Chapter

Regulatory Impediments to Micro-Wind Generation

Ryan M. Yonk, Corbin Clark and Jessica Rood

Abstract

Recent growth in the renewable energy industry has largely been driven by government support for alternative energy. Wind power in the United States is the second largest source of renewable energy, and has been heavily subsidized by state and federal government. There has also been an increasing interest in small scale environmental community projects, and this trend is expected to continue. Currently, there are 2 terawatt hours (TWh) of potential energy capacity through small- and micro-wind projects throughout the United States. Increased development of micro-wind energy could significantly impact America's non-hydropower renewable energy generation. Micro-wind, the utilization of the flow of wind energy to produce electricity for a house, farm or other non-utility scale generation can be regulated at the federal level, as well as at the state and local/community level. We examine two cases of micro-wind energy production to explore the regulatory impediments these smaller projects face. We find that the level of complexity of the regulatory framework is discouraging for innovation and development, and that the benefits of installing energy-generation are often outweighed by the cost of implementation.

Keywords: micro-wind, regulation, renewable energy, regulatory systems, innovation, technology

1. Introduction

Over at least the last twenty years, a substantial and concerted effort has been made to remake the generation of electrical power in the United States. The calls-to-action to move away from fossil fuel-based generation of electricity have commonly called for "green energy", "alternative energy" or "renewable energy" as the replacement. Those terms have faced both widespread adoption and rabid disagreement over which power generation sources and scope should be prioritized as the replacement of fossil fuels. While in practice, these terms are used interchangeably among both policy makers and the general public, for those who choose one term over another, they often represent nuanced differences on what should or should not be included among the alternatives under consideration. Nuclear power generation often falls within this distinction with some suggesting it as a carbon reducing alternative and others pointing to the environmental risks posed by nuclear power generation, such as the disposal of waste products from that generation. Likewise, hydropower, particularly large-scale projects, face similar concerns and complaints from some who advocate for a large-scale movement away from fossil fuels, and the subsequent replacement of fossil fuels with other alternatives. In this chapter we use

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the term renewable energy or renewables to represent the relatively wide swath of non-fossil fuel alternatives [1].

Previous work has explored these controversies in detail and we do not endeavor to recreate this discussion. We will maintain an agnostic position with regards to what term, or power sources ought to be considered, or the necessity of large-scale conversion from fossil fuels in this chapter. We instead explore regulatory burdens and impediments that are faced by the development of micro-wind generation approaches.

Our exploration reviews the regulatory process within larger efforts by the United States to increase renewable energy use. This combined regulatory analysis allows us to explore the impact of regulation and policies supporting renewable energy on the development of micro-wind systems in the United States. We first review the history of these production approaches and then focus on the effects regulation has on micro-wind generation. We use the framework developed in previous work on micro-hydropower and published in "The Regulatory Noose: Logan City's Adventures in Micro-Hydropower" [2].

2. Background

The literature on the impact of regulation has been well documented and thoroughly explored. Scholars have detailed the direct effect of federal regulation, particularly on the economy. Within the broader literature, a substantial critical evaluation has explored the efficacy of the political process in making policies that achieve their stated purpose and avoid unintended consequences. These reviews have generally found that regulation, including federal regulation, faces substantial problems in achieving these dual purposes. One of the most commonly identified problems comes from Tullock [3]. He identified "Rent-Seeking" and the resulting distortions to the policy outcome and decision-making process as one reason political processes are ill-equipped to effectively create policies. Rent-seeking identifies that in order to achieve "rents," some economic or political gain, interest groups are willing to use resources (including economic resources) to influence the regulatory process in their favor. They do so to ensure that long run policy and economic profits are protected. Policies including regulatory preference or expansion, market limitations through tariffs and other restrictions on trade can be obtained from political agents, and those with vested interests face strong incentives to engage. Further expanding in this area, Stigler put forth a strong theoretical frame that is rooted in similar thinking which suggests that the supply and demand for regulatory action is heavily influenced by special interest groups who want public resources and protection that can be supplied by public officials [4].

While rent-seeking models are useful in explaining the adoption and creation of preferential regulatory systems, those systems tend to persist in the face of alternative pressure from other sources. Reversing prior decisions, especially regulatory requirements, has been demonstrated to be particularly problematic. One examination of technological requirements within regulation is illustrated by Arthur [5]. He argues that after a technology has been adopted by its users, there are increasing returns to its use, leading to stronger preferences for continued use of that same technology. As the time horizon extends, the more experience with and adaptation of the regulatorily preferred or required technology increases. As a result, the particular technology becomes stuck; decreasing the probability that it is or will be interchanged with other technology. The cost of switching to a different (possibly more efficient, cost effective) technology becomes prohibitive and the regulatory requirement becomes the default preferred approach. This phenomenon is commonly referred to as path-dependence, and is one of the core mechanisms whereby rent-sought regulatory outcomes become difficult to change even when benefits to alternative arrangements are available.

Path dependence has been well documented within the policy sphere and institutional economics, particularly, historical institutionalism has clearly demonstrated both the propensity for path dependence to emerge, and the costs associated with that path dependence. Arrow's exploration of path dependence highlights the similarities of increasing returns in the costs of establishing and sustaining an institution that relies on technology [6, 7]. These costs are difficult to escape, especially when technology has been regulatorily determined. Pierson explains that political institutions are especially vulnerable to falling into path-dependence [8]. By their nature, bureaucracies tend to grow in both size and scope. Bureaucrats, who often are drawn to their agency due to interest and expertise, seek to influence their particular area and to do so, push for increased influence and regulation. Increased influence and regulatory involvement requires increased authority and larger budgets. This natural push leads to increasingly complex hierarchical webs and complicated regulatory standards. As McClaughlin and Williams point out, bureaucracies continue to pile new regulations on top of the old, further confounding regulations through which individuals and developers must wade through [9]. This stifling regulation hinders innovation and evolution because of increased cost in terms of dollars and time. The end result is a regulatory regime that is neither efficient or efficacious in achieving the goals laid out, but rather serves to protect both the rent-seeker and the rent-providers who are linked in mutually beneficial arrangements that ultimately stifle change and adaptation outside of the artificially created regulatory ecosystem.

In previous work by one of the authors of this chapter, Green vs. Green, he and his co-authors explore this reality by examining the landscape of the environmental regulatory web that green energy producers face [10]. After describing the development of environmental regulations, they provide both an approach to examining the effect of regulation on green energy projects and examples of cases where projects were disrupted. This chapter expands on that approach and applies that lens to micro-generation of wind power. We find that while legislation intends to bolster green energy production, it instead actively increases the costs of green micro-wind projects especially when coupled with other regulatory rules.

3. Introducing micro-wind

Wind energy is the second most utilized renewable energy source in the United States, with 338 billion kilowatt hours (kWh) in 2020, up from 6 billion kWh in 2000 [11]. Advances in technology used to produce wind energy have decreased the cost of producing electricity from wind. Along with the improvement in technology, government programs directed toward increasing green energy have contributed to make wind energy one of the fastest growing industries in the nation. These improvements in wind power are becoming more relevant as the literature finds that alternative energy sources are crucial to the future of both the environment and economy of the United States.

Micro-wind is the most accessible form of micro-energy, and the simplest form of clean energy. Wind turbines work by harnessing the kinetic energy that wind creates. A turbine has blades that function similarly to airplane wings; when wind flows over them, they create lift causing the blade to turn. The blades are connected to a drive shaft that spins an electric generator which produces electricity [12]. Micro-wind is similar to large-scale wind energy production, simply on a smaller scale. Instead of having farms of massive wind turbines, a micro-wind project could include one or more turbines connected to a relatively small generator. Micro-wind is suitable for residential energy production, used mostly for a house or farm. The excess energy can then be exported to the electrical grid, and credits can be provided by the retailer.

There are numerous potential benefits to using wind turbines and generating clean energy. Wind energy proponents claim that it produces no air, water, or thermal pollution, nor greenhouse gases, and no smog. Advocates claim that they leave few impacts on the local environment when they are dismantled, and that most activities on a wind site are not halted due to wind installations. These claims, however, are not with-out controversy and some evaluations have sound significant environmental impacts of wind generation [10]. The price of energy can be competitive, and it is quickly built and installed due to the straightforward design. The initial cost of installation of micro-wind turbines can be higher than that of other energy sources, but in the long-run they have the potential to be cost-effective [13].

Micro-wind is being looked at on a smaller scale than other micro-energy sources, with residential areas using micro-wind at the highest level. Small wind refers to small turbines that typically exert power of between 500 W and 25 kW, which may or may not be hooked up to the grid. Unlike hydro power, wind energy can be harvested from virtually everywhere, with manufacturers recommending a minimum average wind speed of 4.5 to 5 m/s [14]. One of the major benefits from micro-wind power is that it allows for the extension of clean, renewable energy to areas with limited to no grid access [15].

Use of micro-wind has increased dramatically over the past decades, with experts estimating that over one million micro-wind turbines are in use globally [15]. The complications of regulations in the micro-wind energy generation often scare away city officials and homeowners from implementing this technology on a wider scale. Without substantial regulation on micro-wind turbines, many more cities and consumers might choose to utilize the technology, potentially decreasing the environmental footprint, and saving the consumer money. Installation cost for micro-wind is relatively low, and maintenance is comparable to current costs, and is often less common. Wind turbines are not as efficient as other green options (the average wind efficiency of turbines falling between 35% and 45%), but with the low costs mentioned above, they may still be a viable option. At the speed of innovation in the past decades, some have claimed that the rate of efficiency will climb higher. If this claimed rise in efficiency occurs, micro-wind could potentially see greater demand become more widespread and help the United States increase renewable energy production with an efficient dispersed source. While the technical challenges may have solutions likely to occur in the near term, the regulatory environment faced by micro-wind remains daunting, and likely to prevent widespread adoption.

4. Current micro-wind regulation

Micro-wind, unlike the more common micro-hydro, is more isolated from the grid and focused on residential power creation, but that seeming isolation does not necessarily mean that regulation does not exist. Micro-wind regulation is primarily concerned with physical limitations and construction rather than the other more technical aspects which are more relevant to micro-hydro [2]. Many residential areas have zoning, permitting, and covenant guidelines that must be adhered to including, but not limited to, height limits, which proves to be a serious issue for accessing higher speed winds, and noise level caps. The noise issue is not as serious

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an impediment as height because the ambient noise of a micro-wind turbine is only slightly above that of natural ambient wind [16]. There are at least 250 state policies regulating the construction of only small wind projects, with nearly double that applying to both large and small projects.

The current process for permitting and installing a wind turbine can be long and arduous. While the initial steps of assessment can be costly, they are primarily separate from the regulatory system [17]. The following stage is dedicated to complying with federal regulations as well as local government zoning, permitting, and covenant requirements. As a result, the regulatory environment may differ on the federal, state, county, and potentially sub-county levels. Meaning that every sight faces layers of regulation that can be daunting to navigate. In addition, residential micro-wind homeowner's associations may further complicate producing wind energy.

As we note one of the primary complications for the use of micro-wind energy is the necessity of meeting not just local and state requirements but meeting federal regulations that were designed for large-scale projects, and which often did not consider the possibility of smaller projects. Despite some attempts to reduce regulatory burden of interconnections particularly IEEE's 1547 standard which is designated under the Energy Policy Act of 2005 concerns about the applicability of the section remain for micro-wind [18]. We explore the application of these regulations and identify others that might potentially impact micro-wind depending on site specific considerations.

The Federal Energy Regulatory Commission (FERC) is the government regulatory commission that oversees and is responsible for determining what level of analysis is required for a given energy project. Generally, FERC oversees the grid connections and generators connected to the higher voltage systems, while states regulate the retail markets for electricity and oversee the connectivity of generators connected to lower-voltage systems. The commission's oversight includes installing and ensuring the compliance with a laundry list of legislation that includes the Energy Policy Act of 2005, the Federal Deepwater Port Act, the Endangered Species Act, the Fish and Wildlife Coordination Act, the National Environmental Policy Act of 1969 (NEPA), the National Historic Preservation Act, the Rivers and Harbors Act, and the Wild and Scenic Rivers Act [19]. These policies contribute to the difficulty of implementing micro-wind power for consumers.

When applying for a license with FERC, even a small turbine must be registered and adhere to all the guidelines applicable to wind farms. These small turbines that are connected straight to the residential property are subject to an equal level of regulation and inspection as large wind farms that power a much larger area and have a much more significant impact on the environmental landscape. FERC, along with regulating new projects, interferes with the expanding of projects that are already in place. The process by which one has to go through to install a small-wind project begins with notification and pre-filing consultation with any "relevant Federal, State, and interstate resource agencies" [20]. In addition to the agencies that require consultation, Native American tribes and members of the public must be contacted.

This only marks the first step in the regulatory process, after the preliminary process is completed, a joint meeting is held for the applicable agents and members of the public to receive public comment prior to a decision being reached.

Even if FERC approval is likely, projects face the reality of additional regulatory requirements from state and local governments. One source of the development of those regulations is the National Renewable Energy Laboratory.

The NREL is a national program designed to focus on pushing the limits of renewable energy. It is a branch of the U.S. Department of Energy, Office of Energy

Efficiency and Renewable Energy, and operated by the Alliance for Sustainable Energy LLC. This program states that they want to create opportunities for job creation and land lease payments, but their purpose is also to "create a new responsibility on the part of local governments to ensure that ordinances will be established to aid the development of safe facilities that will be embraced by the community" [21]. The NREL is actively seeking to create new regulation in states and counties where few exist. Since the overview given by NREL, they have successfully lobbied for more regulation and ordinances across the nation.

There are a variety of ordinances which NREL advocates for, that fall under three themes; permission, placement, and construction. For permission, ordinances require local governments to issue permits for wind energy developments as well as ordinances that demand signage indicating warnings, the manufacturer, the owner but strictly prohibiting advertisements or promotions. In terms of placement, wind turbines must be put out of the way to limit contact with the public and respect set backs, which exist to create space between roads, private property, buildings, and phone lines. Existing wind energy ordinances also note that projects should be placed in compliance with electrical standards and Federal Aviation Administration regulations, keeping in mind the shadows created from the blades of the turbine and the windiness of the surrounding area. Other ordinances have prioritized not placing too many turbines next to each other, citing esthetic and safety reasons. For construction, NREL acknowledges ordinances that develop rules to limit "esthetic displeasure" caused by the turbine, as well as more technical aspects of the turbine such as restrictions on the arc of the blades, the height, and how much noise the turbine can emit.

The above restrictions are found in nearly every city and county ordinance package that lists regulations on wind energy projects. The strictness of each varies depending on a variety of factors, but there are some that carry across nearly all of them. Namely, signage and appearance, color, and finish, which state that no turbine may carry an advertisement or sign on them and that they be painted a neutral, non-reflective, matte color; white or gray.

Along with NREL's list of suggested ordinances, there are also site-specific laws that could affect micro-wind projects. As listed above, the National Environmental Policy Act of 1969 (NEPA) and the National Historic Preservation Act (NHP) must be taken into account when creating and placing new wind energy projects. These acts require individuals and companies to assess the environmental impact of the project as well as any effect the project could have on locations or buildings of historical significance. As for the flora and fauna, the Endangered Species Act (ESA) and General Wildlife Consultation (GWC) may come into play depending on the chosen location and scope of the wind energy project. Micro-wind regulation encompasses almost every aspect of the project ranging from the planning stage to decommission. In order to grasp the extent to which an individual or company would be subject to these regulations, we look to two counties in the Midwest.

5. Methods

To explore the regulatory environment for micro-wind energy production, we use a case-study to examine which regulations impact the implementation of micro-wind projects. We explore the regulatory environment for a micro-wind energy project from conception to integration into the energy grid of the community, and what steps they need to take to start accessing the energy created. In choosing our case, it was necessary to identify a locale with substantial wind energy potential. With a couple large wind farms in the area, Henry County, Illinois serves as our first and primary example. With that criteria established, we take a closer look at the process

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of implementing micro-wind projects in the county. To verify the extent of the process in Henry County, we look at Swift County, Minnesota, another Midwestern county with high wind energy potential. In both locations, numerous regulatory bodies on the federal, state, and local level have jurisdiction. We also chose counties where cleare regulations in place have a longer history of people seeking to implement renewable energy into their residences. In both cases, the potential for wind energy use is substantial and other non-micro wind generation has been explored.

The cases are different in subtle ways, as detailed in the following sections. The regulations in Swift County are somewhat more lenient, and it is easier to obtain a turbine on the basis of county level regulation, however both counties are faced with the same federal regulatory requirements that limit development. Both cases illustrate that the current regulatory approach significantly increases the costs to entry, in terms of monetary and time costs. These realities discourage people from incorporating micro wind-power on a more widespread scale, potentially defeating the regulatory motivation for a greener energy generation and unblemished environment.

6. Exploring the counties

The regulatory process that must be navigated to set up a small or micro-turbine is nearly equal to installing a large wind farm. All requirements of FERC must be met alongside any state or local regulations. This requirement discourages individuals and communities to undertake smaller non-industrial scale projects, and as a result limits the scope and form of renewable energy in use. By looking at two Midwestern counties, we find that current regulation raises the cost of small-scale wind projects and makes them unlikely to occur. As a result, potential environmental benefits are foregone in the long run.

Henry County, Illinois serves as an important illustration of the regulatory issues. In Henry County wind energy, called Wind Energy Conversion Systems (WECS) in county regulations, even at the micro-level are heavily regulated. As a result, despite having wind potential energy that is high, with an average annual wind speed of 18.86 mph (U.S. average is 16.93 mph), the county is likely not maximizing its potential due to various regulatory requirements [22].

The county ordinances prohibit any wind-energy project to be constructed, operated, or located within Henry County without having fully complied with the regulations. The county goals for the ordinance are to "preserve the health, safety, and general welfare of the public." To begin a WECS project, the applicant must obtain approval from the Henry County Planning Commission (HCPC), a variance from the Henry County Board of Zoning Appeals for any perceived or projected for the WECS project, and an Improvement Location Permit from the HCPC, which is issued by the Zoning Administrator [23]. The initial application for the WECS Commission approved use must include:

- A project summary that includes a description of the project, which entails an approximate generating capacity, potential equipment manufacturer, type of WECS, number of turbines, generating capacity for each individual turbine, maximum height and diameter of the blades and rotors, the location of the project, and a detailed description of the applicant, intentions, and business structures (should the applicant be a business).

- Names, addresses, telephone numbers of applicant, owner, and operator as well as any participating agents and property owners adjacent to any construction related to the WECS.

- A topographic map of the area with an additional mile radius from the WECS project, with contours of not more than five-foot intervals

- A full site plan with appropriate scale (the scale has several additional stipulations listed in the ordinance).

- An additional site plan showing the location of all existing and proposed underground utility lines in the WECS project area.

- Another site plan highlighting the location of amenities such as hospitals, nursing homes, and recreational areas (golf courses, trails, parks, etc.) in the WECS area.

- An agreement to properly train all emergency service agencies (Office of Emergency management, law enforcement, EMS, and fire departments) within Henry County throughout the life of the WECS, as well as addressing safety issues that arise.

- An evacuation plan and zone that complies with local emergency service agencies.

- A projected sound emissions study and map within 8 Hz to 8 kHz for the WECS area performed by a certified sound engineer.

- A small-wind energy project may not require a special use permit if used for exclusively agricultural processes

These requirements are only for the application that gets filed to the HCPC. If a project is to meet these guidelines, they must hire several people to aid them in their quest; someone to topographically map an area of land, a site planner that has the ability to create a scale model of the entire project (this step has another set of rules which make this task even more difficult), bringing in amenities and underground utility lines, and a sound engineer to determine the disturbance level of the WECS.

Once the application has been submitted and accepted by the HCPC, the WECS project is granted a one-year window to act, after which, the application lapses and the applicant must file an extension request (further regulation on what that entails) that may be valid for up to two years. The project may not be started if the applicant has not made a $75,000 deposit into an escrow account to confirm that construction can take place. This deposit may not be used toward any other application fees that are required. If the escrow account dips below the $75,000 mark, then the application is subject to revocation or denial of renewal.

In Swift County, Minnesota, the process to move forward on wind energy projects is very similar to that of Henry County, Illinois. One must apply for Land Use Permits, Conditional Use Permits and Variances which will then be reviewed under the procedures established in the Swift County Code of Ordinances. In the application, Swift County includes mostly the same requirements except they do not require a site plan highlighting nearby hospitals, nursing homes and recreation centers as well as excluding the need for evacuation plans, training for emergency services, and a projected sound emissions study.

As for specific ordinances, Swift County also has fewer restrictions than Henry County. For example, Swift County does not have any spacing regulations relative to other WECS projects, but Henry County does. The county also does not require any access restrictions, which is contrary to Henry County's requirements of a locked barrier or security fence around the WECS. Ultimately, Swift County has fewer regulations on WECS projects, but the process is still long, expensive, and tedious.

There are also regulations *within* the regulations listed above. The site plan must include turbines that are below the height limit, spaced apart appropriately, and with a diameter within the allowed range. The turbines "shall also be new equipment commercially available" [23]. A single new commercial turbine generally costs $1,300,000 per megawatt, and at 2–3 MW in power, that means most turbines cost between $2–4 million dollars [24].

Safety regulations make up a significant portion of both large- and small-scale wind projects, with more attention being paid to large wind farms. A WECS noncommercial turbine may not be closer than 1.5 times the height of the individual turbine from any property boundary lines, roadways, railroad right-of-way, or overhead transmission or distribution lines. This severely limits where a turbine may be placed. For a WECS project, this means that they must buy a large swath of property to produce any amount of electricity, and for residential projects, this impedes their ability to construct any sort of wind generator. The average commercial tower in the United States stands at roughly 280 feet, which means that for a single turbine, one would need a plot of land that is not near a road, railway, or overhead lines, and that is over 420 feet in diameter [25]. For small-wind energy systems, they must be 1.1 times the total tower height away from an occupied structure on a neighboring property and 80% the total tower height or more from an occupied structure measured from the base of the turbine. Small-wind may be located in any zoning map district with both special use and building permits, which require similar application processes as listed above [26].

Failure to adhere to the specified requirements, or violating any of the above may result in a fine of $500 per week if the offense continues without being corrected. If multiple offenses are committed, an additional $500 per week may be assessed per violation.

7. Conclusion

There is a push in congress to deregulate electricity, to open the market to allow for people to choose what their power source will be and allow a wider set of energy production to compete [27]. However, simply allowing consumers more choice in their energy source is incomplete if the regulatory environment stymies the development of innovative generation by insisting on precautionary approaches that treat all projects the same regardless of size, scope or risk. Doing so can only result in unnecessarily high costs to development which will be passed to consumers and as a result reduce the likelihood of them choosing renewable energy.

A London Economics report presented to the Department of International Development and the World Bank included an outline for how to best regulate renewable energy [28]. They suggest that to effectively allow for energy production and innovation:

- Regulation be free from political interference and promote healthy competition.

- Regulation should be maintained at a constant level and not subject to wild fluctuations, and include clear and transparent stipulations.

- Regulation should be suitable for both the cost of the project as well as the financial ability of the applicant and their party.

- Regulation should be formatted to not promote “rent-seeking behavior” by officials and federal agencies.

- Regulation should encourage incentives for developers to ensure consumers’ needs are met in a satisfactory manner.

- Requirements for safety and quality must be enforced to shield both developers and consumers.

The current regulatory minefield one must navigate in any attempt to implement even micro-wind energy does not fit the mold presented in the bullet points highlighted above. In the current energy landscape, the likelihood that micro-wind will be developed further is modest and will remain modest despite specific policies that claim to incentivize renewable energy. These include Renewable Electricity Production Tax Credit, Investment Tax Credit, Residential Energy Credit, and the Modified Accelerated Cost-Recovery System [29]. The stark reality is that federal regulations as well as increasing regulation by state and local governments take many renewable energy projects untenable. As a result, many of the NREL programs which are intended to create avenues for increased renewable energy production instead act to increase the costs and barriers to entry in the renewable energy field, which discourages individuals and companies from entertaining the idea of utilizing the emerging technology.

The increased output of wind energy and small-scale projects have substantial potential to be beneficial in the long-run for more small residential communities as well as more isolated rural communities especially farms. However, if the United States wants to see a sustained increase in renewable energy, one of the simplest and easiest paths to this end is to decrease regulation, specifically by simplifying licensing requirements and regulation. It is difficult to justify the high barriers to entry for small-wind projects because they do not cause the same disturbance that a large-scale project does. They do not utilize the same infrastructure, are more flexible in their deployment, and create fewer negative externalities than larger projects. Those interested in promoting renewable energy would do well to consider the effect regulations have on preventing innovative energy solutions like micro-wind.

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