Wind Energy and Rural Community Sustainability

Sarah Mills

Abstract

Because it is a carbon-free source of electricity, wind energy is often unquestioned as an environmentally sustainable technology. But is this technology sustainable when considered within the context of the rural communities in which it is often sited? This paper uses survey data from paired rural communities with and without utility-scale wind energy projects to understand the economic and social impacts of wind energy development on these predominantly agricultural communities. It finds clear economic benefits to the communities that host wind turbines—namely, that wind developers' payments to landowners are largely re-invested in farming operations, leading to economic stability and increasing expectations that a younger generation will want to stay on the farm. The social impacts of wind development are more nuanced, and depend upon the windfarm's business model. Specifically, windfarms are least disruptive of the social structure in rural communities when wind developers employ a business model that gives more community members a direct financial stake in the project.

Keywords

Wind energy · Social impacts · Rural sustainability

S. Mills (✉)
Gerald R. Ford School of Public Policy, University of Michigan, Ann Arbor, MI, USA
e-mail: sbmills@umich.edu

W. Leal Filho et al. (eds.), *Handbook of Sustainability and Social Science Research*,
World Sustainability Series, https://doi.org/10.1007/978-3-319-67122-2_12

1 Introduction

Given the global urgency to address climate change, we may run the risk of labeling any energy technology that offers reduced carbon emissions as "sustainable." When full life-cycle carbon emissions and other environmental, economic, and social considerations are taken into account, renewable energy technologies—including wind energy—consistently emerge as options that perform well across this broader range of sustainability metrics (Weisser 2007; Gallego Carrera and Mack 2010).

Much of this sustainability analysis, however, has focused on the technology's impact at the national or global scale, not necessarily on the local impacts on the communities where these technologies would be placed (Whitton et al. 2015). Indeed, in looking at public acceptance for wind energy, a number of studies have contrasted the positive attitudes toward wind energy among the general public with opposition in locations of proposed wind projects (Bell et al. 2005; Devine-Wright 2005a; Wolsink 2007). Research shows these differences are not just NIMBYism. Instead, more pessimistic views are tied to anticipation of negative impacts and the localized disturbance caused during construction, and these negative local attitudes often reverse once the windfarm is operating (Warren et al. 2005; Devine-Wright 2005b; Wilson and Dyke 2016).

But even this relatively robust literature about public opinion of wind energy is really only a proxy for the technology's effect on local social and economic sustainability. The aim of this paper is to look beyond public opinion to better understand the social and economic impacts of wind energy development on the communities in which they are sited, focusing in particular on agricultural communities in the American Midwest.

2 Rural Dynamics and Wind Development in the American Midwest

Perhaps more than on other issues, social sustainability is intertwined with economic sustainability for many Midwestern farming communities. The industrialization of agriculture has led to farm consolidation, a decrease in the absolute numbers of farmers living in these communities, and an aging farm population as fewer young people choose farming as their occupation (Salamon 1992; D'Souza and Gebremedhin 1998). In farming communities that are more remote from metropolitan areas, this in turn has led to precipitous population loss, closure of rural schools and—in some cases—abandonment of small towns.

Wind development, and the money that it brings to rural landowners and rural communities, may have the potential to help reverse some of these intertwined social and economic trends. At least that is the claim that has been made by proponents of wind energy (Union of Concerned Scientists 2003; Napier 2012), and which was found to underlie support for wind energy among farmers in Indiana (Mulvaney et al. 2013).

Most of the existing academic work has looked at monetary benefits that accrue community-wide in the form of job creation or tax payments. While some temporary local jobs are created during construction, far fewer rural communities gain more than one or two full-time positions once the windfarm is in operation (Munday et al. 2011; Slattery et al. 2011; Brown et al. 2012). Even so, in rural communities with few other employment opportunities, any job growth is welcome (Black et al. 2014). Additionally, taxes assessed on energy production equipment are usually collected by local governments, and so may be used to improve locally funded public services (e.g., schools, roads, parks, human services), or to reduce the local property tax burden on all landowners (Kahn 2013). Indeed, these community-wide economic benefits are the primary socio-economic impacts noted by residents in Slattery et al. (2012) study of counties with wind development.

What is less researched, but which may have an even bigger impact on rural social sustainability, are wind developer's direct payments to rural landowners. While wind developers usually own the wind turbines, they very rarely own the land on which those turbines are sited. Instead, these wind developers enter into long-term leases to site the turbine on the landowner's property, paying the landowner annually for the land that is taken out of agricultural production and often also paying a royalty: a fixed percentage of the profits from the energy that is produced and sold to the electric utility. This income may help diversify farmers' income streams with a guaranteed revenue source that helps them weather the year-to-year variability in crop yields (Swofford and Slattery 2010; Sutherland and Holstead 2014). In the American Midwest, most wind developments are sited on small to medium-sized parcels of land throughout a rural community, with landowners hosting one or more turbines on their properties. As a result, a larger number of landowners may receive these direct benefits. While the quantitative impact of these direct payments is known (U.S. Department of Energy (DOE) 2015), there has not been any assessment on whether such payments are helping to reduce farm consolidation and ultimately population loss in these communities. This paper aims to fill that gap by considering:

1. Do individual-level windfarm revenues increase farm succession planning?
2. Do individual-level windfarm revenues result in increased farm investment?
3. What other social impacts does the wind development business model have on farming communities?

3 Methodology

To assess the connected social and economic impacts of wind development on farming communities, four windfarm communities in the state of Michigan were chosen using a diverse case study approach (Seawright and Gerring 2008) to cover a wide spectrum of historical population trends and wind development business

Table 1 Characteristics of Case Study Windfarms

Case	1	2	3	4
Year Windfarm Operational	2008	2012	2012	2008
Number of turbines	46	33	40	29
Business model	Traditional	Traditional	Pooled Royalty	Pooled Royalty
2000–2010 population change	−3%	−9%	−17%	+3%

models.[1] While not intending to be representative of all wind development in the Midwest, this case selection technique does aim to be broadly representative of windfarms in Michigan.

All four cases are in predominantly-agricultural areas. Key characteristics of the selected windfarm cases are shown in Table 1. In addition, four matched case (non-windfarm) communities in Michigan were selected to provide a comparison with a similarly-situated agricultural community without wind development. The selection was based upon population trends, land use characteristics (e.g., size of parcels, type of ground cover), and median income.

A mail survey was sent to all owners of farmland in all eight communities (four with wind turbines; 4 without). Formatting and survey administration were conducted according to best practice (Dillman et al. 2009), with multiple contacts, personalized communications, a pre-paid incentive (Groves and Couper 1998), and strategic timing based on the schedules of the target population (Pennings et al. 2002). In total, 1231 respondents returned useable surveys, resulting in a final response rate of 71.9% (AAPOR RR2).

The 12-page survey included a range of both opinion questions related to wind energy, as well as more factual questions about whether or not the respondent had a wind turbine on their property (obviously "no" for those respondents in the matched case communities), details about the respondent's farming operation, and their future plans for their farm.

[1]In the traditional wind development business model, only landowners with turbines on their property are directly compensated. An alternated "pooled royalty" business model spreads this same amount of money among all landowners who initially expressed willingness to have a turbine on their property, regardless of whether they ultimately received a turbine on their property or not, on a per-acre basis. In these pooling arrangements, the royalty share of the lease payment is diluted as it is shared among more landowners, but a higher proportion of community members receive direct payments from the wind developer.

4 Results and Analysis

4.1 Succession Planning

One way to measure whether farmers are expecting to pass their farm off to a younger generation—rather than to sell their land off to a neighboring farmer—is to ask whether or not they have a succession plan in place for their land. Overall 62% of respondents to the survey indicated in the affirmative. However, there is a large difference based on whether or not the landowner has a wind turbine on their property. Among those landowners with turbines on their property, 80% have a succession plan in place, compared to only 62% of their neighbors (i.e., all other farmland owners in the windfarm communities) and 57% of landowners in the matched case community (see Table 2).

A binomial logit regression model finds that the likelihood of having a succession plan increases with each additional acre farmed, which might be expected as those who farm more acres are more likely to expect to pass that large operation off in the future. However, even after accounting for the size of the farming operation, landowners with turbines on their property are 2.5 times as likely to have a succession plan in place as respondents in the matched case (no-turbine) communities who farm just as many acres. Notably, neighboring landowners in windfarm communities are also more likely (1.34 times) than matched case landowners to have a succession plan, but this is not nearly as statistically significant.

The survey did not ask landowners when they created a succession plan, so it is unclear whether windfarm revenues are helping landowners to solidify succession plans. An alternate explanation for the difference in succession planning is that those landowners who had pre-existing succession plans may have been more inclined to diversify farm income and therefore would have proactively sought out wind leases. This theory, however, conflicts with the fact that in all of the case studies, it was the wind developer and not the farmland owners who initiated the windfarm leasing process. Furthermore, while this alternate explanation may explain differences in succession planning between landowners with turbines and their neighbors, it does not adequately explain differences between the turbine group and their matched case counterparts who have not (yet) been approached by a

Table 2 Prevalence of succession plans among survey respondents

			Wind Respondents	
	All Respondents	Matched Case Respondents	Neighbors	Turbines
Yes	62%	57%	62%	80%
No	38%	43%	38%	20%
Number of respondents	1164	471	559	134

wind developer but include a number of landowners who—according to their survey responses—would welcome wind development. As a result, the most likely explanation is that the supplemental income that the wind turbines provide is helping convince the next generation of farmers to stay on the farm.

4.2 Farm Investment

Another way to gauge farmers' longer-term expectations for their land is look at recent farm investments. Those who invest more in their farms likely expect that they—or their heirs—will be farming longer than those who do not invest in their farms (Adelaja et al. 2011). In order to capture the investments that owners of farmland have been making to their property, the survey sent to landowners asked four parallel questions: "Since 2008, about how much money have you spent on improvements to your [… home? …outbuildings? …drainage and irrigation? … new or used farm equipment including trucks, tractors or other farm machinery?]"

When looking at the data from all respondents, the results show that the average investment per landowner is consistently higher in communities with wind turbines than in the matched case communities. This is true for all types of investments, though most pronounced for investments in farm equipment. Landowners in communities with windfarms spend on average $29,813 more on farm equipment than their counterparts in communities without windfarms (see Table 3). When all investment types are combined, the difference in spending between landowners in matched case and windfarm communities is $47,456 over this five-year period.

There are even larger differences, though, between respondents in windfarm communities with turbines on their property and their neighbors without turbines. In most of the investment categories, landowners with turbines invest nearly twice as much as their neighbors. Furthermore, landowners with turbines reported spending over $250,000 more than both their neighbors and the landowners in the matched case communities on improvements to their properties over the five-year period. Notably, this increased investment likely exceeds the total of the revenues the landowner received from the wind developer over that same period,[2] which may be yet another indication that the wind income is helping families solidify succession plans and leading to a surge in investment in the farming operation.

[2]Many wdevelopers require leaseholders to keep lease terms confidential, but in interviews with local officials in the case study communities, the annual payments to landowners are likely less than $12,000 per turbine per year. Considering that most landowners have only one or two turbines on their property, few would be receiving $50,000 per year.

Table 3 Mean landowner investment in home and farm, matched case versus windfarm communities

				Wind Respondents	
Type of Investment	All Respondents	Matched Case Communities	Wind Communities	Neighbors	Turbines
Home	$26,897	$24,035	$28,829	$25,681	$41,970
Outbuildings	$36,521	$29,639	$41,118	$33,786	$71,780
Drainage/Irrigation	$25,321	$22,105	$27,474	$20,236	$57,863
Equipment	$125,027	$107,208	$137,021	$102,901	$279,539
Total Investment	$215,433	$186,899	$234,355	$183,593	$449,087
Number of respondents[a]	1096	437	659	533	126

[a]The number displayed is the number of respondents who answered all four investment-related questions

4.3 Social Impacts Dependent upon the Wind Business Model

Given the large differences in financial impact between landowners within windfarm communities, one might imagine that wind development is causing strain in these communities. Indeed, in an open-ended section of the mail survey, a number of landowners noted that wind energy was causing tension in the community. Their comments include, "This type of energy has ripped apart farmland and communities, neighbors and families," and "Wind turbines have created a strong divide (and rightfully so) between people owning large tracts of land and those owning small parcels."

There are differences, though, based on the business model used by the wind developer. In Cases 1 and 2, where pooling is not used, more survey respondents commented on the divisive aspects of the project, and more often attributed community tension to the *greed* of the small number of landowners who were receiving royalty checks. One respondent in Case 1 wrote:

> Greed has led to the deterioration of the landscape and relationships with total disregard to anyone but themselves. There is absolutely no benefit to these monstrosities to anyone but the landowners that have signed leases and the wind power companies that receive huge subsidies for them.

Another implored, "Put greed aside and be logical!!! This is not good for our community."

There were still a handful of comments about community tension in Cases 3 and 4, where royalty pooling is the business model, but respondents instead explained suggested that it is motivated by *jealousy* on the part of those few who chose not to participate. One respondent in Case 3, who him/herself was not in the royalty pool wrote, "We have a very vocal minority against wind energy. I believe they are motivated by several things: (1) jealousy: if I'm not getting the money and controlling everything, I'm against it…."

Thus, in both cases it is those in the minority who are seen to be causing community discord. In communities where the traditional model is used those few landowners who receive direct payments are considered by the others to be greedy, while in communities where royalties are pooled and more landowners are directly compensated, the jealousy of those who oppose the projects is seen as the cause of the tension.

Notably in all of the case study windfarms, the wind developer pays property taxes to the local government and local schools, serving as an indirect monetary benefit to the whole community. However, it is the equity of the *direct* payment that is pointed to as an explanation of community discord. This underscores the importance of distributional justice (Hall et al. 2013) and fairness (Whitton et al. 2015) in assessing the social impact of wind energy development, and suggests that wind business models that allow for all community members to have a direct financial stake in the project may help minimize disturbing the social order in the communities in which turbines are sited. Indeed, models where the community itself owns the windfarm, much more common in Europe than the U.S., have been found to be both better received in the community and to have a larger impact on household budgets (Warren and McFadyen 2010; Phimister and Roberts 2012).

5 Conclusion

Through surveying agricultural landowners in communities with and without windfarms, this paper aimed to understand the social impact of wind energy as deployed in a Midwestern state (Michigan). It found that landowners with wind turbines on their property are more likely to have a succession plan in place for their farm and are investing significantly more money into on-farm improvements, as compared to both their neighbors without turbines on their property and survey respondents in non-windfarm communities. Both of these findings suggest that the individual-level economic benefits of wind energy may help reverse a decades-long trend of population loss by enabling a younger generation of farmers to take over the family farm. However, this research also cautioned that the influx of cash, particularly when concentrated in the hands of just a few landowners, has the potential to create tensions in the community.

This research just begins to explore the socio-economic impacts of wind energy, and further research is warranted to both explore other aspects of social sustainability and to understand how well these findings hold up beyond the study area. This study, for example, does not consider owners of non-agricultural parcels who are less likely to be receiving wind turbine income and so may have less of a financial incentive to remain in the community. Furthermore, all four of the windfarms studied were relatively new additions to the landscape when this research was conducted. It would be instructive to return to these communities in a decade or two to determine the longer-term social and economic impacts. Finally, while the cases selected were broadly representative of wind development in Michigan, they do not take into account the vast diversity of rural social and economic structures around the country

(Salamon 1992) and world (Alterman 1997; Ellis et al. 2009). More work could be done to understand how contextual factors, including state and national-level policies, impact the social impacts of wind development.

This research reminds us that as our understanding of sustainability matures to incorporate social and economic considerations at various scales, so too must our assessment of environmental technologies. We must look not just at the global and local environmental benefits or improvements of these technologies, but also at the impacts that they have on the social fabric of the communities in which they are deployed.

References

Adelaja, A., Sullivan, K., & Hailu, Y. G. (2011). Endogenizing the planning horizon in urban fringe agriculture. *Land use policy, 28,* 66–75. doi:10.1016/j.landusepol.2010.05.002.

Alterman, R. (1997). The challenge of farmland preservation: Lessons from a Six-Nation comparison. *J Am Plan Assoc, 63,* 220–243.

Bell, D., Gray, T., & Haggett, C. (2005). The "Social Gap" in wind farm siting decisions: Explanations and policy responses. *Env Polit, 14,* 460–477.

Black, G., Holley, D., Solan, D., & Bergloff, M. (2014). Fiscal and economic impacts of state incentives for wind energy development in the Western United States. *Renewable and Sustainable Energy Reviews, 34,* 136–144. doi:10.1016/j.rser.2014.03.015.

Brown, J. P., Pender, J., Wiser, R., et al. (2012). Ex post analysis of economic impacts from wind power development in U.S. counties. *Energy Econ, 34,* 1743–1754. doi:10.1016/j.eneco.2012.07.010.

D'Souza, G. E., & Gebremedhin, T. G. (1998). *Sustainability in agricultural and rural development*. Brookfield, VT: Ashgate.

Devine-Wright, P. (2005a). Local aspects of UK renewable energy development: Exploring public beliefs and policy implications. *Local Environment, 10,* 57–69. doi:10.1080/1354983042000309315.

Devine-Wright, P. (2005b). Beyond NIMBYism: Towards an integrated framework for understanding public perceptions of wind energy. *Wind Energy, 8,* 125–139. doi:10.1002/we.124.

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2009). *Internet, mail, and mixed-mode surveys: The tailored design method* (3rd ed.). New York: Wiley.

Ellis, G., Cowell, R., Warren, C., et al. (2009). Wind power: Is there a "Planning Problem"? Expanding wind power: A problem of planning, or of perception? The problems of planning—a developer's perspective wind farms: More respectful and open debate needed, not less planning: Problem "Carrier" or proble. *Plan Theory Pract, 10,* 521–547.

Gallego Carrera, D., & Mack, A. (2010). Sustainability assessment of energy technologies via social indicators: Results of a survey among European energy experts. *Energy Policy, 38,* 1030–1039. doi:10.1016/j.enpol.2009.10.055.

Groves, R. M., & Couper, M. P. (1998). *Nonresponse in household interview surveys*. New York: Wiley.

Hall, N., Ashworth, P., & Devine-Wright, P. (2013). Societal acceptance of wind farms: Analysis of four common themes across Australian case studies. *Energy Policy, 58,* 200–208. doi:10.1016/j.enpol.2013.03.009.

Kahn, M. E. (2013). Local non-market quality of life dynamics in new wind farms communities. *Energy Policy, 59,* 800–807. doi:10.1016/j.enpol.2013.04.037.

Mulvaney, K. K., Woodson, P., & Prokopy, L. S. (2013). A tale of Three Counties: Understanding wind development in the rural Midwestern United States. *Energy Policy, 56,* 322–330. doi:10.1016/j.enpol.2012.12.064.

Munday, M., Bristow, G., & Cowell, R. (2011). Wind farms in rural areas: How far do community benefits from wind farms represent a local economic development opportunity? *J Rural Stud, 27,* 1–12. doi:10.1016/j.jrurstud.2010.08.003.

Napier, A. (2012). Wind power: Economic growth for rural America. Washington, DC: American Wind Energy Association. http://www.aweablog.org/wind-power-economic-growth-for-rural-america/.

Pennings, J. M. E., Irwin, S. H., & Good, D. L. (2002). Surveying farmers: A case study. *Rev Agric Econ, 24,* 266–277.

Phimister, E., & Roberts, D. (2012). The role of ownership in determining the rural economic benefits of on-shore wind farms. *Journal of Agricultural Economics, 63,* 331–360. doi:10.1111/j.1477-9552.2012.00336.x.

Salamon, S. (1992). *Prarie patrimony: Family, farming, and community in the Midwest*. Chapel Hill: University of North Carolina Press.

Seawright, J., & Gerring, J. (2008). Case selection techniques case study research: A menu of qualitative and quantitative options. *Political Research Quarterly, 61,* 294–308.

Slattery, M. C., Johnson, B. L., Swofford, J. A., & Pasqualetti, M. J. (2012). The predominance of economic development in the support for large-scale wind farms in the U.S. *Great Plains. Renew Sustain Energy Rev, 16,* 3690–3701. doi:10.1016/j.rser.2012.03.016.

Slattery, M. C., Lantz, E., & Johnson, B. L. (2011). State and local economic impacts from wind energy projects: Texas case study. *Energy Policy, 39,* 7930–7940. doi:10.1016/j.enpol.2011.09.047.

Sutherland, L.-A., & Holstead, K. L. (2014). Future-proofing the farm: On-Farm wind turbine development in farm business decision-making. *Land use policy, 36,* 102–112. doi:10.1016/j.landusepol.2013.07.004.

Swofford, J., & Slattery, M. (2010). Public attitudes of wind energy in Texas: Local communities in close proximity to wind farms and their effect on decision-making. *Energy Policy, 38,* 2508–2519. doi:10.1016/j.enpol.2009.12.046.

U.S. Department of Energy (DOE). (2015). *Wind vision. A new era for wind power in the United States*. Washington, DC: US Department of Energy.

Union of Concerned Scientists. (2003). Farming the wind: Wind Power and Agriculture. Cambridge, MA: Union of Concerned Scientists.

Warren, C. R., Lumsden, C., O'Dowd, S., & Birnie, R. V. (2005). "Green on Green": Public perceptions of wind power in Scotland and Ireland. *J Environ Plan Manag, 48,* 853–875.

Warren, C. R., & McFadyen, M. (2010). Does community ownership affect public attitudes to wind energy? A case study from south-west Scotland. *Land use policy, 27,* 204–213. doi:10.1016/j.landusepol.2008.12.010.

Weisser, D. (2007). A guide to life-cycle greenhouse gas (GHG) emissions from electric supply technologies. *Energy, 32,* 1543–1559. doi:10.1016/j.energy.2007.01.008.

Whitton, J., Parry, I. M., Akiyoshi, M., & Lawless, W. (2015). Conceptualizing a social sustainability framework for energy infrastructure decisions. *Energy Res Soc Sci, 8,* 127–138. doi:10.1016/j.erss.2015.05.010.

Wilson, G. A., & Dyke, S. L. (2016). Pre- and post-installation community perceptions of wind farm projects: The case of Roskrow Barton (Cornwall, UK). *Land use policy, 52,* 287–296. doi:10.1016/j.landusepol.2015.12.008.

Wolsink, M. (2007). Wind power implementation: The nature of public attitudes: Equity and fairness instead of "backyard motives". *Renewable and Sustainable Energy Reviews, 11,* 1188–1207. doi:10.1016/j.rser.2005.10.005.

Author Biography

Sarah Mills holds a master's degree in engineering for sustainable development from the University of Cambridge and a bachelor in mechanical engineering from Villanova University. She earned her PhD in urban and regional planning at the University of Michigan. She currently serves as a postdoctoral fellow at the University of Michigan's Center for Local, State, and Urban Policy (CLOSUP), where she serves as project manager for two ongoing large-scale surveys. Her research interests are at the intersection of environmental and land use policy, particularly as they relate to rural communities.