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Wind Deployment in the United States: States, Resources, Policy, and Discourse

ELIZABETH J. WILSON*
Humphrey Institute of Public Affairs, University of Minnesota, 301 19th Avenue South, Minneapolis, Minnesota 55455

JENNIE C. STEPHENS
Department of International Development, Community, and Environment, Clark University, 950 Main Street, Worcester, Massachusetts 01610

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A transformation in the way the United States produces and uses energy is needed to achieve greenhouse gas reduction targets for climate change mitigation. Wind power is an important low-carbon technology and the most rapidly growing renewable energy technology in the U.S. Despite recent advances in wind deployment, significant state-by-state variation in wind power distribution cannot be explained solely by wind resource patterns nor by state policy. Other factors embedded within the state-level socio-political context also contribute to wind deployment patterns. We explore this socio-political context in four U.S. states by integrating multiple research methods. Through comparative state-level analysis of the energy system, energy policy, and public discourse as represented in the media, we examine variation in the context for wind deployment in Massachusetts, Minnesota, Montana, and Texas. Our results demonstrate that these states have different patterns of wind deployment, are engaged in different debates about wind power, and appear to frame the risks and benefits of wind power in different ways. This comparative assessment highlights the complex variation of the state-level socio-political context and contributes depth to our understanding of energy technology deployment processes, decision-making, and outcomes.

1. Introduction

President Obama has called for a 14% reduction in U.S. greenhouse-gas emissions below 2005 levels by 2020 and an 83% reduction by 2050 (*1*). Achieving this level of greenhouse gas reduction requires a fundamental shift in the way the U.S. produces and consumes energy and will necessitate large-scale deployment of low-carbon energy technologies. While many low-carbon technologies exist (*2*), the scale of deployment required to achieve deep reductions will require significant coordination between federal and state initiatives, as U.S. states have authority for many key deployment decisions. This research focuses on wind power to improve understanding of the state-level socio-political context within which low-carbon energy technologies are deployed.

* Corresponding author phone: (612) 626-4410; fax: (612) 625-3513; e-mail: ewilson@umn.edu.

In the U.S., the state-specific context is critical to integrate into climate and energy technology policy and initiatives because the states, rather than the federal government, hold important authority for regulating energy facilities and transmission, planning energy system expansions, and siting plants. In the absence of a U.S. federal policy, some states have also adopted renewable portfolio standards and greenhouse gas reduction targets. State context is particularly important for wind power because unlike coal, natural gas, nuclear plants, or even energy efficiency programs which can be built or deployed almost anywhere, wind power is limited to areas where the wind blows. The relative importance of state policy for wind has received some attention (*3*−*6*) and comparative assessment of state-specific socio-political contexts can facilitate more effective understanding of the policies and processes which affect wind deployment. Many studies have examined socio-political factors contributing to variation in wind deployment among EU countries (*7*−*9*) but U.S.-based studies have not fully explored the complex contexts and variety of socio-political factors which shape state-level policy, industry, and technology deployment patterns. The critical influence of state-level decisions, policy, and discourse is demonstrated by acknowledging that the best wind resources are not always correlated with the most installed wind power. Indeed, 65% of all turbines installed in 2008 were in just six states (TX, CA, IA, MN, WA, and OR) with Texas alone hosting 28% of the nation's wind in 2009 (*10*). And the Great Plains States (ND, SD, and NE) have some of the nation's greatest wind resource potential, but installed wind power capacity is only 4% of the national total (*10*).

Wind power could help to reduce electric sector emissions and provide affordable, low-carbon power (*2*). Indeed, wind power development is surging globally, with over 112 GW installed worldwide and over 29.4 GW installed in the U.S. (*11, 12*). Record levels of wind turbine deployment in the U.S. were reached in 2008, with over 8.5 GW installed and $17 billion invested—with added wind capacity comprising over 42% of new electric generation capacity (*11*).

U.S. wind development has been characterized by "boom and bust" cycles, driven by the passage, renewal, and expiration cycle of the federal Production Tax Credit (PTC). The PTC provides renewable energy generators roughly 2.0 cents/kilowatt hour for electricity produced for the first ten years of the project. Left by Congress to expire in 1999, 2001, and 2003, the resulting drop in wind capacity addition is evident (Figure 1). Although the current economic crisis has slowed deployment, the renewal of the production tax credit (attached as a rider onto the Emergency Economic Stabilization Act (*13*)) and new policy attention is encouraging wind turbine deployment with over 5.8 GW new construction planned (*10*).

Acknowledging the critical influence of state-level activity on energy technology deployment, our research focuses on assessing technologies, policies, and media discourse at the state level to compare the socio-political context for wind power deployment in four states: Massachusetts, Minnesota, Montana, and Texas. Section 2 introduces the methodological approach, using the Socio-Political Evaluation of Energy Deployment (SPEED) framework, Section 3 examines demographics and the existing electric system, Section 4 analyzes relevant state-level policies and legislation, and Section 5 assesses state-level discourse through media analysis of newspapers. For the integration of these multiple analytical approaches we use state-level census and energy data, legislative dockets, technical reports, and newspaper

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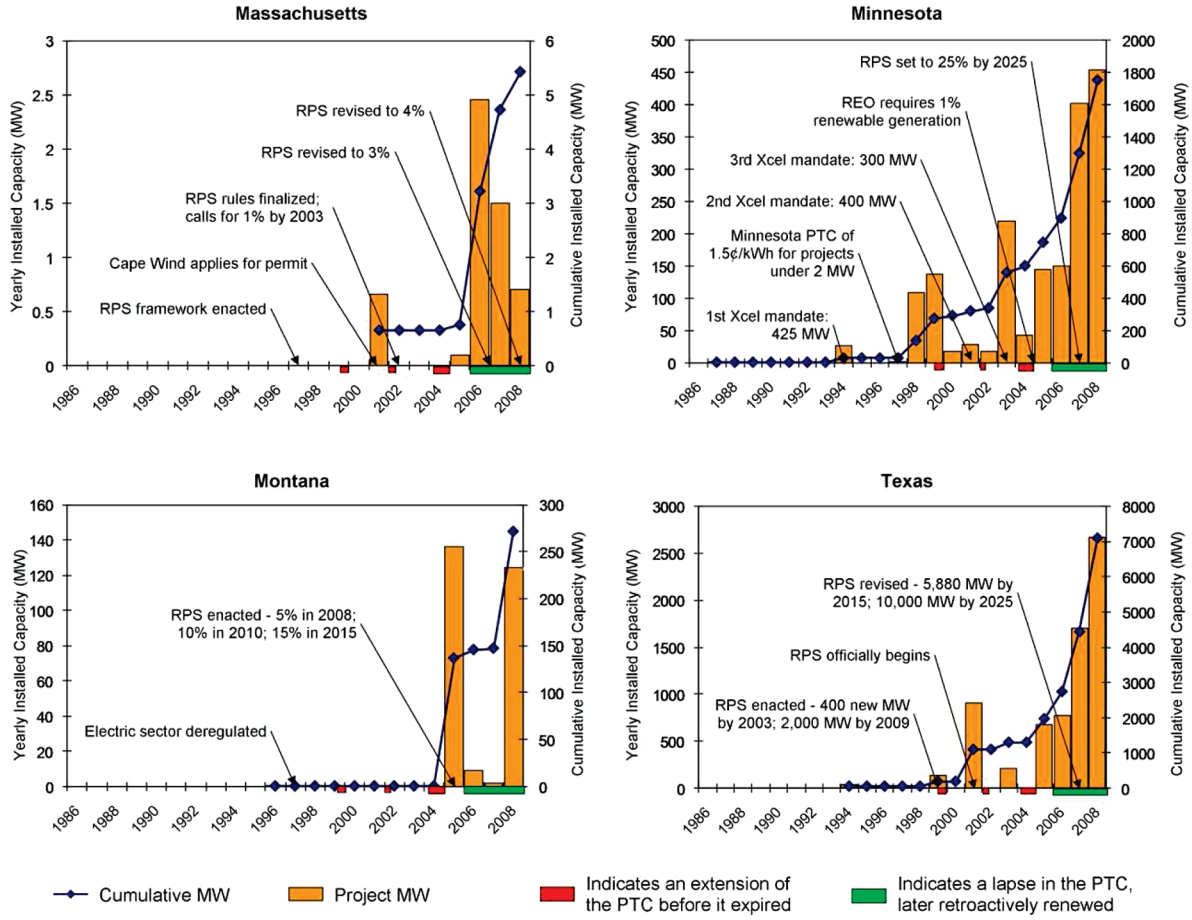


FIGURE 1. Wind capacity installation and major policy actions for Massachusetts, Minnesota, Montana, and Texas. Note different *y*-axis scales and the effect on wind capacity when the Production Tax Credit has expired (shown in red below the *x*-axis).

TABLE 1. Research Design for State Selection: High Climate Policy versus Low Climate Policy and High Wind Deployment versus Low Wind Deployment

	high wind deployment	low wind deployment
high climate policy	Minnesota	Massachusetts
low climate policy	Texas	Montana

articles. By integrating these different approaches we simultaneously explore multiple socio-political influences affecting wind energy deployment, contributing a new richness and depth to our understanding of the complexity of technology deployment processes.

Massachusetts, Minnesota, Montana, and Texas were chosen for this study because their contexts for wind deployment are very different. Texas, Montana, and Minnesota each have a large on-shore wind resource potential while Massachusetts has a smaller, but still sizable resource on- and off-shore. These states are geographically, politically, economically, and institutionally diverse, with different population densities, land areas, and land values, as well as different energy contexts, reliance on and production of fossil fuels, and state-level renewable energy policy (*14*). These states also vary across two important dimensions: wind deployment and climate policy (Table 1). Montana and Massachusetts both have low wind deployment, compared to high deployment in Minnesota and Texas (*10*). Massachusetts and Minnesota both have adopted greenhouse gas reduction policies, while Texas and Montana have not (see Table 1).

2. Methodological Framework: Socio-Political Evaluation of Energy Deployment (SPEED)

This integrated analysis of policy, natural resource potential, public discourse and perceptions of risks and benefits applies the SPEED framework, a structure of inquiry that facilitates simultaneous exploration of multiple socio-political factors influencing deployment (*15*) (Table S1). The SPEED framework builds upon work highlighting the importance of state policy for wind deployment (*4, 6, 16, 17*) and provides a structure to explore the "why" behind energy policy creation and public perception. It integrates elements from the fields of technology diffusion, regulatory analysis, risk perception, transition management, and policy diffusion, to facilitate the exploration of socio-political factors that influence energy technology and industry development.

3. Demographic and Electricity System Context

The context of wind deployment in Massachusetts, Minnesota, Montana, and Texas is shaped by demographic, institutional, infrastructural, and economic aspects affecting the electricity sector. Massachusetts is a typical New England state, with high population density, small land area, and relatively high per capita income. In contrast, Minnesota's population is concentrated in the Twin Cities area, with large differences in income and population density between the metropolitan and rural areas. Montana has a small population, with one of the lowest population densities in the U.S. Texas hosts several large urban centers (Houston, Dallas, Austin, San Antonio), and vast rural areas. Texas, Montana, and Minnesota have experienced strong population growth since 2000 (*18*), while Massachusetts population has been

steady. Per capita income is highest in Massachusetts, followed by Minnesota, Texas, and then Montana. Neither Massachusetts nor Minnesota have fossil fuel reserves or production, in contrast to Texas, which supplies 25% of all natural gas and 21% of all oil produced in the U.S., and holds 4% of coal reserves, and Montana which holds 7% of U.S. coal reserves (Table 2) (*19*−*21*).

The electric sector structure also varies among the states. Demand, generation, age of facilities, transmission availability, market concentration, whether the state is traditionally regulated or restructured, and other factors affect electric sector structure and institutions and the relative power and influence of political interests. Minnesota has a traditionally regulated electricity industry, while Texas and Massachusetts have been restructured. Montana was partially restructured, but this process has been suspended. The Herfindahl−Hirschman Index measuring market concentration shows that the electricity sectors in Montana, Massachusetts, and Minnesota are highly concentrated, with just a few investor-owned utilities serving the majority of the customers, though roughly 30% of all electricity in Minnesota is sold by rural electric cooperatives or small municipal utilities. In Texas, investor-owned utilities are counter-balanced by a large number of power marketers, rendering the electricity market one of the most competitive in the United States.

The fuel mix—and resulting regional carbon intensity—for electricity generation is also different. Due to the coal-intensive fuel mix, Montana and Minnesota have a high carbon intensity factor of 0.91 and 0.88 t of CO_2 per MWh, respectively, closely followed by Texas at 0.73 t per MWh (*22*). Massachusetts emits just 0.47 t of CO_2 per MWh. Sixty-three percent of Montana's and fifty-nine percent of Minnesota's electricity is produced by coal (*22*−*24*). In contrast, both Massachusetts and Texas obtain half of their electricity from lower carbon natural gas, followed by coal and nuclear power. Montana exports electricity, but the other three states were net importers of electricity with Massachusetts and Minnesota importing a calculated 27% and 29%, respectively, while Texas' imports have declined from 5% to zero in 2007 (*25*).

Actual wind deployment and wind industry concentration across the states is also different. Massachusetts has minimal installed wind power, only 5 MW, with the majority of the wind resources located off-shore (off-shore is 2−3 times more costly to develop than on-shore resources (*26*)). The seven on-shore wind facilities are small, with one or two turbines each. The proposed off-shore Cape Wind Project, which was to become the nation's first off-shore wind farm, has been repeatedly delayed in its permitting and approval process in response to environmental, aesthetic, and economic concerns. Complicated unprecedented jurisdictional issues have emerged as many local residents have voiced concerns about the proposed project.

With an installed capacity of 1,805 MW and another 40 MW planned as of September 2009, Minnesota is the fourth largest wind power producer in the nation, and wind now provides 7.5% of the state's electricity generation—the highest share in the nation (*10, 17*). Initial increases in wind capacity were mainly driven by an agreement between the state and Xcel Energy, supplier of 50% of Minnesota's electricity, over the storage of nuclear waste that involved a commitment to wind production (*6*). Minnesota, more so than the other states, has also seen a strong movement toward community-based wind projects. Of the 84 built projects only 7% are larger than 100 MW, with the median project size of 5.8 MW (*10*). Wind in Minnesota has been developed by a number of different firms and communities and the electricity is sold directly to Minnesota's utilities to help meet their renewable production commitments.

In contrast, 46% of all projects in Texas are larger than 100 MW and the median size of a wind project is 88 MW. Annual wind capacity growth in Texas is the fastest of any U.S. state, and wind now represents 3% of in-state electricity generation (*17*). Installed wind capacity reached more than 8,400 MW and another 1,100 MW planned as of June 2009, making Texas not only the fastest growing, but also the largest, producer of wind energy in the United States (*10*). Texas' wind resource is concentrated in the Panhandle region, far from its demand centers, making transmission especially important. Siting of wind farms in Texas is centralized and has proven to be relatively easy compared to other parts of the country. And the Texas electrical grid is heavily dominated by relatively high-priced natural gas, so the moderately high electricity prices help to make wind-generated electricity economically competitive (*3*). Wind ownership in Texas is highly centralized, with just three firms owning almost half of the wind capacity and most of the wind is sold directly to the market, with the remainder contracted to public utilities.

Despite significant low-cost wind resources, as of September 2009, Montana has only seven developed wind projects, for a total of 270 MW with another 100 MW proposed. The largest two were developed after 2005 when Montana passed its Renewable Portfolio Standard (RPS). Transmission has emerged as a salient issue in Montana, due to Montana's role as an energy exporter.

4. Policy Context

State-level policy is important because states control regulation of energy facilities and transmission, planning energy system expansions, and plant siting. In the absence of federal climate policy, they have also been setting overarching climate and energy policy goals. Previous studies have found streamlined siting, RPS, and mandatory green power to be positively correlated with wind deployment and retail choice negatively correlated for "average" states (*3, 4*). This comparative research enables deeper examination of the interaction of policies, media, and wind industry development. Table 2 and Figure 1 summarize state-level policies that directly and indirectly influence wind deployment, including both targeted energy and climate policies. Details on how and what state policy information was compiled for this analysis are included in the Supporting Information.

The majority of Massachusetts wind-related bills were enacted within the past 12 years, and most (6 out of the 14) are related to the siting of specific projects around the state and leasing of certain lands in townships. Massachusetts passed an RPS in 2008. Other laws affecting the Massachusetts electric sector range from sector restructuring and renewable energy standards in 1997 to renewable energy funding and promotion of conservation, efficiency, and renewable capacity improvements with the Green Communities Act passed in 2008. Massachusetts is also a participant in the Regional Greenhouse Gas Initiative (RGGI) a 10-state CO_2 trading and reduction program. (The ten RGGI states are: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.)

Since the original compromise to allow Xcel Energy to expand high-level nuclear waste storage, Minnesota wind advocates for both large- and small-scale wind energy have created a policy environment to support continued wind power development. Laws have provided renewable production incentives, partially funded renewable energy projects, provided incentives for Community Based Energy Development (C-BED) tariffs, studied wind capacity and transmission infrastructure, and created microloan programs for wind (*14*). A large proportion of the wind laws (16 out of the 50) have been related to tax exemptions for Wind Energy Conversion Systems (WECS). This type of legislation supporting "community wind", aims to establish local ownership that directly

TABLE 2. Energy Context Indicators for Massachusetts, Minnesota, Montana, and Texas

	Massachusetts	Minnesota	Montana	Texas
population, 2008 (millions)[a]	6.5	5.2	1.0	23.3
population growth, 2000–2008[a]	2.3%	6.1%	7.2%	16.7%
land area (sq. mi.)[a]	7,800	79,600	144,600	261,800
persons per sq. mi., 2000[a]	810	62	6.2	80
electricity consumption per capita (MWh), 2007[a,c]	8.8	13.1	14.1	16.1
cost of electricity cents/kWh, 2007[c]	15.2	7.4	7.1	10.1
total electric power industry CO_2 emissions (million metric tons), 2007[c]	25,539	37,706	20,013	255,092
carbon intensity of regional electricity (metric tons CO_2/MWh)[c]	0.47	0.88	0.909	0.73
installed wind turbine capacity in MW (and ranking among U.S. states), 2009[b]	5 (33rd)	1,805 (4th)	272 (21st)	8.361 (1st)
renewable percent of fuel mix (excluding hydro), 2007[d]	2.6%	7.2%	2.1%	2.5%
wind energy price ($/MWh)[e]	48	30	29	27

[a] US Census Bureau 2009 (*3*). [b] AWEA 2009 (*10*). [c] EIA 2007 (*18*). [d] EIA 2009 (*22*). [e] Bohn and Lant 2009 (*32*).

benefits rural communities and is not seen in the other states. Minnesota passed a voluntary Renewable Energy Standard (RES) in 2001, and a mandatory RES in 2004 which will ramp up in stages and provide certified renewable energy credits. In 2007 Minnesota revised its RES, making it one of the most aggressive in the nation. This will eventually add 5,000–6,000 MW of new renewable energy, expected to largely come from new wind turbines. In 2007, Minnesota passed legislation to reduce greenhouse gases in the Next Generation Energy Act.

Wind laws passed in the Texas legislature have been varied, and include funding and cost analysis of wind development, and RPS bills. Texas Senate Bill 7, enacted in 1999, deregulated the state's electric industry and established Texas' first RPS which mandated the inclusion of specified amounts of renewable energy including solar, wind, geothermal, hydroelectric, tidal energy, biomass, and landfill gas into the state's fuel mix. This first RPS mandated that electricity providers generate a total of 2,000 MW of additional renewable energy by 2009. Then in 2003 the Legislature passed a bill targeting the Public Utility Commission's authority to order construction of electric transmission capacity—a salient issue for Texas. In 2005 Senate Bill 20 increased the RPS mandate and created a plan for electricity transmission to remote, high-wind areas. The Electric Reliability Council of Texas (ERCOT), the state's transmission operator, was assigned to collect wind data and reorganize competitive renewable energy zones. Unlike Massachusetts or Minnesota, Texas has not adopted explicit greenhouse gas reduction regulation.

Montana's Governor Brian Schweitzer has been very proactive in regional climate and renewable energy activities, and the state has completed a Climate Action Plan. However the Legislature, which meets only every other year, has not passed any climate-related legislation. Overall, they have passed 21 bills affecting renewable energy, and 6 bills within the last 5 years directly influencing wind. Montana passed an RPS covering investor-owned utilities which generated roughly 45% of the electricity in 2005, however legislation for wind turbine siting occurred much earlier with wind easement provisions enacted in 1979 and 1983 and a net-metering law enacted in 1999.

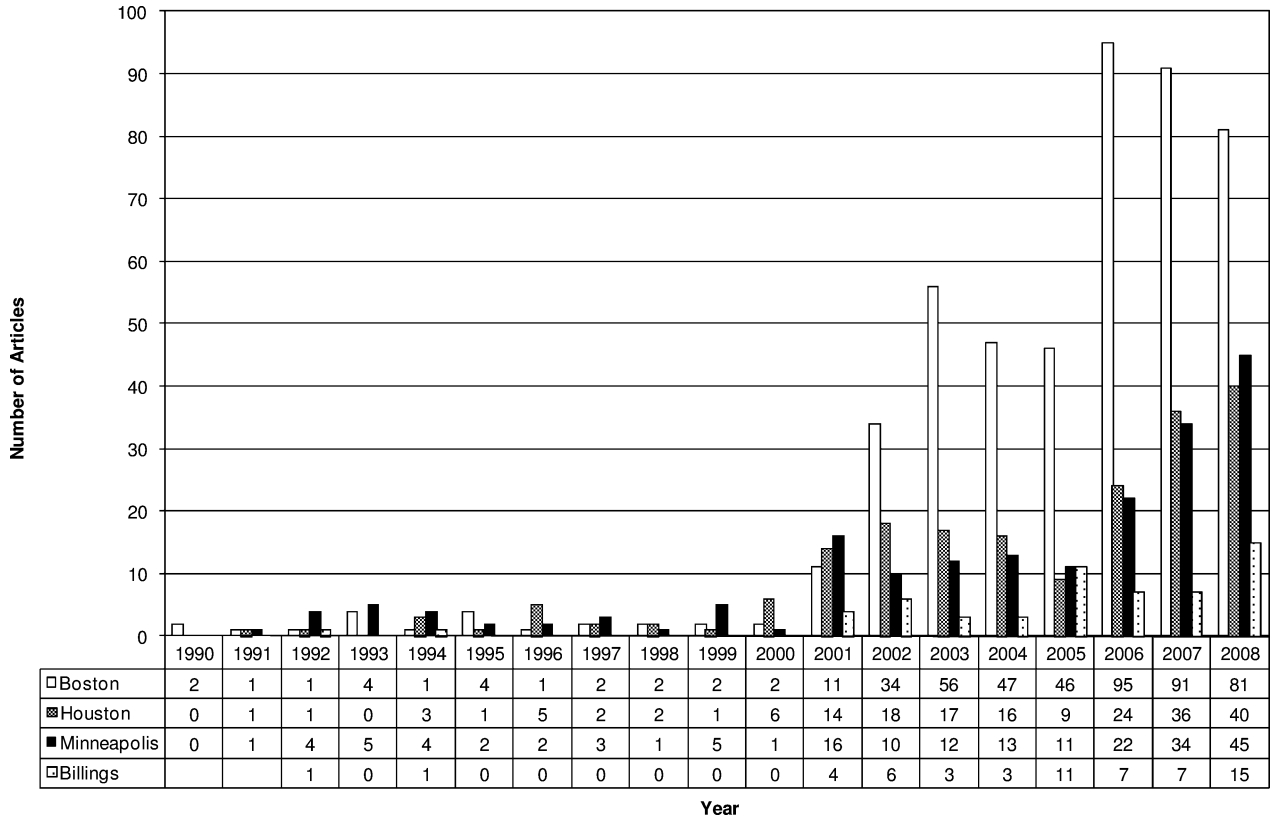
While all four states have passed a RPS, Massachusetts and Minnesota also have broad climate policies, including greenhouse gas reduction targets, climate action plans, and regional greenhouse gas reduction initiatives; neither Montana nor Texas legislatures have passed climate policies. The focus of enacted wind legislation has also differed among the states: Massachusetts policy has been largely focused on siting considerations and specific projects. In Minnesota the majority of legislation is related to tax incentives for wind generation systems and support for small community-owned wind projects. Texas has passed legislation to study the costs of wind development, to clarify property rights issues, and to support renewable capacity improvements. And in Montana, legislation to promote significant deployment of wind resources is relatively recent. Interestingly, both Texas and Minnesota have passed legislation to build state capacity—academic and governmental—for wind deployment, funding studies and research efforts to characterize wind resources and aid deployment.

5. Public Discourse and Media Analysis

Media analysis is a useful approach to probe and analyze public discourse, because the news media provides a representation of public discourse (*27*), while also playing an important role in developing the public's perceptions (*28*). This component of the research analyzed newspaper articles focused on wind energy technology within the highest circulating newspapers in the four study states (The Boston Globe in Massachusetts, The Houston Chronicle in Texas, and The Minneapolis Star Tribune in Minnesota, and The Billings Gazette in Montana) using the Lexus Nexus Academic database and ProQuest database. The search covered January 1, 1990 to June 15, 2009, and included all article types (news, business, editorials, etc.), and identified articles mentioning six terms (wind energy, wind power, wind turbine, wind and renewables, wind farm, windmill) in the heading or the lead paragraph. Using NVIVO 7.0 text analysis software, each article was assessed for the salience of wind technology in the newspaper reporting, and the frequency and type of frames used to describe wind power's risk and benefits.

Salience was assessed by quantifying the frequency and distribution over time of relevant articles, as well as their placement and categorization, e.g. front-page, business, or op-ed (the placement and categorization information was not accessible for the Montana articles). Articles selected to be on the front-page of a newspaper are generally considered to have an appealing quality; these are articles that editors hope will draw readers in, attract them to pick up and read the newspaper (*29*). Opinion pieces reflect issues that are currently on the political agenda and have some degree of controversy, while articles within the business section demonstrate a financial/economic angle to the topic (*29*).

Frame analysis of newspaper articles allows for systematic and comparative assessment of how the media presents the risks and benefits of a particular technology to the public. We established six frames, which correspond with the social functions suggested by Luhmann (1989) to be critical to late modern society (*30*), within which mentions of both risks and benefits of wind technology were coded; technical, economic, environmental, health and safety, political, and



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Boston	2	1	1	4	1	4	1	2	2	2	2	11	34	56	47	46	95	91	81
Houston	0	1	1	0	3	1	5	2	2	1	6	14	18	17	16	9	24	36	40
Minneapolis	0	1	4	5	4	2	2	3	1	5	1	16	10	12	13	11	22	34	45
Billings			1	0	1	0	0	0	0	0	0	4	6	3	3	11	7	7	15

FIGURE 2. Media analysis results: frequency over time. The number of wind-power-related articles published in each of the four newspapers from 1990 to 2008.

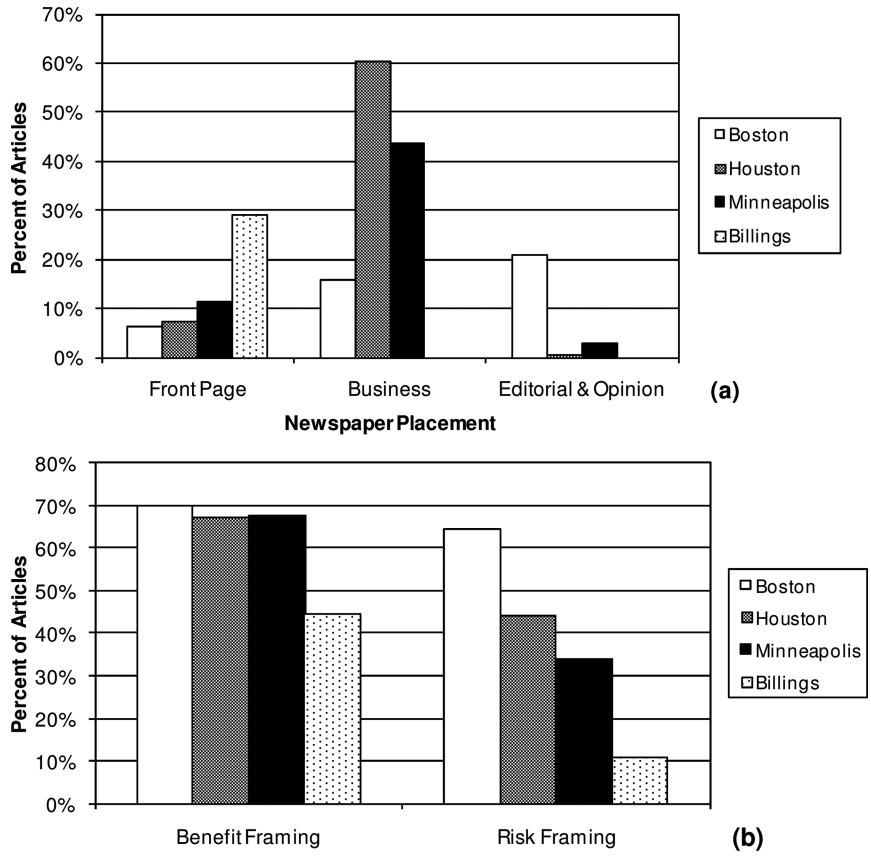


FIGURE 3. Media analysis results: (a) Placement—Percent of wind-related articles published on the front-page, in the business section, or as an opinion piece in three of the newspapers (the business and opinion section information was not available for the Billings Gazette articles). (b) Risk and benefit framing—Percent of articles from each newspaper that include some type of benefit framing and risk framing.

aesthetic/cultural (see Table S2 and SI for more details on coding methology and intercoder reliability).

The frequency of newspaper articles about wind power in all four newspapers increased steadily after 2000, with the most articles in the past three years, reflecting the increasing relevance and interest in renewable energy technologies during this period (Figure 2). The increasing salience of wind power during this time parallels an increase in national awareness of climate change (*31*). In the case of Texas and Minnesota, the timing of the increase in newspaper articles mirrors, to some degree, the timing of the increase in installed wind capacity (*11*). This pattern does not hold true for Massachusetts or Montana, states with minimal wind deployment. The comparatively large number of articles, and increase in the number of articles published in the Boston Globe, are more likely related to developments in the controversial Cape Wind project that was first proposed in 2001. The Billings Gazette has far fewer articles on wind than any of the other three newspapers.

With respect to the placement and type of wind technology articles, Boston had a higher percentage of wind articles that were classified as opinion pieces, Minneapolis had more articles that were published on the front page, and Houston had a much higher percentage of articles in the business section (Figure 3a). In Boston, the higher absolute number of articles, together with the higher percentage that were opinion pieces reflects the higher degree of controversy and politicization of wind power in Massachusetts. Of the 94 total opinion pieces published in the Boston Globe, 66 of them (70%) of them mentioned the controversial Cape Wind project. The high percentage of wind articles in Minneapolis that made the front-page (60%) suggests that wind power is an intriguing, hot topic in Minnesota with potential for wide appeal. This is in contrast to Texas, a state with a long history and close association with the energy industry and energy technologies, where developments in wind power are less likely to be new and exciting front-page news. The high percentage of the Houston Chronicle newspaper articles about wind power published in the business section (65%) is consistent with the economic focus on energy and energy technologies in the state of Texas.

The comparison of frames used to describe risks and benefits of wind power provides more details on the varied discourse in the four states (more detailed description of frame analysis results is in the SI). The overall higher attention to risk in the Boston Globe articles (Figure 3b), specifically articles that mention risks within the aesthetic/cultural, health and safety, and environmental frames (Figure S1a), confirms the controversial nature of wind power in that state. Massachusetts' higher level of sensitivity to potential negative implications of wind power may be related to demographic and energy system factors, as well as the controversial Cape Wind Project. With Massachusetts' higher population density and land prices, competition among land-uses is greater, so wind turbine proposals have run into conflict with other residential and commercial land-uses and off-shore resources are more costly to develop. In addition, for Massachusetts residents, who import a significant portion of their electricity and are not accustomed to living close to energy technology, the prospect of new energy infrastructure in proximity to where they live may invoke fear about the unknown, which could translate into concern about their personal safety.

Minnesota had the most positive framing of wind technology (highest percentage of benefits). This may reflect a greater degree of perceived local gains from wind power development. While many Massachusetts residents of Cape Cod appear to feel they have little or nothing to gain and quite a bit to lose by allowing an offshore wind farm to be built in Nantucket Sound, for struggling Minnesota farmers who receive payments for renting parts of their land or who

TABLE 3. Review of Relevant Policies and Bills[a]

	Massachusetts	Minnesota	Montana	Texas
Renewable Portfolio Standard	15% of sales by 2020, additional 1% of sales each yr after, no stated expiration, S.B. 2768/2008	Xcel Energy: 30% by 2020, Other utilities: 25% by 2025, S.F.No. 4/ 2007	15% of the electricity generated in Montana to come from renewables by 2015, SB 415, 2005, only IOUs covered	5,880 MW by 2015, 10,000 MW by 2025. At least 500 MW from renewables other than wind, SB 7/ 1999, Texas Utilities Code § 39.30, PUTC Rule 25.173
Community Wind Allotments	none	Community-Based Energy Development (C-BED) Tariff, utilities file 20 yr PPA for community-owned renewable energy projects. SF 1368/ 2005 and SF 145/ 2007	none	none
Greenhouse gas reduction policy	Global Warming Solutions Act 2008 requires 80% below 1990 levels by 2050, with interim target reductions of 10 and 25% below 1990 levels by 2020, as well as targets for 2030 and 2040. Chapter 298 of the Acts of 2008	The Next Generation Energy Act, 2007 target of reducing greenhouse gas emissions by 80% by 2050. Interim reduction goals of 15% by 2015, 30% by 2025. S.F. No. 145	none, though Governor has been active in regional initiatives	none
Climate Action Plan	finished in 2004, updating one for the Global Warming Solutions Act, due in 2009	Minnesota Climate Change Advisory Group, 2008	Climate Change Action Plan, July 2007	none
Regional greenhouse gas initiatives	Regional Greenhouse Gas Initiative, Jan 1 2009	Midwest GHG Reduction Accord,, in negotiations for cap and trade program	Western Climate Initiative	none

[a] Sources: DSIRE, Massachusetts, Minnesota, Montana, and Texas Legislature websites, Pew Global Climate Initiative (*14, 33*).

own a turbine as part of a "community-wind" venture, wind turbines are an apparent "win−win" situation, so wind power is likely to be viewed as a net positive development. Economically favorable projects owned by farmer cooperatives have been critical to the recent growth of wind power in Minnesota. The higher percentage of articles in Minnesota that mention technical risks could reflect a greater challenge for ensuring transmission lines to connect these widely distributed community wind projects to the grid.

The lowest percentage of risk framing was identified in the Montana articles, which may reflect the minimal local concern associated with wind power due to the low deployment levels. Interestingly the articles in the Billings Gazette had the lowest percentage of both risk and benefit framing—suggesting that some of the Montana articles are quite neutral. In Texas, the comparatively lower frequency of benefits mentioned within either the aesthetic/cultural frame or the environmental frame in the Houston articles reflects the highly economic, competitive, business orientation of wind technology discourse in the state. The economic growth potential of wind power is also often integrated into many of the Houston Chronicle articles. And an additional typical component often included in the Houston articles is a state-level competitive pride further reflecting the competitive, economic, industry-oriented energy technology discourse in Texas.

6. Discussion

This research highlights that the socio-political context for wind development varies significantly across states. The case of Massachusetts shows that supportive policy is insufficient to trigger deployment when deployment costs are high, and the case of Texas demonstrates that targeted policy and streamlined permitting can facilitate deployment. The Montana case demonstrates that resource capacity and state-level leadership can begin to spur deployment, and Minnesota highlights the positive aspects of community-based wind. While all four states have wind resources and policies in place to promote wind power, the nature of wind energy debates within state discourse differs significantly.

In these states, the nature of existing energy systems and relative cost of wind does appear to influence deployment, yet effect of policy and discourse is more complex. Climate policy and the amount of media coverage are part of the larger socio-political context but do not correlate directly with the amount of wind deployed. There is reasonable congruence, however, between the type of media coverage—and the relative importance of risks and benefits in state discourse—and the type of wind-related legislation enacted. This in turn affects the structure of the wind energy industry—and state positioning in national energy and technology debates and policy-making.

In Massachusetts, the policy and energy context for wind deployment *looks* promising; the state is an electricity importer with high energy prices, carbon constraints, and a RPS, but the low-energy demand growth, high cost of off-shore wind, and political controversy surrounding development of wind resources has stalled wind power development. The controversial off-shore Cape Wind project has dominated the public discourse, but opposition to wind projects has not been limited to that project; opposition to onshore wind projects in the western part of the state has also emerged. In Massachusetts, the intensity of media coverage appears to be inversely related to actual deployment. The dominance of controversy in the public discourse is congruent with the state's legislative history—the dominance of bills relating to siting of specific projects.

In contrast, in both Minnesota and Texas, wind energy development is proceeding at a record-breaking pace, but this study highlights differences within the discourse, industry structure, and factors driving wind power deployment in these two states. Minnesota, like Massachusetts, is an electricity importer, with carbon constraints and a RPS, but Minnesota is still a regulated electricity market, and wind deployment has been 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 electric sector makes low-carbon wind deployment particularly attractive for reducing greenhouse gas emissions. Minnesota discourse about wind technology is generally positive, often linked to the rural economic development potential of wind. Legislation fits this pattern, concentrating on tax incentives and support for "community" wind and the small size and highly dispersed ownership of wind projects.

Texas discourse likely reflects the state's strong energy-industry history and rapid demographic growth and tends to focus on the business perspective of wind energy through an economic frame (most wind articles appearing in business sections) with comparatively little risk discourse, with large projects and a concentrated ownership. The state has enacted no carbon constraints, and the public discourse shows limited association with climate change, but a supportive policy environment has emerged. The high electricity prices and restructured competitive electricity market could be seen as driving wind deployment and supporting the generally positive, economics-oriented 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. The low levels of media coverage on wind in the state of Montana, and the low percentage of those articles that discuss risks of the technology, reflect the low level of activity and controversy surrounding wind.

The socio-political context for wind power deployment differs significantly across the states studied and highlights important lessons for 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 state-level 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.

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Supporting Information Available

Additional information on the methods used in the policy and media analysis and additional discussion on the risk framings across different states. Table S1 refers to factors included in the SPEED Framework, Table S2 describes the risk and benefit frames, and SI Figure 1 presents a comparative risk and benefit frames across the states. This material is available free of charge via the Internet at http://pubs.acs.org.

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