an electricity exporter, Montana's incentives to develop wind may be different. While the Governor of Montana has been proactively supporting renewable and climate policies, the Legislature has not always followed.

Methodological Approach

In this study, we combine and compare content analysis of media articles with that of stakeholder interviews to provide comparative insights on stakeholder perceptions of and media discourse on wind. News media provide a representation of contemporary public discourse (Gamson and Modigliani, 1989), and influence public opinion (Culbertson and Stempel, 1985). One function of the media is to frame issues, as well as to interpret information (Weaver *et al.*, 2009). For technology, framing and interpretation are important to shape risk perception and the acceptance or rejection of technology. For complex issues such as climate change, news media frame both the problem and its possible solutions (Hansen, 1991). In the process of mediating between the public and scientific information, media simultaneously influence and represent public perception of risks and benefits (Peterson and Thompson, 2009; Stephens *et al.*, 2009; Feldpausch-Parker, 2010). With regard to climate change and climate mitigation technologies, media not only inform the public of scientific and technological advances, but also of the risks and benefits associated with the biophysical processes and new technologies advanced in response to these processes (Corbett and Durfee, 2004; Carvalho, 2007). News media therefore not only influence the flow of information, deciding its newsworthiness, but also influence political agendas by framing how the information presented.

Where media analysis provides insights into the broader public opinion on salient issues, examining stakeholder discourse reveals the perceptions of actors participating in the energy policy process. Social acceptance of renewable technology has institutional, market and political dimensions (Wüstenhagen *et al.*, 2007) and interviews with influential stakeholders can reveal these complex issues directly, rather than accessing them indirectly through social acceptance indicated by public opinion and media discourse. Key actors' (including community and business leaders, politicians, entrepreneurs, etc.) perceptions of risks and benefits of emerging energy technologies may influence deployment by four primary mechanisms: (1) impacting policy decisions that may provide incentives or barriers to deployment, (2) influencing siting of specific new facilities required for the new technologies, (3) increasing consumer demand for the new technology and (4) influencing the ability to attract capital for research, development and deployment. The importance of key actors' perceptions and positions in deploying energy technologies can be seen from the analogous literature on public perception in the siting of hazardous facilities (Boholm and Lofstedt, 2004; Owens, 2004; Kasperson, 2005). Together, the two sources examined in this study provide a comprehensive view of both expert and public opinion related to the deployment of an emergent energy technology, and provide a comparison between the public discourse and the stakeholder discourse.

For both the media articles and the interviews, we use content analysis to identify patterns of meaning in the qualitative data we collected, a method especially appropriate for analysing large amounts of text (Holsti, 1969; Krippendorf, 1980). We employed a priori coding (Creswell, 1998), meaning that our coding categories were developed from a theoretical foundation as opposed to emerging from the material (Stemler, 2001). In this approach, codes are pre-structured from theory and refined during coding to guarantee a high degree of exhaustiveness and mutual exclusiveness of coding categories (Weber, 1990).

Stephens *et al.* (2009) proposed adapting Luhmann's (1989) social function systems theory for analysis of the socio-political context of state-level energy deployment. In applying social function systems theory to ecological

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communication, Luhmann (1989) proposes that society's responses to environmental perturbations are structured by internal interactions within society itself. Responses to system-wide issues such as environmental pollution can only be achieved through communication across multiple subsystems, including economics, politics, law and science. Since each subsystem possesses its individual code (e.g. money in the economic system), and messages have to be translated across subsystems, responses to environmental perturbations such as climate change are encumbered and slowed down (Peterson *et al.*, 2004).

We used Luhmann's social theory to provide a systematic framework for analysing stakeholder perceptions and media discourse associated with wind power technology. The codebook for analysis was developed based on six social function frames: aesthetic and cultural, economic, environmental, health and safety, political, and technical. Additionally, to differentiate negative and positive evaluations, risk perception served as a frame for evaluating and incorporating discourse on wind technology. Table 2 provides an overview of signalling words and themes used in coding.

Media Analysis

For the media analysis, we performed content analysis on newspaper articles about wind power from the highest circulating newspaper in each state (Table 3). These articles were found using the LexisNexis™ Academic search guide and ProQuest™. The search criteria included the terms wind energy, wind power, wind turbine, wind and renewables, wind farm and windmill. We limited the search to the title and lead paragraph to ensure that only articles which focused on wind were selected. Search dates were from 1 January 1990 to 31 December 2009. For an in-depth comparison with the interview data, we coded the articles from the most recent 2 years, using QSR International's NVivo™ 9 qualitative analysis software, a text-analysis program that facilitates coding and quantitatively assessing large amounts of text.

	Wind	
Frames	Positive (facilitator)	Negative (barrier)
Aesthetic	Positive visual impacts.	Negative visual impacts or other nuisance (e.g. noise).
Economic	Market is available for technology.	Technology is expensive.
	Financial incentives make technology feasible.	Technology is not developed to commercial scale.
	Low cost.	
	Creates jobs.	
Environmental	Technology will reduce GHGs or carbon emission, mitigate climate change, reduce other air pollution.	Negative environmental consequences (e.g. bird kills, habitat loss, groundwater contamination).
Health and safety	Technology may improve human health and safety (i.e. reduce respiratory problems, asthma, etc.).	Technology may pose health risks for workers, public.
Political	Legislation is present or being considered that would help or facilitate the technology.	Technology is politically sensitive or controversial.
	Technology is easy to sell to public, socially acceptable, popular among the public or the community.	Technology deployment may be difficult due to permitting or siting process.
	Technology helps reputation of the state, or some other political entity.	Technology deployment is difficult because of the absence of a legal framework or regulatory uncertainty.
Technical	Technology has been proven reliable in other uses.	Technology may not work, is unproven or uncertain.
	Takes advantage of existing natural resource.	Infrastructure does not yet exist to support technology.
	Technology is feasible, doable, promising and/or has potential.	Technology is limited in its technical capacity.

Table 2. Signalling words and themes used to code interview and media content into socio-political context and risk perception frames, based on Luhmann's (1989) social function systems theory

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	Massachusetts	Minnesota	Montana	Texas
Largest circulation	*Boston Globe*	*Minneapolis Star Tribune*	*Billings Gazette*	*Houston Chronicle*
No. of wind articles in largest circulating newspaper	494	193	42	186

Table 3. Number of newspaper articles addressing wind energy from 1990 to 2009

Stakeholder Interviews

Between May 2008 and December 2009, we interviewed 84 stakeholders who were involved in the state-level energy policy process, and whose background ranged from industry, the public sector and non-governmental organizations (NGOs) to academics (Table 4). For each state, stakeholders were initially selected by searching state-level databases of legislative committee testimony and identifying participants. Additional stakeholders were identified via snowball sampling during the first round of interviews. Similar to the newspaper articles, the transcribed text of each interview was coded using NVivo™ 8 and the same basic coding scheme was employed. Due to the complexity of both the codebook and the analysed material, each interview was coded by two coders, who then compared their work to reconcile the interview into a single set of codes. The results were analysed quantitatively by comparing the number of sentences coded in each frame and qualitatively by reviewing the content of the coded text.

Results

The results demonstrate some interesting differences between perceptions of wind in the different states and between media discourse and stakeholder perceptions.

Framing of Wind Power in the Media

The frequency of articles relating to wind power increased considerably in all states starting in 2001, and the years 2006–2007 had the highest number of articles, with numbers falling slightly in 2008 and 2009 (Figure 2). Massachusetts had by far the most articles, Minnesota and Texas had similar numbers of articles on wind, while very few articles on wind were published in Montana during the study period. Media coverage of wind has increased over time, indicating the growing salience of wind technology in the state-level public discourse. This parallels the increase in national awareness about climate change (Leiserowitz, 2005). In Minnesota and Texas, and to some extent Montana, this development coincides with increased wind installation, while in Massachusetts the discussion revolves around contentious attempts to site wind farms, in particular the Cape Wind Project (referenced in roughly half of all articles after 2001).

For the purposes of direct comparison with the 2008–2009 interview data, we will only address the equivalent timespan for the media articles. Of the 205 articles sampled from 2008 to 2009, only 58 articles or 28% related wind power directly to climate change by including at least one of the following words or phrases: 'climate change', 'global

	MA	MN	MT	TX	Total
Academic	1	3	2	1	7
Government	6	3	7	9	25
Industry, Industry Group	5	10	6	6	27
Environmental NGO	7	7	5	6	25
Total	19	23	20	22	84

Table 4. Distribution of interviews across states and policy stakeholders

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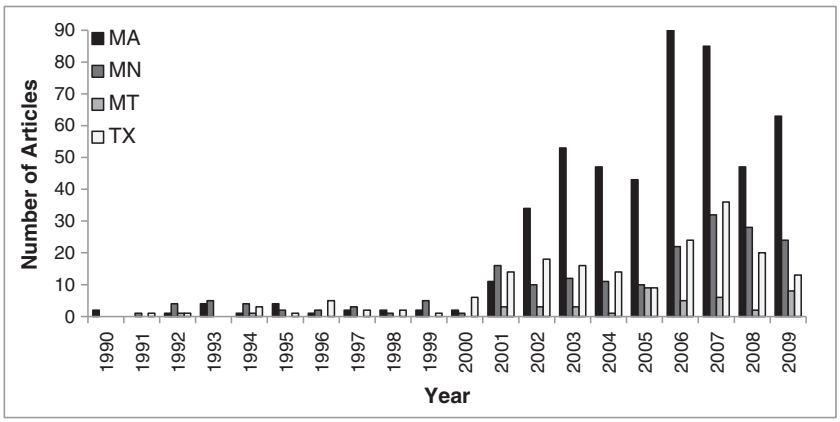

Figure 2. Frequency over time. The number of wind-power-related articles published in the major circulating newspapers in Massachusetts, Minnesota, Montana and Texas from 1990 to 2009

warming', 'climate' or 'carbon'. Nineteen per cent of the wind articles from Minnesota, 33% from Massachusetts and 36% from Texas included at least one of these phrases in the text. In contrast, in Montana articles failed to link wind energy to energy solutions for climate change.

Analysis of risk and benefit perceptions of wind power demonstrates some distinct differences in the wind technology framing among the four states. All the state newspapers demonstrated high coverage of economics, with the majority focused on the growing demand for wind energy, retention of incentives for wind projects, creation of new jobs and the search for cheaper alternatives to fossil fuels. Although Montana included this frame in a majority of their *Billings Gazette* articles, it was discussed more as potential than realized benefits and risks.

Similar to the attention given to the economic frame, the political and technical frames were among the highest recorded frames in a majority of the state newspapers, with political aspects mentioned slightly more often. Massachusetts, however, proved the exception, demonstrating more even distribution among framing usage. Massachusetts, Minnesota and Texas demonstrated a higher level of coverage on political benefits than risks. The difference was more pronounced in Minnesota (46 vs. 12%) and Texas (48 vs. 18%), possibly due to their state rankings as wind energy leaders as well as city and state mandates to diversify their energy portfolios to include more alternative energy. In turn, wind power in Massachusetts has both political advocates and opponents, explaining the high level of both political risks and benefits cited in this state's newspapers. Montana was the exception with equal coverage of political benefits and risks. Most risks centred on state lawmakers' abilities to overcome the hurdles of shaping legislation viewed as acceptable to all parties.

The technical frame showed less uniformity among states with more references to technical benefits in Minnesota and Montana, and more references to the technical risks of wind in Massachusetts and Texas. Technical risks for these latter two states are particular. For Massachusetts, the technical risks were associated with the testing of offshore or floating wind turbines in the Atlantic, whereas in Texas, it was a mix of issues including wind energy intermittency and transmission problems that allegedly caused a series of rolling blackouts (which were later reported as inaccurate). Therefore, in a state with little adoption of wind power to date, Massachusetts, technical risks were associated with circumventing local opposition to wind power by using more advanced technologies (wind turbines at sea, out of sight), while risk in Texas related to the continued expansion of an already thriving wind sector.

The aesthetic and environmental frames were mentioned equally frequently. For the aesthetic frame, this was driven by the Massachusetts' *Boston Globe*, which mentioned risks to scenery and the local culture in more articles (36%) than the other three state newspapers (Figure 3). Much of this risk framing resulted from coverage of the controversial Cape Wind Project and its impact on community viewscapes and the industries dependent on them (i.e. tourism). The contentious nature of wind power in Massachusetts probably explains why the number of articles in the *Boston Globe* is much higher than in the other states. The media tend to illuminate different sides of political conflicts, and controversy often drives reader interest.

Minnesota and Montana newspapers both had more beneficial than risk references to aesthetic aspects, pointing to the perception of wind turbines enhancing the landscape in these states with large tracts of open land. Texas mentioned

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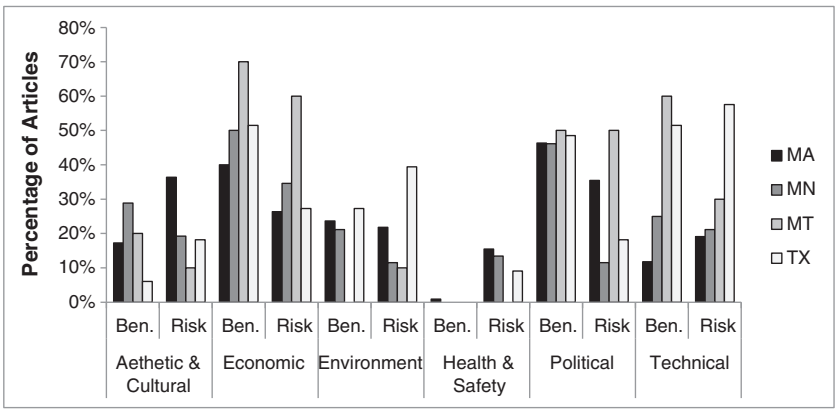

Figure 3. Comparative breakdown of specific benefit and risk frames for each state

the least amount of aesthetic benefits (6%) in its *Houston Chronicle* articles, gaining few perceived benefits from the presence of wind turbines in the western and coastal regions of the state.

The environmental frame also showed some variation across states. Impacts on wildlife (i.e. birds, bats and some marine species) were a major concern in all states, although Massachusetts (22%) and Texas (39%) experienced more article coverage on this particular topic due to their locations in relation to migratory bird routes. Environmental benefits were generally limited to an almost universal view of wind as a clean energy source that could reduce CO_2 emissions. However, the *Billings Gazette* made no mention of any such benefits in the 10 articles collected during this period. Overall, the presence of environmental benefit statements over risks in the *Boston Globe* and Minnesota's *Minneapolis Star Tribune* articles was higher than their western counterparts (Texas and Montana), presenting a more even distribution between risks and benefits of wind energy to the environment. This finding is in line with the policy status of Minnesota and Massachusetts, which both have a stronger record in climate change policy than Texas and Montana.

The frame receiving the least amount of attention from all state newspapers, and none at all from Montana, was health and safety. With the exception of Massachusetts, acknowledging some preventive measures being taken by project proponents to ensure the safety of ferries near Cape Wind, many of the articles highlighted local concerns such as hazards posed by turbines to air and ground traffic, falling ice, impacts to radar and noise pollution.

From a more national perspective, Figure 4 provides an overview of all coding frames, broken down by the presence of risk and benefit statements in newspaper articles from all four states. As indicated above, the economic and political frames received the most attention from newspapers, most of which was positive, and health and safety received the least and mostly negative attention.

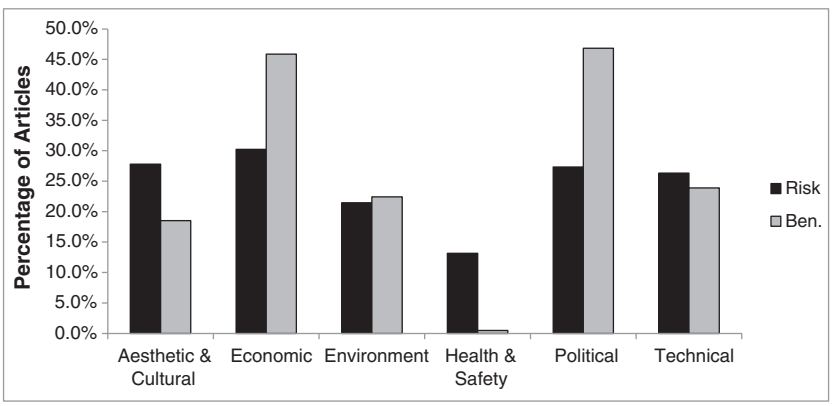

Figure 4. Proportion of articles containing social function frames, shown as a percentage

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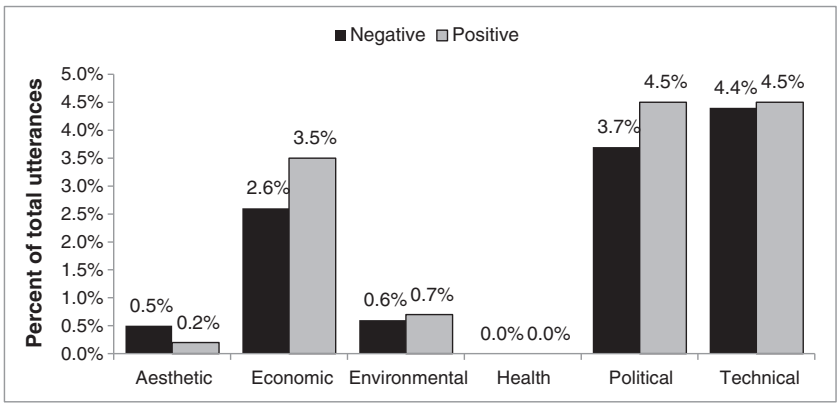

Figure 5. Proportion of sentences coded in social function frames, shown as a percentage of all sentences in the interviews

Framing of Wind Power in Stakeholder Interviews

Energy policy stakeholders were asked about wind technology deployment in their state during a series of interviews. The content analysis of the interview texts reveals differences across the four states. Roughly 25% of all sentences were coded as relevant to one of the six frames, for a total of 4198 sentences relevant to wind energy.[4] An overview of all coding frames, broken down by risk and benefit-coded sentences as a percentage of the entire interview material, is provided in Figure 5.

Close to 9% of sentences referred to technical aspects of wind technology, making this the most frequently discussed frame. Responses were almost evenly balanced between benefit and risk categories, indicating the prominent position of both technical challenges and opportunities in the framing of wind technology. The political frame was the second most commonly referenced frame, closely followed by the economic frame. The economic and political frames for wind power had significantly more beneficial comments than risk-orientated comments. The environmental frame was discussed relatively infrequently. Of the two remaining frames, 'health' was not mentioned at all, while 'aesthetics' was mentioned only a few times.

When broken down by state (Figure 6), substantial differences in stakeholder perceptions of wind power emerge among the six pre-determined socio-political frames and in the risk/benefit perception of this technology. With the exception of Montana, stakeholders in every state discussed wind predominantly positively (more positive than negative statements were made). Risk–benefit perceptions of the technology and the distribution of coded sentences across socio-political frames are connected in complex ways with the level of development in the state. When assessing state by state responses in more detail, it becomes apparent that stakeholders in each state characterized wind power in unique ways. The framing was associated with both technology development and policy status in the state.

The technical frame captures aspects of the technology related to a state's resource base, electricity infrastructure, R&D and potential uses of the technology. Beneficial comments in the technical category on wind energy described it as having substantial 'resource' and 'promise'. On the risk side, problems with transmission capability and intermittency were mentioned most often. Based on the aggregate numbers, policy stakeholders' discussions appeared relatively balanced between beneficial and risky aspects of technology. Overall, benefit comments in the technical frame outweighed risk comments in Massachusetts and Minnesota, while stakeholders in Montana and Texas had more risk-orientated than beneficial technical comments.

The political frame was the second most commonly mentioned risk/benefit frame for wind. Its frequency indicates the relevance of political processes in the deployment of emergent energy technologies (Menz and Vachon, 2006; Bohn and Lant, 2009). There were some differences in the salience of this category. For wind, Minnesota and Texas stakeholders spoke more of both the benefit and the risk aspects of the political frame than stakeholders in the other two states. In Montana, risk comments prevailed, while Massachusetts stakeholders had only slightly more positive comments, reflecting the contentiousness of wind energy in this state.

[4]The interviews also addressed another technology, carbon capture and sequestration, explaining the comparatively low percentage of coded material. In addition, descriptive statements were not coded as relevant, but only such statements that expressly referenced a risk or benefit frame.

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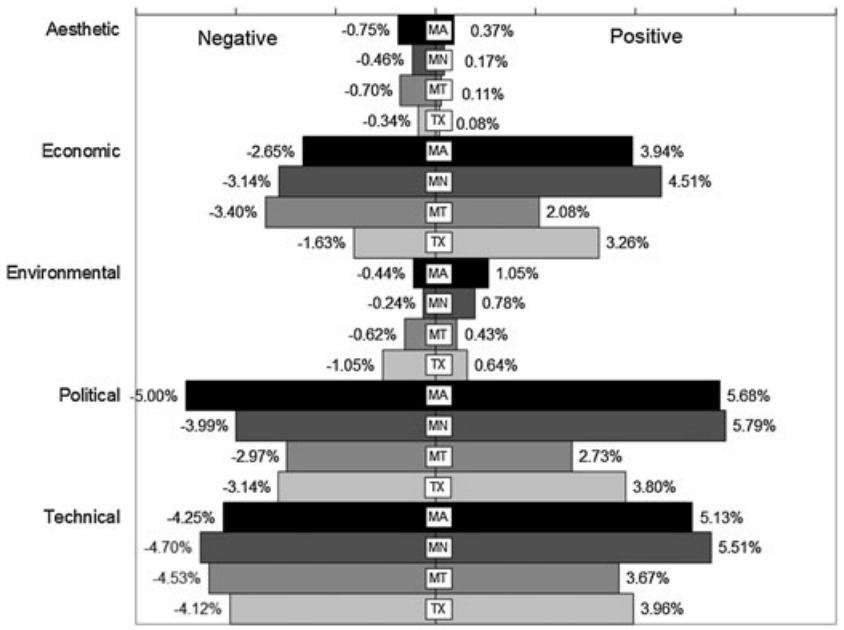

Figure 6. Positive and negative coding in risk/benefit frames for each state, shown as a percentage of all sentences in the interviews. Negative percentages represent the proportion of negative sentences in the interviews; positive percentages represent the proportion of sentences that were positive. Figure adapted from Fischlein *et al*. (2009, 2010)

The economic frame was the third most dominant frame of the stakeholder interviews. In all four states, the economic frame incorporates the financial aspects of technology development and deployment, including its cost competitiveness, its potential for revenue and job creation, ownership patterns and costs related to changes in the wider energy system. Texas had twice as many benefit-orientated than risk-orientated economic references for wind power, the largest difference of any state, and a sign of the economic success of wind power in this state. In Massachusetts and Minnesota, beneficial economic references also outweighed risk-orientated references. Montana was the only state where risk economic comments predominated.

The environmental frame was much less frequently referred to than the three dominant frames, but it presents some interesting variations across states. For environmental aspects, stakeholders' attention to risks and benefits showed the greatest disparity from state to state of all categories. In Minnesota, benefit comments outweighed risk ones more than three to one, while Massachusetts had two benefit comments for every risk reference to the environment. In contrast, both Montana and Texas had 30% more risk than benefit references to environmental issues associated with wind power. More frequent mention of the environmental frame by stakeholders in Massachusetts and Minnesota corresponds to the stronger climate change and environmental policies in those states, and could indicate that the connection between environmental issues and wind energy is more salient. In Montana and Texas, wind deployment is not strongly associated with climate change mitigation, although environmental concerns such as habitat loss and bird and bat kills did feature prominently within the discourse of some stakeholders.[5]

In every state, aesthetic comments were more risk- than benefit-orientated for wind. Overall, the aesthetic category was quite small, indicating that although aesthetic concerns are present in every state they appear to be less influential or pertinent than other categories for stakeholders involved in the state-level energy policy process. The health and safety frame for wind was minimally mentioned. This indicates that wind energy is generally perceived as safe by stakeholders, with little or no health impacts. No explicit connection was made in the interviews between reduced air pollution and associated health benefits.

[5]Note that the environmental category overall was quite small in all states, and counts were driven by a small number of stakeholders, mostly from environmental NGOs. Many stakeholders did not mention environmental impacts or benefits at all.

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Comparing Media and Stakeholder Representation of Wind Power and Their Impact on Technology and Policy Development

Similarities as well as differences emerge between media and stakeholder framing of wind power in each state. In Massachusetts, political aspects of wind technology dominated the stakeholder discussion, while aesthetic aspects were much more prominent in the media. Massachusetts demonstrates that policies encouraging wind power are no guarantee that wind will be deployed. While 'there are actually a lot of market signals that have happened in the state through legislation over the last couple of months' (MA11), stakeholders agreed that 'the real challenge is to site the major wind facilities' (MA10). Stakeholders had more positive economic references than negative, reflecting the perceived benefits of the technology. Mentions of environmental benefits (e.g. climate change) were countered by the potential for negative consequences (e.g. wildlife). Lessening their previously overwhelming focus on aesthetic aspects (Stephens *et al.*, 2009), media in Massachusetts are increasingly reporting on economic and political aspects of wind power, although coverage of the aesthetic frame was still stronger than in other states. To some extent, these differences may result from the tendency of the media world to emphasize conflict, but it also indicates that stakeholders deeply involved in wind power have a more balanced view of the technology than the media.

In Minnesota, the difference between media and interviews was less pronounced. The media articles most often referred to economic aspects, followed by political aspects. In the interviews, this was reversed. Stakeholders portrayed Minnesota as a leader in developing wind through policy action: 'In the last legislative session, Minnesota sort of went toward the head of the pack in the nation as far as states on the wind power issue' (MN19). Stakeholders mentioned some opposition to wind based on environmental concerns, but this was not presented as a significant hurdle to the technology. Rather, 'Climate change has really driven the market for wind power' (MN 20). This connection to environmental aspects was also apparent in the news media, which often referenced climate change and wind power. Most of the pushback in this state develops from transmission lines, dating back to a controversy about transmission siting from the 1970s. In line with this, a significant share of the media discussion mentioned transmission projects, in particular the CapX line project connecting wind-rich regions with the Twin Cities metropolitan area.

Overall, Montana stakeholders were more likely to question the general feasibility of wind projects, reflecting the issues experienced by a wind industry that is still small but developing rapidly. The media often referred to the transmission and system integration constraints preventing further development of wind power. Similarly, stakeholders often placed technical and economic concerns in the context of Montana's status as an electricity exporter: 'The big problem is that Montana's got this tremendous resource for generating electricity using renewable sources, but the question is getting it out of the state' (MT02). Stakeholders also mentioned that they '[did] not have the resources to firm [...] wind power up' (MT10). Policy was not seen as a particularly effective driver by stakeholders: 'there have been some attacks on renewable energy standards, pieces of legislation that would undermine it, that would reduce its impact, its ability to spur growth of new wind development in the state' (MT17). Interestingly, policy risks and benefits were both quite prominent in media articles, indicating a slight difference in focus by the media. Stakeholders related that proponents of the technology had to distance themselves from environmental concerns while advocating its deployment. In the media, there was also little mention of environmental or aesthetic aspects.

In Texas, the technical and economic frame was dominant for wind power both in the media and among stakeholders. It was discussed by stakeholders from the position of already having lots of wind power on the grid, and any political aspects mentioned were focused on steps taken to ensure future development: 'We now have so much wind on the grid that Texas being an electrical island, [if] the wind generation does not occur [...], then you have to be ready to back it up with other generators [...] dispatchable within ten minutes.' Stakeholders also emphasized that wind energy is competitive in Texas: 'Wind typically displaces natural gas generation. As natural gas prices have gone up and stayed high, the cost of generating electricity with natural gas is basically what wind is competing with. So it competes very favorably.' (TX07). Discussion of further facilitating development of the wind industry and of the associated business opportunities were also prominent in the news media. Both stakeholders and the media framed wind and renewable energy policy as economic development opportunities, and not in terms of environmental benefits. Stakeholders 'don't talk about climate change when [they] go over to the capitol; [they] talk about economic development' (TX09).

On average, stakeholders in the two states that already had a significant amount of wind power on the grid (Minnesota and Texas) did not speak much more positively of wind power than stakeholders in Massachusetts and Montana. Qualitatively, however, the risks they referred to were very different. In Montana and Massachusetts, both risks and benefits

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were more likely to be discussed in general terms, with a focus on their potential. By contrast, Texas and Minnesota stakeholders discussed specific projects and detailed specific steps needed to overcome barriers. This difference was also apparent in the media, but the contentious nature of wind power in Massachusetts resulted in more specific risks associated with one project (the Cape Wind Project) dominating much of the media coverage in this state. Related to this, there were also differences between portrayal of intermittency in the media and among stakeholders. While the media in all states – and to some extent, stakeholders in Massachusetts and Montana – presented intermittency as a serious obstacle to wind power development, this idea was mostly dismissed by stakeholders in Texas and Minnesota, who had more actual experience with wind power. They did not see major obstacles to system integration of more wind power, but instead emphasized transmission as the largest obstacle. The level of deployment of a technology therefore seems to influence the types of risks and barriers that become salient.

Overall, media coverage of wind power was more critical and negative for the aesthetic, environmental, and health and safety frames than stakeholder perceptions of the technology, i.e. more risks were mentioned in the media than in the interviews of those involved in energy policy. For the three other frames, positive aspects were mentioned more often by both stakeholders and the media. The three dominant frames were the same in both media and stakeholder analysis, with political aspects the second most commonly mentioned in both studies. While discussion of the economic aspects dominated in the media, the economic frame was in third place for stakeholders. This was reversed for technical aspects. So while stakeholders were most focused on technical aspects, the media most emphasized economic aspects of wind power. The media tend to focus on economic and political aspects of technology, perhaps because this might have the most resonance with potential readers. Although the US public is not known for being particularly technically literate, stakeholders directly involved in considering energy technology and energy policy may have a higher capacity or stronger need to understand and discuss technical issues associated with energy technologies. This may explain some of the differences between media and stakeholder framing of wind power.

The media also emphasized aesthetic aspects of wind power. Interestingly, this category was mentioned only in passing, if at all, by stakeholders. This again highlights a gap between media and stakeholders, explained perhaps by the fact that controversy makes for interesting newspaper coverage. A final result of this study was the minimal mention of health and safety frames, or environmental aspects of wind power. We found almost no references to these categories in either the media or the stakeholder interviews. Apparently, wind power is seen neither as dangerous nor as detrimental (or beneficial) to human and environmental health. The environmental benefits of wind power are apparently relatively self-evident, which may explain why both media and stakeholders did not feel the need to discuss these aspects.

It is unclear if or how to conceptualize a relationship between the media framing and stakeholder perceptions. Within the context of this project, media and stakeholder views were found to overlap on some issues, although the main focus for each group was on slightly different issues. Further research explicitly designed to test this relationship would be fruitful. Our analysis demonstrates the existence, and differentiated elements of, an entire complex of factors involved in shaping both stakeholder and media framing. Geography, the resource base and existing electrical system influence state power structure and shape state-level priorities. We now proceed to put these factors into context, by broadly examining the primary mechanisms of how media analysis and stakeholder perceptions relate to the deployment of wind technology and the development of energy policy in each of the case study states.

A modest renewable portfolio standard has helped to kick start wind power in Texas, but exogenous factors – most notably the important role of natural gas in Texas' electricity supply coupled with high natural gas prices in the early and mid-2000s – have spurred wind development by making wind the low-cost electricity production option. The media analysis demonstrates the intense focus on economic benefits of wind power within the state of Texas. Stakeholders also subscribed to economic benefits as the main rationale for wind power, but expounded more deliberately on the technical and political strategies to achieve this goal. The desire to exploit additional economic opportunities of wind power seems to have driven the passage of the policy creating the Competitive Renewable Energy Zones (CREZs). This has ensured coordinated and rapid transmission development and, in turn, further helped wind power development in Texas.

Despite this initial success, the drawbacks of the Texas approach are increasingly becoming apparent: the wind power success story in Texas may be limited as natural gas prices have dropped. Where support for wind power is driven by business reasoning alone, upheaval in energy markets to a large extent determines the fate of wind power. There is currently no policy in place to create additional demand for wind power and buffer the wind industry from the impact of

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the extremely low natural gas prices experienced since the development of new unconventional gas resources. Wind is no longer the cheapest resource in Texas. In 2011, Texas for the first time in years dropped from the top spot in the ranking of wind capacity installations (AWEA, 2012). In the absence of a secondary policy rationale for wind power (e.g. for environmental reasons), new wind power deployment in Texas has slowed. Proponents of wind power have emphasized economic benefits over other outcomes of wind power. In our stakeholder interviews and the media, both policy and technology were characterized as strategies to achieve the economic goals behind wind development. As the economic benefits of wind power falter under the new market conditions, divisions between different camps may become apparent again, and wind development in Texas will probably stall soon.

In contrast to Texas, hopes continue to run high for wind power in Montana, the second state in our study with little policy development supporting wind power. While internal policies supporting wind power – most notably the weak RPS – remain embattled in the Montana legislature, Montana continues to benefit from demand in surrounding states. Similar to Texas, policy has to some extent played an enabling role, but is not the main reason behind market pull. Overall, the regulatory environment in Montana remains underdeveloped. Construction of additional wind power capacity is largely supported by export opportunities and federal tax breaks, while being contingent on further transmission build-out. Both the governor and the federal senators of Montana have spoken out in favour of continuing the federal production tax credit, which would support Montana's wind exports. Montana therefore provides another good example of a state where wind development is driven less by local governance than by broader market conditions, as well as regional and national policy. In contrast to Texas, the combination of external factors continues to favour further wind development in Montana. Nevertheless, the lack of internal demand drivers could be a problem in the future, because it puts Montana wind at the mercy of political decisions that are not happening at the local level (e.g. dependence on federal production tax credits). Some of the perceptions of technical risks will probably dissipate as more wind power comes online in Montana.

In both Texas and Montana, the policy picture shows relatively little influence of national or international discussions around climate change governance. In both states, wind power is viewed by media and stakeholders as primarily a resource to be turned into financial gain. Wind power in Texas was supported because it was an economically competitive resource compared with the relatively costly natural gas at the time. Wind power in Montana is increasingly being pushed as another energy resource for export to surrounding states. The historical, structural energy mix at the state level has therefore shaped the reaction to wind power in different, but parallel ways in these two states. In turn, framing wind primarily as an economic opportunity has resulted in some amount of path dependency with regard to further policy development. Neither Montana nor Texas seems bound to strengthen their renewable portfolio standard or adopt any climate policy. However, the deployment of new wind resources in Texas, which runs its own power grid, is much more exposed to the effect of low natural gas prices. Montana is less affected by this, as demand for wind exports in the region is driven by adjoining states' demand for renewable power. Montana will have to solve its transmission problems in coordination with surrounding states to achieve its full potential for wind power.

The two remaining states in our study tell a different story. Both Massachusetts and Minnesota have passed fairly strong legislation in response to climate change. While both states have relatively good wind resources, initial policy decisions in favour of wind power were not driven directly by the structural energy mix at the state level. Neither of the two has any meaningful fossil fuel resources. Therefore, while the stakeholders in these two states framed wind development as an opportunity for economic development, it was coupled with the larger national and international policy discourse around climate change.

For Minnesota, the RPS was passed with certain coalition interests which came together to highlight the larger issues of climate change and domestic energy resources. The lower natural gas prices today provide ammunition to opponents of wind power, and the new political majority is actively opposed to climate change action, with some members calling for a return to 'traditional' energy sources. Although the political climate and market environment have evolved since the RPS was passed, challenges to repeal or stall the renewable mandate have not yet come about. One possible explanation is the influence of localized benefits of wind power in Minnesota. Rural, traditionally more conservative areas of the state benefit from easement payments for wind turbines, as well as a limited amount of maintenance and construction jobs. By framing wind power as a boon to farmers and rural populations, Minnesota has been able to avoid the kinds of discussions rampant in Montana, where some stakeholders fear that local populations will pay the price for wind power and transmission, while reaping none of the benefits. A second explanation relates to the strong support by the state's largest utility, Xcel Energy. The strategic buy-in by this company into wind power is extremely strong;

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for years, Xcel has topped the list of wind power producers across the US. Overall, Minnesota stakeholders have been able to translate policy signals from the international and national realm and align these interests with locally rooted stakeholder coalitions which continue to provide strong support for wind power.

In more densely populated Massachusetts, it continues to be difficult to build any new wind power onshore, so efforts to develop offshore wind power have been recently renewed. At the same time, strong concerns about the aesthetics of wind power remain. Opposition to wind power has found renewed fodder in the noise impacts of wind turbines. State environmental officials have determined that noise levels are not acceptable and will now conduct reviews of all existing wind sites (Abel, 2012). This recent development echoes the opposition against the Cape Cod development due to its impact on the local landscape, but opposition causing limited operation of installed wind turbines adds an additional level of frustration among wind proponents and represents financial losses and power production inefficiencies. Massachusetts wind continues to be caught between a rock and a hard place: while stakeholders and public opinion are – in theory – in support of mitigating climate change through renewable energy development, the idiosyncrasies of this state prevent wind power from being accepted as a local solution to climate change. The two states in our study with the most wind power development (Texas and Minnesota) have both been able to demonstrate local benefits of wind power; Montana has at least some hopes to realize such localized benefits. In marked contrast, local impacts of wind power in Massachusetts are widely portrayed as negative.

In closing, our analysis indicates that while prior policy on climate issues and a good wind resource at the state level influences outcomes for wind power, the relationship is not deterministic. Prior experience with energy production from domestic sources has helped Texas frame wind power as one among many energy sources. Wind has developed rapidly in Texas, in part because its self-contained grid facilitates transmission build-out. Montana is following a similar track, but the lack of internal demand for and doubts about local benefits of wind power has held back its full development so far. In turn, strong climate change policies in Minnesota have resulted in rapid development of wind power, while similar policies in Massachusetts have not been able to overcome strong risk associations with regard to wind power. External influences on local policy preferences therefore were successful only in Minnesota and to some extent in Montana (demand from adjoining states). If one clear message emerges from this analysis it is that there are multiple pathways towards wind development; but without local benefits, wind build-out is difficult to achieve.

Conclusions

This multi-faceted approach to comparatively assessing discourse on wind demonstrates very different contexts for energy technology development at the state level. Many different factors are shaping and framing wind power, and this complexity and heterogeneity makes national-level policy difficult. These differences have relevance for examining central–local relations in energy policy. While the federal government creates programmes like the production tax credit, or national-level policy-makers discuss the benefits of a future US RPS, the varied state-level contexts create different socio-political interests to encourage or thwart any wind technology deployment. Furthermore, the coordination between centralized national-level policy and state-level initiatives for advancing emerging energy technologies is not always straightforward and a nuanced view would be helpful to anticipate the effectiveness of different policies. For some states, implementing state renewable energy policies will also require regional coordination and cooperation between states, a novel test of multi-level governance within a context of wind energy deployment. In the absence of national policies or international agreements, state policies can make significant contributions to climate change mitigation and represent stepping stones towards collective action (Engel and Saleska, 2005).

This analysis also highlights variation between energy policy stakeholders' discourse about risks and benefits of emerging energy technology and the public discourse as represented in newspaper articles. The integration of these two different approaches to characterizing wind power discourse at the state level provides a unique perspective that enables understanding of some of the complexities of deploying wind energy at the local and regional sub-national levels. If the US is to develop sufficient low-carbon electricity to achieve the deep emissions cuts necessary, the development of emerging energy technologies will have to take place across the entire land area, not just in some states. Sub-national contexts play a role in this process that should not to be underestimated. Wind turbines are being rapidly deployed

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in some parts of the US. The combination of the production tax credits and state-level renewable portfolio standards are driving record numbers of wind turbines to be installed in some locations, but not others. The policy questions facing wind, in some places of the country, are now focused on how to integrate the wind that has been installed to make way for further wind deployment. Within this context, problems of transmission and grid integration must be actively addressed. However, in other parts of the country, these same federal and state policies have been largely ineffective in driving investment in wind and reveal the need for a more refined evaluation of the policies to spur low-carbon deployment and their effectiveness.

The socio-political context for wind power deployment differs significantly across the states studied and highlights important lessons for examining and evaluating future federal and state-level policy. As we move into a carbon-managed world, policy-makers and energy planners would be wise to recognize the role sub-national socio-political factors play in shaping technology deployment. Acknowledging and understanding these state-level socio-political factors can create a critical bridge between creating low-carbon policy and actually deploying low-carbon energy technology to reduce greenhouse gas emissions. Future coordination between sub-national policy and national initiatives is crucial for maximizing the impact of future policies to deploy low-carbon technologies. It is important for national-level policy-makers to recognize and integrate consideration of the state-level nuances when designing future policies. This research highlights that one size does not fit all, nor will one policy at the national level create the same response across different states.

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