

Article

Utility-Scale Solar in the Great Lakes: Analyzing Community Reactions to Solar Developments

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Abstract: In the coming years, it is expected that reliance on utility-scale solar projects for energy production will increase exponentially. As a result, communities throughout the Midwest will become potential solar facility hosts. Previous research has sought to identify factors that influence community support and opposition to solar developments throughout the country. This paper builds upon prior research by examining community perceptions about the economic, environmental, local and global impact of solar projects in four Great Lakes states using a content analysis of local newspaper articles. Ultimately, this paper identifies the most common perceptions of solar facilities and offers some preliminary suggestions on strategies to mitigate the most prevalent concerns.

Keywords: utility-scale solar energy; renewable energy; public acceptance; Midwest; content analysis

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1. Introduction

In recent years, scientific consensus has made two things clear: human emissions are both causing rising global temperatures and must be drastically reduced in order to mitigate the worst effects of a rapidly changing global climate [1]. Currently, experts estimate that 27 percent of all United States greenhouse gas emissions originate from electricity production processes [2]. However, fossil fuel emission is no longer a necessary aspect of electricity production. In recent years, improvements in renewable energy technology have increased the efficiency and cost of many renewable energy systems, including solar facilities. Now, solar power is cheaper than coal and natural gas in many parts of the country, even without government subsidies [3]. As a result, market forces and a concern for emissions reductions have aligned, and they are both pushing for a transition to solar power in communities. While solar power can be a practical choice on a small-scale, individualized level with rooftop installations, utility-scale solar projects bring renewable energy to the grid on a larger, more cost-effective scale [4]. However, not every community is embracing opportunities to have utility-scale solar projects in their backyard. Opponents have raised many concerns, ranging from frustration over the loss of the natural beauty of their area to worries that installations on farmland could threaten their local economy and food production [5]. Meanwhile, supporters have framed these utility-scale projects as win-win solutions that help the environment and provide economic opportunities to their communities [6]. However, as several past studies emphasize, utility-scale solar facilities are large developments that have strong potential to make both positive and negative impacts on their hosts [7–10]. In addition to their wide-ranging effects on biodiversity, land conservation and water use, utility-scale solar facilities may also have social impacts on their host communities. As solar developments push communities to

transition from traditional agricultural towns and economies to energy production centers, many questions are raised about the impact that these facilities will have on the jobs, livelihoods and traditions of community members. As past studies have shown, strong community support is a key component in any successful implementation of an energy project [11]. Therefore, as the need for renewable energy resources continues to rise, it is important to understand how potential solar communities are answering these vital questions about the environmental and social impacts of solar.

In recent years, the Great Lakes states have become a new epicenter of utility-scale solar developments. Though the Midwest has typically lagged behind the rest of the United States in renewable energy development, changes in state renewable energy goals and improvements in solar panel technology have made solar an attractive option for the region [12]. According to the United States Energy Information Administration's dataset on all existing and new power generation facilities, the 120 GW of proposed solar projects in the four Midwest states addressed by this paper (i.e., Indiana, Michigan, Minnesota, and Wisconsin) would more than double the existing 114 GW already in operation [13]. Furthermore, the size and scale of solar projects in the region are quickly increasing, with existing solar energy facilities in these states averaging 20.7 MW, compared to 77.8 MW for proposed facilities [13]. The Great Lakes states are clearly in the midst of a solar energy boom.

But how is this boom perceived among the communities being asked to host these projects? Are these projects seen as an opportunity for participating in cleaning what has been a largely coal-dominated grid or, alternatively, as a threat to existing energy-sector jobs? While the Midwest's vast tracts of farmland present cost-effective sites for hosting solar panels, to communities with agriculturally based economies, these developments may be seen as just another productive use of the landscape and way to diversify farm incomes or as a threat to farming and farm landscapes [14]. By analyzing local newspaper articles for community reactions to large solar projects throughout four states in the Great Lakes region, this research considers the factors that influence community support and opposition for utility-scale solar energy projects in order to build a greater understanding of this debate.

2. Literature Review

The public's attitude towards any given energy technology is a crucial component in its adoption and deployment. Of all the renewable energy sources, solar power tends to have the most support from the public [11,15–17]. A large majority of Americans want an increased reliance on renewables such as solar and wind power [16]. Americans also strongly support the development of utility-scale solar energy, or USSE, as people perceive solar power as cleaner, fairer, and more just than other energy sources [18,19]. However, local attitudes towards USSE developments do not always match overall public support of solar power.

While solar power has strong support from the general population, studies have shown that individuals often react differently when presented with a proposed development in their area. According to van der Horst [20], individuals who are very supportive of renewable energy tend to support projects proposed in their area while individuals who are opposed tend to remain opposed. However, the individuals who are only weakly supportive of renewables usually end up opposing local projects [20]. This phenomenon is referred to as NIMBYism. NIMBY, or Not In My Backyard, is defined by Dear [21] as "the protectionist attitudes of and oppositional tactics adopted by community groups facing an unwelcome development in their neighborhood" [21] (p. 288). A case study from Portugal found that, of all the renewable energy sources, solar power received the weakest NIMBY response from residents [15]. Despite this, NIMBYism can still impact local attitudes towards large USSE projects coming to their communities. These NIMBY responses are typically dependent on how visible and audible the proposed solar project is for a resident [20]. The noise and visual impacts can usually be mitigated with a buffer distance.

In a case study from California, individuals preferred a buffer distance of one to five miles between a USSE development and residential areas [18]. Carlisle et al. [18] proposes that these buffer distances should be regarded as proxies for solar development opposition, where any projects that encroach on one to five miles should anticipate some local pushback.

However, NIMBYism is not the only factor that influences community support of new USSE developments. Beyond proximity, support for USSE projects is also dependent on other facility characteristics, such as size or scope of the development [18]. Additionally, studies have found that the level of transparency and involvement of local stakeholders during development can have significant impacts on community support [22]. Usually, local stakeholders oppose USSE developments when they do not see substantial public participation in the planning and development processes [8]. Attitudes towards USSE developments have also been known to shift throughout the stages of development [23,24]. Typically, projects receive the most opposition at their proposal stage and then the opposition fades after the project has been completed [18]. Once opposition fades after a project is complete, perceptions can shift towards acceptance for future projects. When an individual already lives in proximity to a renewable energy project, they are often much more willing to accept another development within their community [25]. All of these findings demonstrate that community support cannot be simplified into one measure of proximity to a proposed solar development. Opposition to USSE projects can change based on the scope, stage, experience with and the perceived equity of a development.

Additionally, many residents cite their concern for the aesthetic of their area as the motivating factor for their opposition to nearby USSE developments. Many studies in the US Southwest, where land and sun for solar developments is abundant, have noted concerns that USSE projects will damage the natural beauty of the region, especially its national parks, wilderness areas, and trails [8,24,26]. Although PV modules or mirrors are placed low to the ground, many communities also worry about glare from their highly reflective surfaces that can reach miles from the site [26]. Additionally, communities may dislike the fact that solar energy developments require a large amount of land per unit of energy produced [26]. However, the impact of the visibility of a project on its community support is not uniform throughout every community. Individuals who live in stigmatized areas are typically more supportive of green developments [20]. In opposition, individuals who gain a sense of identity from their landscape or rely on the beauty of their local environment to support their economy are typically less supportive of green developments [20,27]. For example, support for a USSE development in California called Ivanpah was directly linked to the value that different groups placed on the land in question. Developers of the project argued that Ivanpah's proximity to a highway and Las Vegas made the visual and environmental impacts of the project inconsequential [28]. However, opponents argued that the site was on a biodiverse old growth desert habitat. Local Native American tribes protested the siting because it was within view of a sacred prayer site [28]. In the opponents' view, the land was more valuable than the developers made it out to be. Ultimately, the project moved forward, but Ivanpah still represents the tradeoff that plagues so many USSE developments: local habitat degradation vs. global climate mitigation.

Environmental concerns can lead to both local support and opposition of proposed USSE developments. On one hand, USSE developments prevent large amounts of carbon dioxide from being released into the atmosphere and help to mitigate against the dangerous effects of global climate change. One study estimates that a 50 MW parabolic trough can keep 80,000 tons of carbon dioxide out of the atmosphere every year [29]. On the other hand, USSE disrupts local habitats and can negatively impact carbon sequestration from vegetation removal [9]. Abbasi and Abbasi [7] argue that this issue is not so nuanced and claim that, "renewable energy sources are not the panacea they are popularly perceived to be; indeed in some cases their adverse environmental impacts can be as strongly negative as the impacts of conventional energy sources" (p. 121). These concerns are largely

attributed to local habitat degradation. Conservationists have been very vocal about opposition to USSE developments in the desert Southwest, particularly at Ivanpah. Many studies present the direct impacts of USSE on local habitats [8,9,29–31], but quantifying these impacts is an area that requires additional research. Despite these existing uncertainties, both concern for the global climate and concern for local habitats are regularly cited as motivating factors in an individual's readiness to support USSE projects in their community.

Finally, studies have found that support for USSE is often driven by economic impacts. Generally, solar power has such high levels of support nationally because it is a very cheap way to produce energy. Solar energy systems have become much more affordable in recent years, and utility-scale systems enjoy economies of scale which further lowers the cost of the energy that they produce [32]. However, one economic drawback to USSE is the high cost of land. Solar energy produces approximately 200 W per 1 square meter of land, so large amounts of land are required to build USSE developments [29]. When farmers rent out their land for USSE development, they gain supplemental income. Compensation for a project typically translates to project acceptance from the farmer and even from the surrounding community [33]. In addition to these aspects, there are a variety of other economic impacts, such as the effect of tax revenue and changing community economic conditions on residential support, to be explored.

Navigating national–local solar acceptance gaps can be difficult. Many variables, from proximity to local economic impacts, can change the perception, and ultimately acceptance, of proposed USSE developments. No one factor seems to influence communities more than the rest, and even factors that appear to be simple, such as NIMBYism, have complex nuances [18]. Previous studies have shown that, theoretically, communities would be most receptive to a USSE project that has a large buffer zone, is smaller in scale, and includes considerations for local residents in the development process. Additionally, communities are more likely to support developments that are not placed on highly valued land or perceived to have a negative impact on the local environment or economy. It is clear that community support for USSE developments is nuanced and complicated. If USSE projects are going to be part of our efforts to mitigate climate change, it will be important to have a strong understanding of these complexities, so that USSE projects can be distributed in the most equitable and successful manner.

While previous research on community reactions exists, much of it is based in the Southwest and focuses on solar developments in open, undeveloped areas. In the Midwest, USSE projects are being proposed and developed on farmland which raises additional concerns from local communities. One study by Bessette and DePew [34] analyzed a sample of town hall meetings and newspaper articles related to community reactions to both wind farm and USSE developments throughout the state of Michigan. Similarly to other studies, Bessette and DePew [34] found that residents who were concerned about the development of a USSE project in their communities in Michigan were often focused on the lack of consideration for the community in the development process and the effect the USSE project would have on the aesthetics of their area. However, additionally, many community members raised new concerns about the impact a USSE project would have on their local agricultural production and economy. In order to better understand this concern and other aspects of local support for USSE developments throughout the Midwest, this study hopes to build upon Bessette and DePew's work through a wider reaching content analysis of newspaper articles written about USSE projects in four Midwestern states since the end of 2018, a time period with significant expansion of utility-scale solar developments in the region [13]. Through this work, this study ultimately hopes to answer the following question: what factors most contribute to community support and opposition for USSE developments throughout the Midwest?

3. Materials and Methods

In order to learn what the most common community reactions were to utility-scale solar energy projects in Michigan, Wisconsin, Minnesota, and Indiana, this study conducts a content analysis of locally-based newspaper articles. Newspaper content analyses are a well-established method of increasing understanding local opinions, especially in energy research. Olive and Delshad [35] compared Canadian and American news coverage of hydraulic fracturing projects to illuminate differences in opinion between the two countries. Evensen, Clarke and Stedman [36] conducted another study on community support for fracking using a database-sourced collection of local newspaper articles to code and compare differences in the opinions of Pennsylvania and New York residents living near existing or potential hydraulic fracturing developments. This study borrows from Evensen, Clarke and Stendman's [36] method of analysis to consider local opinions on solar developments in affected communities throughout Indiana, Michigan, Minnesota and Wisconsin using local newspaper coverage.

For this study's purposes, we focus on local and state newspapers, as utility-scale solar projects in the region are approved by either state or local (county, or even sub-county) government, and so are unlikely to receive attention in national and international publications. Local articles often capture prominent themes from community dialogue, and their analysis is a valuable way to discover public opinion on a given topic. Additionally, local newspapers not only demonstrate community support for or opposition to an issue, but also can serve as a public forum for community leaders and local officials [37]. To conduct a content analysis of public opinions on Midwest solar development projects, this paper collected articles from local papers in the four identified states and analyzed them using a thematic coding scheme. The sample of articles was sourced from NewsBank, a news database resource which draws from a large database of local and national news sources throughout the United States.

3.1. Sampling

The data collection of articles was generated through a keyword search of all local newspaper articles in each targeted state from 1 January 2019 to 12 May 2020, a time period intended to capture the most recent experiences with solar at the genesis of this research project in Summer of 2020. In order to ensure that this study captured all of the newspaper mentions of utility-scale solar developments within these dates, a variety of terms for solar projects were tested. Ultimately, the terms "solar farm," "solar development" and "solar project"—each in both the singular and plural form—provided the most full and focused sample. The data sample, as of 1/1/2019 to 5/12/2020, resulted in 153 articles for Michigan, 246 articles for Wisconsin, 149 articles for Minnesota, and 244 articles for Indiana.

Results that are duplicates of previous articles are excluded from the analysis, as well as those that are irrelevant to solar energy in that state. Community notices, public hearing notices, and meeting agendas without useful content have also been removed.

3.2. Coding Scheme

The newspaper content is analyzed using a thematic coding scheme. Community concerns highlighted in the literature are included in the coding scheme to encourage comparisons between prior findings and this study's results and determine the abundance of the previously researched frames in current public discourse. In addition to frames extracted from the literature, several themes were selected through independent news browsing or discussion among researchers. After Michigan Gov. Whitmer announced solar panels could be placed on land under the Farmland and Open Space Preservation Program, farmland preservation programs and use of brownfields were added as themes [38]. Additionally, since this paper is particularly interested in community reactions toward USSE's potential impact on local water sources, the researchers created four codes for

mentions of agricultural water use, runoff/erosion, groundwater, and solar panel material contamination.

In total, there are 39 codes grouped into 6 different categories (see Table 1). Each article in the data sample was read and assigned a code(s) based on its content. If an article contains multiple frames, it receives multiple codes, as well as no codes if it does not include any of the listed themes. Additionally, each article is classified as positive, negative, neutral, or mixed in respect to utility-scale solar projects. In order to reach this conclusion with minimal bias, the researchers determined criteria to distinguish the tone. “Positive” articles listed only optimistic views toward the projects (i.e., appreciation of increased income for landowners, economic benefits to aid the community) while “negative” articles listed only critical concerns toward USSE (i.e., irritating noise from turbines, destruction of farmland underneath). “Mixed” articles contained both favorable and unfavorable comments regarding the solar energy projects. “Neutral” articles did not have either positive or negative comments regarding the projects (i.e., fact-based news reports). Since this category has the highest risk of subjectivity, a separate intercoder reliability test was conducted. The result—93.88%—indicates a high level of agreement between the coders.

Table 1. Coding frames and categories.

Over-all	Economy	Land Use	Community Issues	Environmental	Non-Local Issues
Positive	Tax Revenue for Community (Tax on Developers)	Prime Agricultural Land	Aesthetics	Local Pollution	Government Incentives for Developers
Negative	Changes in Income for Farmers	Farmland Preservation Programs	Attitudes towards Developers	Water: Agricultural Use	Cost of Energy Source
Neutral	Revenue Stability for Landowners	Use of Brown-fields	Community Values	Water: Run-off/Erosion	Efficiency/Reliability of Solar Panels
Mixed	Economy Transition from Farming to Energy	Vacation Homes	Change in Number of Residents	Water: Groundwater	Climate Change/Emission Reduction
	Local Electricity Rates	Land for Industry	Noise	Water: Solar Panel Material Contamination	Global Pollution
	Jobs	Plans for Removal	Community Involvement in Process	Local Climate/Environment	Statewide Renewable Portfolio Standard

Property Val- ues	Construction Process	Local/En- ergy Com- pany Re- newable Portfolio Standards
Equity/Share of Benefits		
Safety		

3.3. Reliability Test

In this study, two researchers independently analyzed and coded each article in the data collection. For the first twenty-five articles in the dataset, the researchers compared their results for each article and agreed upon the classifications for each category and code. By analyzing and confirming the initial results together, the researchers were able to eliminate potential areas of subjectivity and confusion, along with significant inconsistencies. There was intercoder reliability of 96% across the entire dataset, with reliability within states ranging from 95% in Wisconsin to 98% in Minnesota.

4. Results

After coding, each researcher's results were combined and averaged to produce the final results shown in the table below. Table 2 lists the percentage of articles each code appeared in within the individual states and overall. Further, to make these results easier to understand, the table also ranks the general codes in terms of frequency of appearance. Overall, most articles took a neutral tone towards USSE developments, and positive articles were considerably more prevalent than negative ones. In terms of the issue codes, community involvement, the aesthetics of a solar development and the cost of energy sources were the most commonly cited considerations for community USSE developments while issues surrounding vacation homes and changing population sizes were rarely mentioned. In most instances, the prevalence of each code remained fairly stable across all states. However, there were some areas in which one state's articles had considerably more mentions of an issue than others. To further understand these results, the following sections analyze and discuss each code category in the context of the articles read and existing understandings from previous research.

Table 2. Frequency of all codes, within states and overall.

	Code	IN	MI	MN	WI	Total	Rank
Overall	Positive	27%	34%	32%	38%	35%	
	Negative	7%	7%	8%	4%	7%	
	Neutral	47%	46%	34%	31%	37%	
	Mixed	15%	10%	18%	20%	16%	
Economy	Tax Revenue for Community	21%	19%	2%	14%	12%	12
	Revenue Stability for Landowners	9%	5%	2%	9%	5%	22

	Revenue Stability for Landowners	11%	5%	3%	8%	5%	23
	Economic Transition from Farming to Energy	2%	5%	0%	4%	3%	26
	Local Electricity Rates	22%	15%	23%	21%	20%	5
	Jobs	14%	26%	19%	20%	22%	4
	Property Values	16%	6%	5%	7%	6%	21
Land Use	Prime Agricultural Land	18%	14%	9%	17%	13%	9
	Farmland Preservation Programs	0%	4%	1%	2%	2%	27
	Use of Brownfield	3%	4%	4%	4%	4%	25
	Vacation Homes	0%	1%	0%	0%	0%	35
	Land for Industry	3%	0%	2%	2%	1%	30
	Plans for Removal	12%	19%	7%	10%	12%	11
Environmental	Local Pollution	7%	7%	3%	4%	5%	24
	Water—Agricultural Water Use	1%	0%	0%	1%	0%	34
	Water—Runoff/Erosion	8%	7%	11%	5%	8%	15
	Water—Groundwater	3%	2%	1%	0%	1%	32
	Water—Solar Panel Material Contamination	6%	4%	1%	1%	2%	28
	Local Climate/Environment	12%	6%	19%	18%	15%	8
	Local/Energy Company Renewable Energy Standards	9%	19%	16%	20%	18%	6
Community Issues	Aesthetics	34%	22%	16%	16%	18%	7
	Attitudes towards Developers	6%	10%	5%	9%	8%	16
	Community values	4%	10%	5%	9%	8%	16
	Change in # of Residents	0%	1%	0%	1%	0%	33
	Noise	3%	11%	1%	7%	6%	20
	Community Involvement in process	31%	31%	32%	21%	28%	1
	Construction Process	1%	1%	1%	1%	1%	31
	Equity/Share of Benefits	6%	8%	13%	11%	11%	13
	Safety	7%	5%	10%	5%	7%	19
Non-local Issues	Government Incentives for developers	23%	9%	16%	12%	13%	10
	Cost of Energy Source	19%	14%	22%	32%	22%	3
	Efficiency/Reliability of Solar Panels	7%	5%	14%	5%	8%	14
	Climate Change/Emission Reduction	10%	22%	23%	31%	25%	2

Pollution (Global)	0%	2%	3%	1%	2%	29
Statewide Renewable Portfolio Standards	1%	5%	11%	5%	7%	18

IN = Indiana, MI = Michigan, MN = Minnesota, and WI = Wisconsin.

5. Discussion

5.1. Overall Tone

Across all states, the majority of news articles on utility-scale solar took either a neutral or positive tone. In most states, the plurality of articles was neutral, though in Wisconsin, more articles (41%) were positive than neutral (see Figure 1).

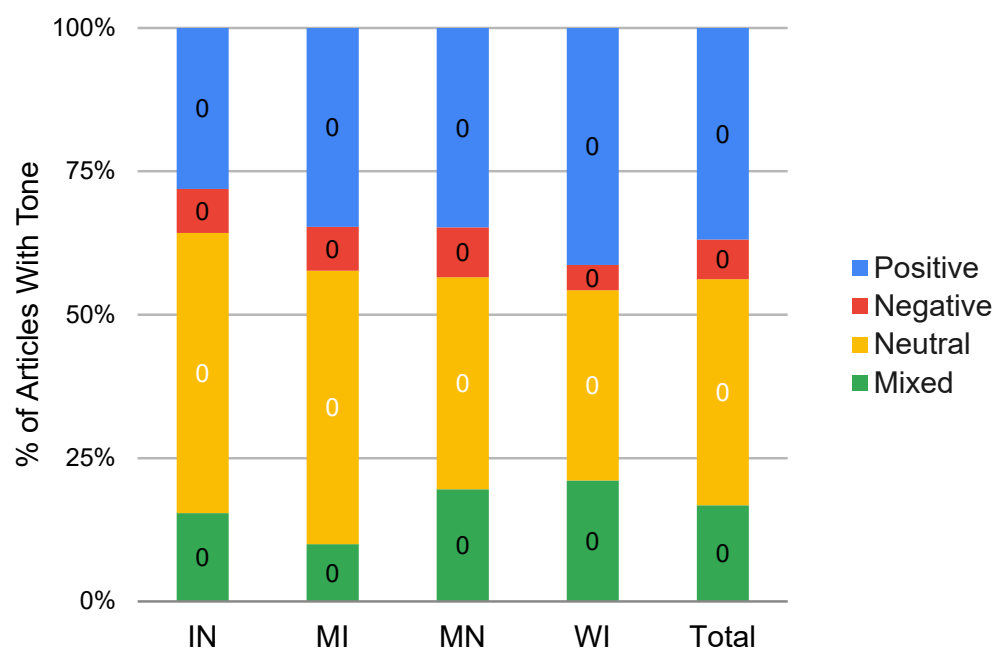


Figure 1. Stacked bar chart of overall tone results for each individual state and in total. IN = Indiana, MI = Michigan, MN = Minnesota, and WI = Wisconsin.

5.2. Economy

Codes listed under the economic category were mentioned very frequently and predominantly in a positive light, specifically in reference to jobs and local electricity rates (Table 2). Although each local economy has different needs and priorities, the analysis finds that most Great Lakes communities believe investing in a USSE project is a sound, stable, and beneficial economic decision. The favorable attitude ends, though, when discussing solar power's potential effect on neighboring property values, which sparked widespread community concern and negative reactions. Unlike the other states, Minnesota lacked mentions of the majority of economic codes, besides jobs and local electricity rates.

The "tax revenue for community" code was used to determine the reactions toward increased tax revenue for the local community as a result of USSE projects. It was the 11th most frequently mentioned code in the scheme, and often appeared in positive or mixed articles (Table 2). The additional tax revenue generated from local solar developments was always listed as a positive impact to the local economy and community. This code was most popular in Michigan and Indiana, totaling approximately 20% (Figure 2). The new tax revenue was mentioned as benefiting schools, social programs, and township opera-

tions, such as libraries and fire stations (MI #25/MI #32). There was overwhelming community support for the additional tax revenue, which was usually projected to range from \$5 to 20 million, depending on the size of the solar installation, over the lifespan of the project. The tax revenue generated by USSE was said to help “offset the lost tax revenue from crops,” since these projects were mostly sited on farmland (WI #210). Although most states assess property taxes on solar developments, large solar developments are exempt from property taxes in both Minnesota and Wisconsin and are instead replaced by an alternate tax (MN #85/MN #37/WI #37). While the assessment of how revenues are shared with the host communities are beyond the scope of this study, it is notable that both states have fewer mentions of “tax revenue” than Indiana and Michigan, where utility-scale solar is subject to a local property tax. This lack of mentions about tax revenue benefits is most notable in Minnesota, where only 2% of articles mention it.

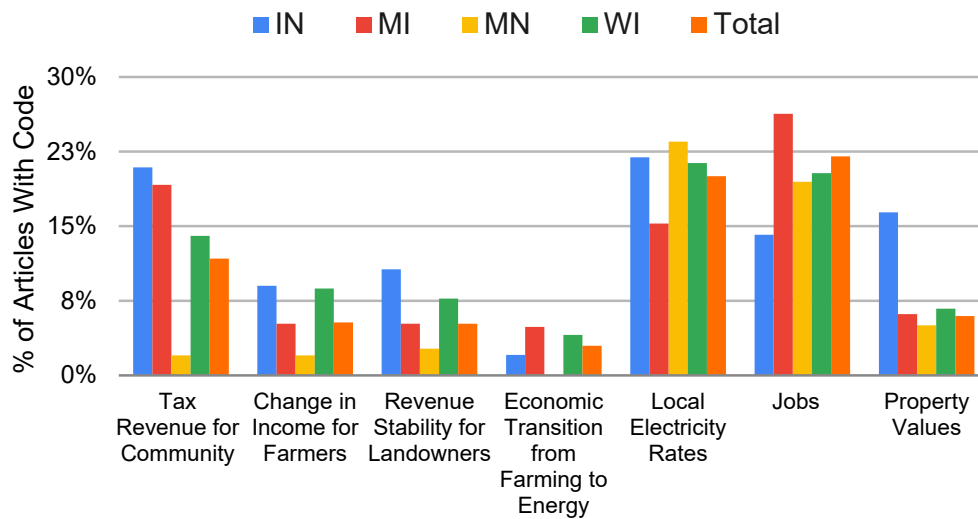


Figure 2. Bar chart of economic results for each individual state and in total. IN = Indiana, MI = Michigan, MN = Minnesota, and WI = Wisconsin.

The “changes in income for farmers” code was meant to capture the reactions of potential changes in income for farmers after leasing their farmland to solar energy developers. Although farmers would be at least temporarily losing the ability to farm the land on which the solar project would sit, they typically are annually compensated for the land lease—often with more stability than farming crops can provide. This frame was almost always coupled with mentions of “revenue stability for landowners,” which is shown through the paralleled data between the two codes in terms of their frequency of mentions across states (see Figure 2). Both codes were almost always mentioned in a positive light, with community members and landowners themselves discussing the needed income source for farmers. Articles also mentioned the stable revenue stream could help farmers retain land ownership into the future (WI #23), and that solar farming is “drought-resistant and weather-resistant,” making it a supportive proposition for farmers (WI #25). Bob Bishop, a grain farmer included in the Badger Hollow solar project in Wisconsin, reiterated that “farming is a business; [the opportunity for revenue stability through solar farming] is a business decision” (WI #25). In the few instances where these codes were mentioned in a negative light, it was often from quotes of non-farmers who often also disagreed with the use of prime agricultural land for USSE projects (MN #50/IN #197).

Unlike most of the economic codes, USSE as an option for “economy transition from farming to energy” was scarcely introduced among articles and ranked 27th out of all 40 codes (Table 2). Yet, when this concept was discussed, it was mostly portrayed in a negative light. Those in opposition to USSE projects would cite how the projects would devour

prime agricultural land and shrink the farming economy in their city—a sentimental and important layer of their community (MI #26). After developers entered Deerfield Township, Michigan, several community members simply voiced their opposition to the energy economy entering their area, stating: “we are farmers, and we want to use this land for just that” (MI #27). This code often parallels concerns about aesthetics, since the solar-sited portion of prime agricultural land and its crop production would be taken away both economically and visually.

“Local electricity rates” was the 5th most mentioned code in the set (Table 2). This code was frequently used in positive, neutral, and mixed articles, and mostly introduced with objective content about the USSE project’s impact on electricity rates (MN #47) or subjective support for a cost reduction in customer bills through solar power (WI #4). In most of these cases, articles discussing the economics of utility-scale solar projects interwove quotes from property owners who had installed solar panels on their property to offset their own electricity use, which though using a similar technology, has different implications on a customer’s electricity bill. In these stories, owners of businesses, schools, and community buildings mentioned how their switch to solar energy was focused on electricity savings (WI #29/WI #4). In regard to direct customer savings from *utility-scale* solar projects, most articles stated that the bills would either reduce in cost or remain unchanged from the existing electricity mix, dominated by fossil fuels (MI #4/MI #53). Where this code was mentioned in articles with a “mixed” tone, it was often by community members who reacted negatively to USSE’s impact on energy prices would claim that the project would not lower electricity rates, and therefore is not worth the negative impacts on surrounding landowners (IN #135). Additionally, some community members were concerned the energy would be sent to neighboring counties, thus giving surrounding areas the lowered electricity costs while the host county would see no such benefit (WI #154).

Jobs was the 6th most mentioned overall code, positioning it right under “local electricity rates.” It was frequently used in articles with positive, neutral, and mixed tones, with either data-based content about newly created jobs from local solar projects (WI #63) or subjective support for the USSE project’s job creation in their community (MI #94). Many articles mention that the majority of jobs would be temporary during the construction period (MI #151), though several articles quoted project developers who insisted that some local residents would be hired after construction to manage maintenance and security of the project. While some national critics will argue that renewable energy does not create long-lasting jobs [39], these findings do not indicate any negative concerns regarding jobs associated with USSE projects—temporary or long term—in the following Great Lakes states. There are some differences, though, across states. Jobs were discussed the most in Michigan (26%), with 20% of articles in Minnesota and Wisconsin including notes, and only 14% in Indiana (Figure 2).

The “property values” code places 14th across all frames, with significantly more mentions in Indiana than in the other states (Figure 2), where concerns over the potential impact of USSE projects on neighboring properties was often the key reason why residents would oppose the development (IN #78). When community members voiced their concerns in public forums, solar developers often stated that studies have found that the project does not affect property values at all (MN #48), or in some cases, affects them positively (IN #78)—due to well-funded schools as a result of increased tax revenue, or the lack of future large development building in the area (WI #20). However, even if developers pointed out studies or spoke with local real estate agents, worry regarding decreased property values often persisted in news coverage.

5.3. Land Use

Since the great majority of articles focused on USSE projects located on farmland, this code was the most mentioned under the “land use” category (Table 2). “Prime agricultural land” was frequently used in each four “overall tone” categories. When coupled with increased income and revenue stability for farmers, the use of farmland was portrayed in a

positive light. Farmland was also mentioned in neutral articles, simply listing where the solar project was sited. However, there were also numerous articles featuring quotes from community members who opposed the placement of solar “farms” on prime agricultural land. Residents opposed to siting solar projects on farmland often mentioned how a significant amount of local farmland was being taken out of production, which was a concern for the local economy, the reduction in locally produced food, aesthetics, and community values (IN #38). In some stories, solar developers responded to this opposition by noting that solar projects are temporary, and the farmland will return in the same or better condition after decommissioning (MI #60). Even so, this appeared not to quell all concern, with several community members insisting the panels would environmentally degrade the land and fertile soil (IN #38), and ultimately were against a utility-scale solar project on “precious [state] farmland” (IN #38).

As for “farmland preservation programs,” Michigan was the only state where this code reached significance (Figure 3), which aligns with specific events in Michigan during the research period. In June 2019, Michigan amended its Farmland and Open Space Preservation Program to allow for solar development (MI #73). Mentions of this change were often listed as “neutral” or “negative,” with the former corresponding with a neutral noting of the change and the latter often criticism from some farmland preservation advocates.

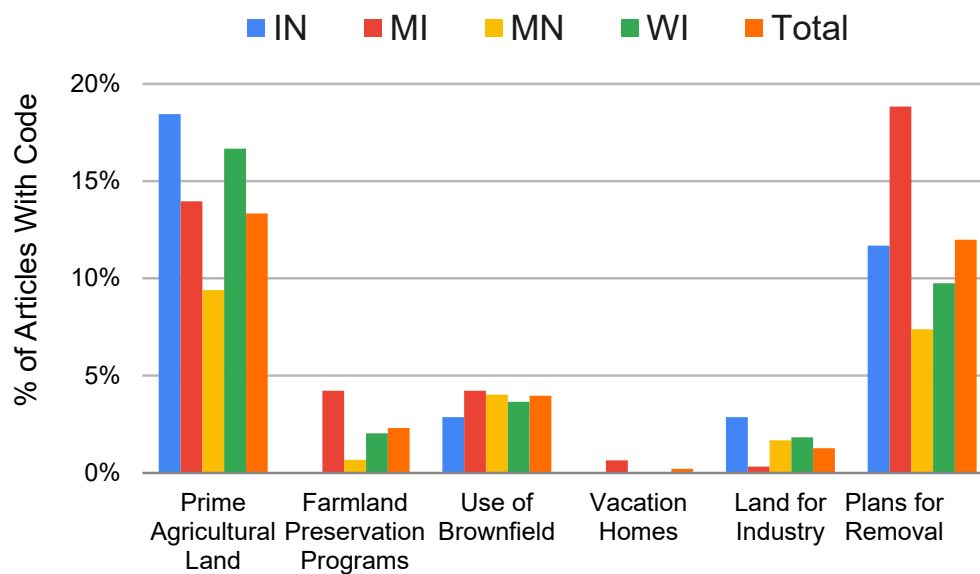


Figure 3. Bar chart of land use results for each individual state and in total. IN = Indiana, MI = Michigan, MN = Minnesota, and WI = Wisconsin.

The use of brownfields was rarely mentioned in news coverage of USSE, with less than 5% articles in each of the four states. The code was common in “neutral” articles, discussing the use of brownfields for solar siting, or “mixed” articles, where community members opposed to solar on farmland offered up brownfields as a land use compromise. One Wisconsin resident, who wrote an article criticizing the Badger Hollow solar project which was proposed on farmland stated: “why can’t lower quality land be used for something like this?” (WI #187).

Although there is acknowledged concern for wind energy’s impact on vacation home views [40], this study found limited evidence (see Table 2) of the subject influencing community reactions toward USSE projects in the Great Lakes region, perhaps due to the location of proposed projects. Additionally, this study included “land for industry,” which was very briefly mentioned as a land compromise from community members opposed to

farmland solar projects (IN #53). One critic stated: “it only makes sense to keep such large-scale industrial projects on zoned industrial land.” Despite some support for solar projects on industrial land, there was little mention of USSE projects being sited on this land. If they were covered through the newspaper articles, they were most commonly placed on land in or surrounding airports (IN #33/WI #4). Those projects received widespread support from community members.

Finally, community members focused heavily on the USSE project’s decommissioning plans (i.e., “plans for removal”), and it placed 12th among most frequently mentioned frames (Table 2). This code was discussed most often in “neutral” or “negative” articles, since the plans for removal either corresponded with fact-based project details (WI #20), updates on zoning ordinances (MI #136), or community concerns about the decommissioning process (IN #39). Some community members had concerns about the lack of information provided by the developers for the decommissioning of the USSE project, like whether the deconstruction cost would be covered, or the ground would be returned to its original condition (IN #39). Developers who openly discussed their project’s plan for removal often appeared more favorably in the community. The largest concern associated with decommissioning was potential land degradation (MI #93), and whether the cost for removal and repair would be covered by the developers. That mentions of decommission in Michigan were twice as high as other states may be because the aforementioned changes to the Farmland and Open Space Preservation Program in that state laid out specific guidelines for decommissioning.

5.4. Local Environment

This section of codes was created to encompass any mentions of the effects that new USSE development could have on the quality of a community’s surrounding environment. Throughout this section, there is no clear agreement between and within communities as to whether USSE projects are beneficial or detrimental to local ecosystems, often reflecting a lack of science on the impact of these projects within Great Lakes ecosystems. In the catch-all code “local climate and environment” that was designed to capture all mentions of the environment that did not fit into another specific code, was one of the most common used, placing 8th, but this study found a variety of different perspectives. Some residents saw USSE developments as beneficial for the environment by giving land a break from the burden of constant agricultural production (MN #7). On top of this, some USSE developers have proposed planting native prairie grasses that attract pollinators underneath their project’s solar panels. Many community members take this as evidence that USSE developments are not only beneficial for the global climate, but for their local environment as well (MN #67). However, this is not the case with all mentions of the “local environment” code. Other community members saw potential USSE projects as threats to the natural biodiversity of their area (IN #25). As noted in the literature review, both sides of the debate raise valid points, and it will require further research to truly understand the impact that USSE developments will have on local ecosystems. However, for the purposes of this study, the findings from this code and the rest of the codes in the “local environment” section illustrate a lack of community consensus on either side of the issue.

In addition to the catch-all code, this study also identified several specific areas of environmental concern surrounding USSE developments. For each of these, however, there were relatively few mentions. The “local pollution” code, found in 5% of total articles reviewed, was most often concerned about materials leaching from the solar panels into the soil (IN #180). Again, while experts say that solar panels are secure and frequently monitored to prevent such a disaster [41,42], there still appears to be a perception that it could occur in a few communities throughout the Great Lakes.

Given the primacy of concerns about water use and contamination in the Great Lakes, this study included three water-related codes. The most common water-related code concerned runoff and erosion in relation to USSE developments. It appeared in 8% of the

overall articles, and most frequently in the Minnesota articles, where two farmers struggled with drainage issues after a solar farm was developed next to their properties (Table 2; Figure 4; MN #24). In the rest of the states, the conversation about drainage and runoff issues would occur was mostly theoretical. Many opponents of USSE developments cited it as a reason for their reluctance to support a new solar farm in their communities while developers argued that there would be no issues with runoff as result of their USSE project (MI #71). In addition to debate over runoff at solar developments, others argued that solar projects could help to eliminate runoff and erosion issues by taking land out of agricultural production and ensuring that it was always covered by natural plants (MN #37). This issue has multiple competing sides that see solar developments as both harmful and helpful to soil preservation, and in order for communities to effectively make a responsible choice about a USSE project for their environment, they need more information from expert sources.

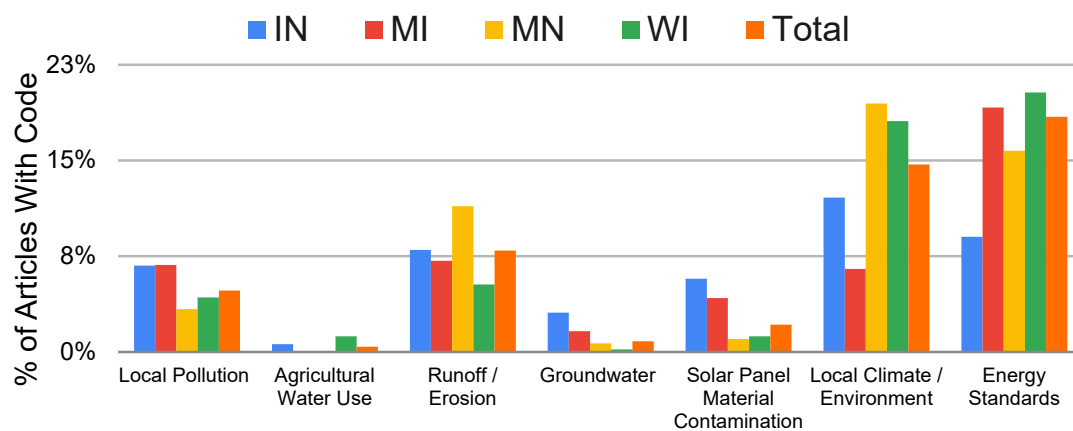


Figure 4. Bar chart of local environment results for each individual state and in total. IN = Indiana, MI = Michigan, MN = Minnesota, and WI = Wisconsin.

The “water–agricultural use” code was created to record mentions of the amount of water used in farming. It was expected that there would be some comments about the difference between the amount of water needed to support agricultural activity compared to the amount of water needed for a USSE development, but ultimately this code was only mentioned in 0.5% of all of the articles surveyed, and therefore does not seem to be an important consideration in community support for USSE developments (Table 2). Similarly, concerns over groundwater were rarely mentioned (1%), but when they were, these overlapped with the “solar panel material contamination” code, with some concern about panel materials leaching into ground water (MN #97) or rebuttals by solar developers or groundwater experts (WI #34).

Our final code for the “local environment” section, “locality and energy company renewable energy standards,” was applied to all mentions of localities or energy companies setting goals to be powered by a certain percentage of renewable energy by a set date. It appeared in 16% of total articles coded (Table 2). While the concept of local renewable goals was often mentioned, from the articles coded, these standards did not appear to be significant impacting factors on actual community support or opposition. Some articles did note that town leadership believed developers would be more attracted to areas that had indicated through their goals that they were ready to embrace renewable energy, but there was little mention of community members’ opinions being shaped by these policies (MI #91).

5.5. Community Level Concerns

In addition to economic, land use, and environmental concerns, this study also identified several other issues that frequently arose in both past research on community reactions to USSE projects and in the preliminary articles read for this study (Figure 5). The “aesthetics” code was created to encompass all mentions of the effects that a USSE development could have on the beauty of the landscape. It was the second most prevalent code overall, appearing in 18% of the articles reviewed, but was particularly prominent in Indiana with 34% of all newspaper articles mentioning it (Table 2). Often, these articles would refer to the requirements for setbacks from the USSE project to surrounding properties in order to mitigate the impact that the development would have on neighboring views. Local residents lamented the loss of their “bucolic view” from their homes, and many pointed out that they had worked and saved to live in a home that overlooked natural countryside, not an industrial development (IN #183), and often argued for the project to be set farther away from their home. While some articles quoted solar developers open to addressing these concerns, these articles also noted that additional buffer distances may make a project financially infeasible. This finding falls in line with previous literature that has found that setbacks, or buffer zones, are often used as a means for compromise between the interests of solar farm developers and surrounding landowners [18].

Relatedly, the “community values” code appeared in 7% of the articles surveyed, most commonly in the context of a negative tone, reflecting some feel that solar developments replacing agricultural production threatens the nature of their communities [22]. One Wisconsin letter to the editor author argued that utility-scale solar farms were being placed “without regard for... community purpose or character” (WI #216). Another article states that residents feared that their communities could become a “solar wasteland” if USSE developments were allowed to proceed (WI #183). Few of these mentions, however, go so far as to suggest that these changes will lead to population loss. Change in the number of residents was only mentioned in 0.4% articles in the sample. Two Wisconsin articles argued that converting farmland to solar power projects would result in population loss by pushing individuals whose careers are based in supporting the agricultural economy to leave the area (WI #183/WI #216). However, a Michigan article argues that as a result of consecutive difficult years in the agriculture industry, populations are already declining in rural areas and solar farms could offer a solution that brings individuals into rural areas (MI #12).

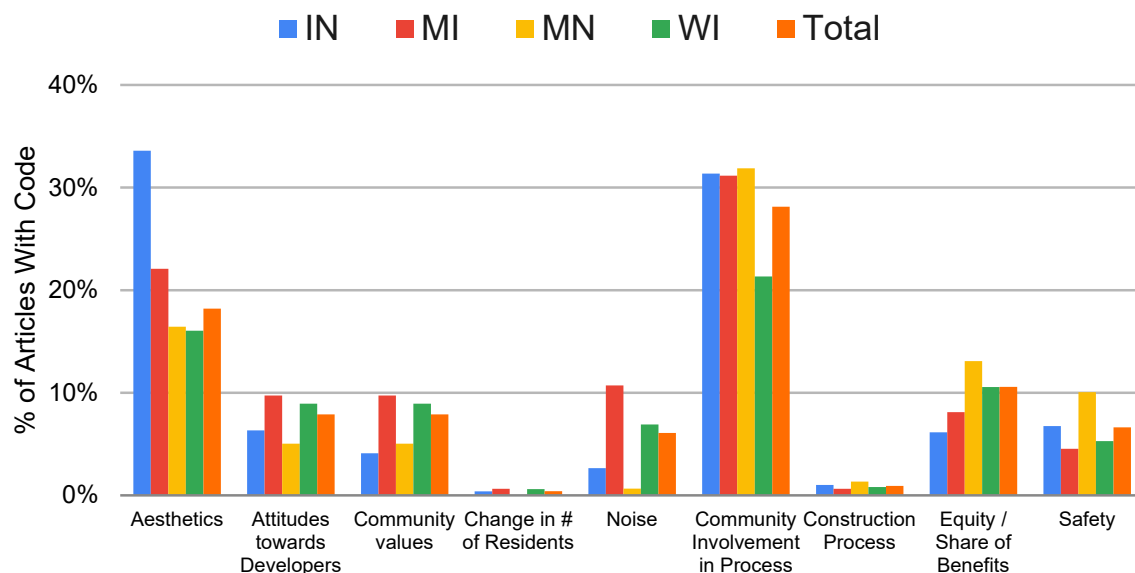


Figure 5. Bar chart of community level concerns results for each individual state and in total. IN = Indiana, MI = Michigan, MN = Minnesota, and WI = Wisconsin.

Specific concerns about USSE physical impacts were noted less often. The “noise” code, appearing in 5% of the articles coded, aimed to capture mentions of sound pollution in relation to USSE projects (Table 2). The majority of the articles referencing solar panel noise were positive or neutral because this was most often used when juxtaposing solar with wind turbines, which have a longer history of development and discussion in the region (IN #170). While potential noise from solar panels was occasionally cited as a reason to exclude them from localities, most articles that included this concern also included evidence from official research that solar facilities would be essentially silent to anyone standing on surrounding properties (MI #24). Similarly, the “safety” code, appearing in 7% of total articles reviewed. Often, it was brought up in mixed and neutral articles that stated that some worried solar panels were unsafe, along with information from experts that they were heavily monitored and did not pose a threat to communities (WI #20). Other coverage, though, took a negative tone, with just the concerns about highlighted (WI #17).

More common, though, were codes about community inclusion, developers, or the solar development process. The “community involvement in the process” code was designed to record mentions of community participation in the process of either encouraging or discouraging the development of local USSE projects and was the most prevalent code in this study, appearing in over a quarter of the total articles analyzed (Table 2). Overall, there was no one clear tone for the articles that mentioned community involvement. The articles ranged from very positive stories about community solar gardens that allowed Minnesota residents to participate in the transition to green energy to negative pieces about packed town halls in Michigan full of opponents to proposed USSE developments (MN #2/MI #118). The articles with community involvement mentions do not even agree on the appropriate level of involvement from community members. Some Indiana articles lament the fact that disagreement over a proposed solar playing out at county siting meetings is “tearing neighbors apart” while other articles from Wisconsin, where the state controls siting decisions, offer frustration about the lack of community control where and how solar farms are developed (IN #209/WI #226). The one area of agreement among all of the articles that mention community involvement is that there are high levels of participation in the USSE development approval process throughout the Great Lakes states. This conclusion matches with the idea from Mulvaney [8] that communities are more likely to support USSE projects if they feel developers have included and helped their communities in the development process.

While there were many comments about community input in the development process, there were fewer mentions about specific “attitudes towards developers”. The code appeared in 8% of articles coded, and more often than not, this code appeared in negative or mixed articles (Table 2). Many of these articles noted that some residents felt that developers lacked transparency, and therefore, were concerned about or opposed to the potential USSE development in their town (WI #44). However, not every community facing a new USSE development felt the same way about their respective solar companies. According to newspaper articles from the area, Shiawassee County residents overwhelmingly embraced the idea of a development in their area, and the developers for the project credited “the early community outreach and engagement... [from their team]... which made this project a partnership rather than a development” (MI #145), demonstrating that a negative relationship between residents and developers is not necessarily a given [22].

There were slightly more mentions of “equity and share of benefits,” which captures all the mentions of fairness and equal or unequal distribution of all of the aspects of having a USSE in a community. It appeared fairly frequently, in 10% of the overall articles coded for this study (Table 2). In terms of the tone of the mentions of the Equity code, there were essentially two different types of references. The first theme is largely associated with community solar projects or other initiatives that allow more residents who are unable to access rooftop solar to participate in green energy (MN #25). These articles were most prevalent in Minnesota—which was the most robust community solar program of these

four states—but were also occasionally from elsewhere. The second set of equity considerations that fell into this category, though, has a less positive tone: the perception that rural communities are taking on a burden in hosting USSEs that serve other areas. According to one Wisconsin article, there is a perception that developers are coming in to gain money for themselves and provide energy to others with little to no benefit for the county that must live alongside them (WI #245). Another negative article from Indiana asserts that a solar project will only provide energy to communities out of the state without helping the host community (IN #118).

5.6. Non-Local Issues

This final category of codes encompasses non-local issues that were also considered in the local articles analyzed. This category includes a variety of different subjects from financial concerns, such as the cost of renewable and non-renewable energy, to environmental concerns, such as climate change (Figure 6).

The “cost of energy” code included all discussions about the cost of producing solar energy, especially in comparison to other traditional energy sources and appeared in 22% of the total articles, slightly more often than the “local electricity rates” code (Table 2). There were a few outlying articles that named cost as a reason not to support solar energy, but, overall, cost was one of the most cited positive arguments. Articles noted that solar was one of the cheapest sources of energy, even without government subsidies, and would help consumers and communities in the long term (MN #26). This code was especially prevalent in Wisconsin (Figure 6), a state that has traditionally relied on imported coal and faced high energy costs. Nearly one-third of the Wisconsin articles mentioned the cost of solar, and the majority of those noted that its low cost could bring newfound energy independence and lower electricity rates to the state (Figure 6; WI #14). Overall, the low cost of solar energy appears to encourage community support of USSE developments.

Often discussed in conjunction with the “cost of energy” code, the “efficiency and reliability of solar panels” code appeared in 8% of the articles studied (Table 2). Like in many aspects of USSE developments, the community members in the articles reviewed had mixed perspectives on solar reliability. Many of the articles mentioned reliability in a neutral or positive context and note that solar panel technology has improved to make developments much more efficient in recent years (MI #81). However, some argued that investing in USSE projects is reckless as we cannot rely on the sun to shine and produce energy at all times (MI #64).

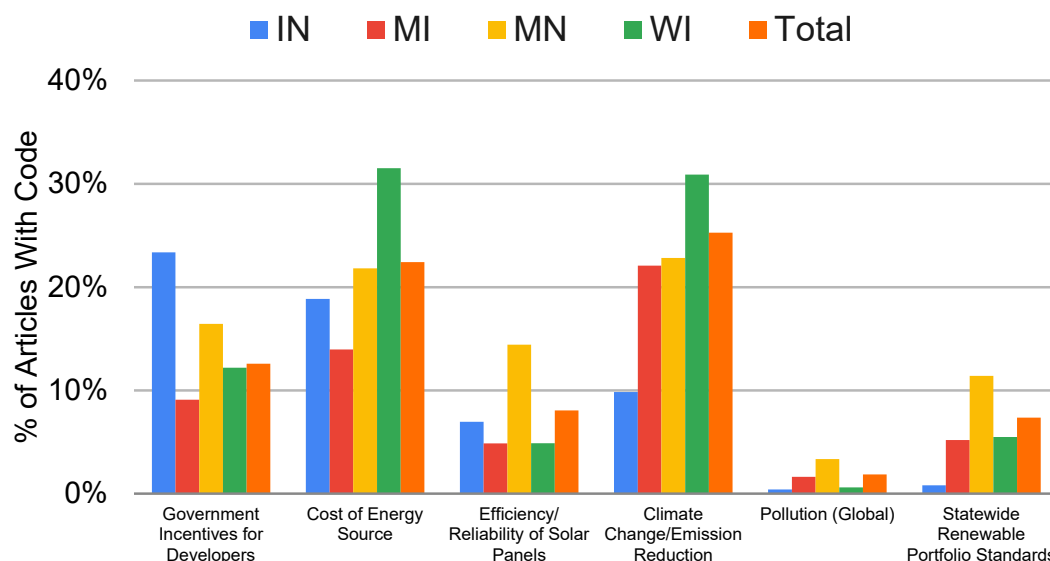


Figure 6. Bar chart of on-local issues results for each individual state and in total. IN = Indiana, MI = Michigan, MN = Minnesota, and WI = Wisconsin.

This study also aimed to understand how often the global environment impacts appear in local discussions about USSE. Any mention of climate change or the need to reduce carbon emissions went under the “climate change” code, which was mentioned in 225% of the articles read (Table 2). Unsurprisingly, climate change was overwhelmingly cited as a reason to support, not oppose, solar projects. In general, locals and communities highly concerned about climate change appeared to be more eager to embrace solar projects in their area as a means of emissions reduction (MN #2). Few articles (2%) sited community discussion about how solar intersects with pollution, and those that did included concerns about the recycling process for solar panels, or a mention of the worldwide air pollution caused by traditional energy sources (MN #6), but, overall, worries about global pollution do not appear to have a strong influence on local support for USSE developments.

Mentions of state or federal policies or incentives also arise in newspaper coverage of USSE proposals. There were mentions of statewide renewable energy standards in 6% of the articles surveyed (Table 2). Many articles noted that these standards encouraged developers to consider creating projects in the state in question, but most within a neutral tone, with few mentions of these standards influencing local opinions on USSE developments within their own communities. More common was a mention of some other “government incentives for developers” which appeared in 15% of the coded articles (Table 2). The majority of occurrences of this code neutrally mentioned how the federal tax credits and other incentives helped to make large-scale renewable energy economically feasible in the region. Sometimes, however, this code appeared in negative articles that asserted that utility-scale solar developments were only feasible because of high levels of government subsidies (MI #142).

As a whole, many of the global issues included in this study tended to be less of a pressing concern for residents of potential USSE development communities than local issues. However, this study did find that climate change and affordability are both perceived as strong motivating factors for USSE project support while the reliability of solar developments continues to be a worry for some individuals.

6. Conclusions

While solar energy is largely widely acknowledged as bringing with it global environmental benefits, this research highlights that community conversations over hosting large-scale solar projects include considerations of a wide range of potential positive and negative impacts that the proposed project might bring to the local community. This research analyzes the full range of community reactions towards solar development projects in the Great Lakes region. Each potential issue is ranked by frequency of mentions, and discussed thoroughly in the analysis section, with additional comments from the researchers when relevant. This paper quantifies the most common areas of support and opposition towards solar development—a significantly important list for policy makers focused on the renewable energy transition, or solar energy developers in the Midwest. Not only can this research be used to pass more effective, efficient solar energy legislation, but can also assist utility companies and energy developers in their communication efforts with prospective solar farm cities.

6.1. Policy Implications

This research highlights that the most common policies that states or the federal government have used to facilitate additional solar energy development generally produce neutral or negative reactions in potential USSE host communities. Both renewable energy requirements and developer incentives—most notably in the form of federal tax credits—do come into local newspaper coverage, and while most of the coverage is neutral, tax credits in particular were cited by some communities as a strike against hosting a project. This does not necessarily mean that these policies should be abandoned, but rather that

policy attention might be given to other policies that factor more prevalently in community conversations.

Key among these non-traditional policies is ensuring community involvement in the siting process. This emerged as the most prominent theme in the newspaper analysis, but the findings from Indiana and Wisconsin highlight that there is no straightforward solution. Across the nation, states generally determine how much discretion local communities have in setting solar siting rules. In some state, such as Michigan and Indiana, local governments have the authority to set these rules, while in both Minnesota and Wisconsin, for example, the state government is responsible. More research is needed to understand which approach yields greater community acceptance, but there are opportunities for increasing community voices in both regimes. For local government siting, states can provide local governments—who may lack technical expertise on solar—with more guidance on planning process and perhaps encourage proactive (rather than reactionary) planning, so that the community has an opportunity to consider the merits of USSE as a land use and its fit within the community prior to a developer proposing a project. In states where USSE fall under state siting authority, making sure that there are ample opportunities for community involvement and expertise in understanding how a proposal would impact other community priorities might help meet this common concern.

The analysis also highlights that positive local economic impacts also come into play in newspaper coverage of USSE proposals, with jobs, local electricity rates, and local tax revenues being the top three concerns. States with renewable energy standards could provide a multiplier for USSE projects, for example, that create additional local jobs. On electricity rates, the state of New York is currently considering whether those in the vicinity of utility-scale wind project should receive a credit on their electricity bill. Last, with respect to property taxation, as states consider how to tax this relatively new land use, they should consider that there is a balancing act in finding a tax rate that is not so high as to discourage solar development, but which still provides local communities with ample economic benefits to want to serve as hosts for USSE projects.

Finally, there is a role primarily for federal policy makers to provide science funding to research the range of economic and environmental impacts that arise in USSE siting discussions. This research highlights that whether it is concerns over property values or local pollution, many communities are left with competing narratives over the true extent of potential positive or negative impacts. Scientifically sound research funded by a neutral party may help better adjudicate some of these concerns.

6.2. Data Limitations and Future Research

While a content analysis of newspaper articles is not burdened with some of the complications researchers encounter with other methods (i.e., survey data, interviews), it has its own set of limitations. First, this research focuses on just four states, all located within the Great Lakes region. There are several regional differences that limit this research, such as the limited existing and proposed solar installations in the Great Lakes region compared to the Southwest region, or land use characteristics unique to the Midwest (i.e., mix of farmland, “rust belt” industrial sites, recreational land).

Additionally, due to time constraints, the data collection samples articles from January 2019 to May 2020, which is a relatively narrow scope of news coverage. By analyzing more articles over a wider window of time, researchers could better understand how community reactions to USSE projects have changed over the years, and how developers and solar advocates have adjusted their communication strategies to fit those concerns. Further, due to the researchers’ lack of experience with network analysis, each of the five factors (i.e., economy, land use, community level concerns, local environment, global issues) were analyzed independently. Therefore, another opportunity for future research includes conducting a network analysis on the data in order to discover whether and how the categories are interrelated.

Finally, this research was only able to catalog the initial reactions of community members towards solar energy projects. Thus, future research could test whether certain data or arguments presented by developers or solar supporters changed the minds of initially opposed residents, which could help developers and policy makers discover a faster, more effective, and less contentious process for siting solar energy projects in the Great Lakes region.

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