Researchers model interactions between wind farm developers and landowners

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Wind farms are large, highly technical projects but their development often relies on personal decisions made by individual landowners and small communities. Recognizing the power of the human element in

wind farm planning, Stanford University researchers have devised a model that considers how interactions between developers and landowners affect the success and cost of wind farms.

"I've been doing work on the costs of wind farms for about 10 years and I've found that the soft costs—basically the cost interactions between people—are overlooked," said Erin MacDonald, assistant professor of mechanical engineering at Stanford. "Existing models can tell us how to eke out a little more value by making a blade turn in a slightly different way but aren't focused on the reasons why a community accepts or rejects a wind farm."

In a paper, published June 19 in the *Journal of Mechanical Design*, the researchers present a model that highlights three actions developers could take during this process of landowner acquisition—community engagement meetings, preliminary environmental studies and sharing plans for wind turbine layout with the landowner—and investigates how those actions would affect the eventual cost of the wind farm. The cost analysis suggests that these actions, while contributing to upfront costs, may end up saving developers money in the long run.

With additional input from real-life landowner acquisition case studies, the researchers hope to further refine this model to ultimately increase the success of project implementation and reduce the cost of overall wind farm development.

Quantifying interactions

During the process of planning a wind farm, a developer uses models to predict how much the project will cost versus how much energy it will produce. These models are mathematical formulas that map the relationships between different pieces of a project—such as materials, labor, land and, in this case, interactions between developers and

landowners.

In previous work, MacDonald and her former graduate student and postdoctoral fellow, Le Chen, created a model where they integrated landowner decision-making into a wind farm layout optimization model—which otherwise focuses on what physical layout will produce the most energy. With this model, developers can anticipate and prioritize which landowners will have the most influence on the success of their project. This latest work adds details about other interpersonal interactions throughout the early development process.

"When I worked in the energy industry, the models I used often lacked human input," said Sita Syal, a graduate student in mechanical engineering and lead author of the paper. "We don't deny the rigor of economic or engineering analysis, but we encourage developers to consider the benefits of social analysis as well."

"This work gives developers a framework to evaluate different actions, whereas right now it's hard to compare potential impacts of those actions, for example, how investing in landowner relations stacks up against buying more efficient equipment," said Yiqing Ding, a graduate student in mechanical engineering and co-author of the paper.

To account for soft costs in their model, the researchers had to study and brainstorm different scenarios for the interactions that occur during wind farm development—and their outcomes—and then translate the most crucial details of those interactions into formulas that could integrate with more traditional project analysis models. Their model, which is an initial proof-of-concept, suggests that actions that increase landowner involvement in the planning process lead to more landowners accepting a development contract, and this increase in acceptance would translate to cost savings overall—particularly in cases where they prevent failure of the project.

"The model suggests that taking preemptive actions can improve landowners' acceptance but can also incur cost," said Ding. "Timing is also important: we found that when an action is taken can influence landowner acceptance."

While some developers conduct community meetings and preliminary environmental studies, sharing a layout plan with landowners is rare. Typically, all landowners involved in a wind farm will be given a vague contract that does not actually specify how their land will be used by the final project and, relatedly, how much money they will be paid.

A co-design process

The researchers recognize that making the development process more transparent is challenging and adds to initial expenses. However, they are still optimistic about the potential for innovative, collaborative actions that could ultimately improve the success and value of wind power.

For example, MacDonald suggests that virtual reality mockups of turbine plans might increase landowner contract acceptance, given that previous studies have found that people tend to be more accepting of the appearance of turbines once they see them in place.

"It would almost be like a co-design process between the developers and landowners," said MacDonald. "The developer is including the landowner in the process in a collaborative way by showing them, not just where the turbines would be, but also explaining the advantages and disadvantages of different layouts."

Other options for increasing transparency and collaboration could include making contracts easier to read and giving landowners some choice, such as two alternatives for how their land could be used.

Meanwhile, the proof-of-concept model for landowner acceptance requires continued research and refinement. The researchers are hoping to see more studies of soft costs for wind farms in general and would like to gain more insight into developers' processes—which tend to be proprietary—in order to make the model useful to them.

The best outcome would be that all their painstaking efforts to distill and translate human interaction into mathematical relationships result in a program where a developer could, for example, input the amount of money they plan to spend on community meetings and receive a probability for landowner contracts that is customized to that community.

"We're thinking many steps down the line but someday this could be a tool for creating community-supported sustainable energy infrastructure," said Syal.

More information: Sita M. Syal et al, Agent-Based Modeling of Decisions and Developer Actions in Wind Farm Landowner Contract Acceptance, *Journal of Mechanical Design* (2020). DOI: 10.1115/1.4047153

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