The missing component of energy models: People

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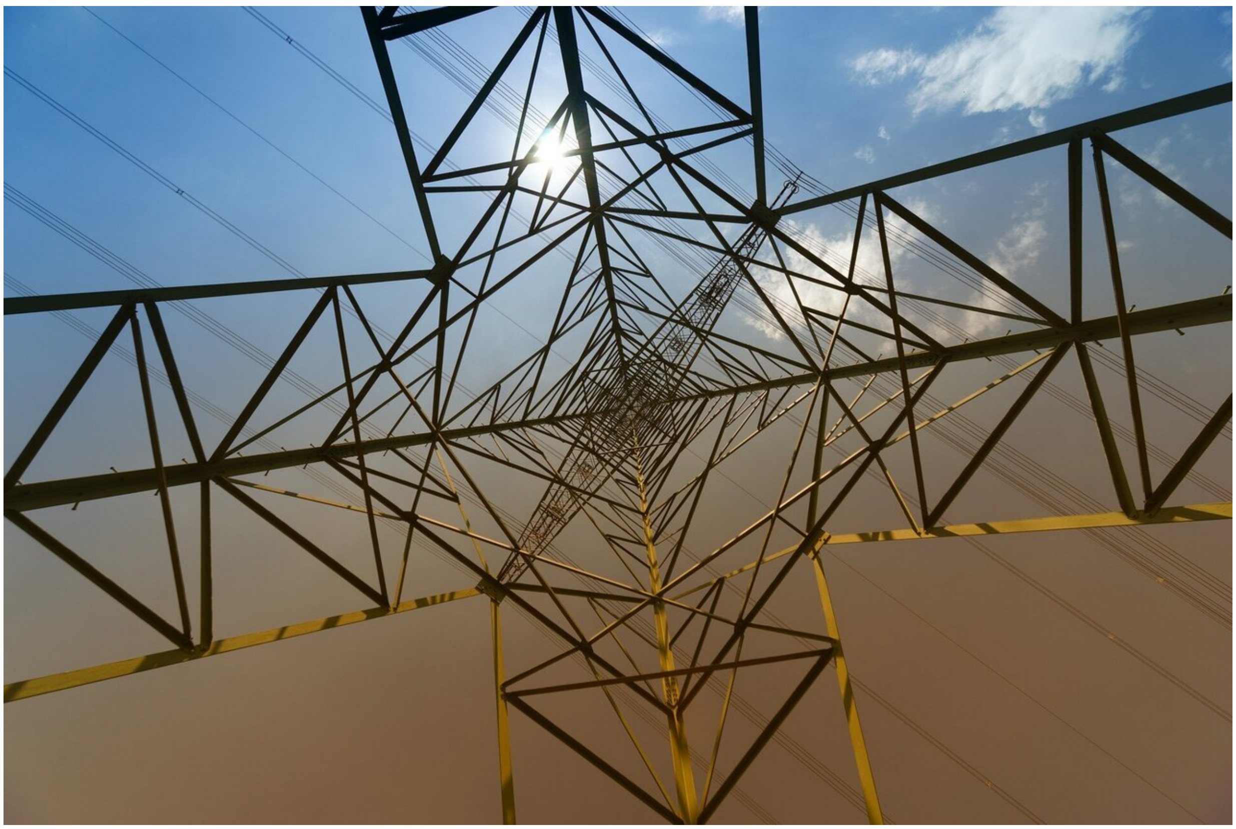

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A team of Carnegie Mellon University researchers led by Turner Cotterman, an engineering and public policy (EPP) Ph.D. student, has shown that sustainably decarbonizing our energy system by 2050 will require us to change the way we model energy transitions and account for the role of public opinion. Advised by Mitchell Small, professor of engineering and public policy and civil and environmental engineering, Cotterman and co-authors use nuclear energy as a case study of how conventional energy models—which minimize system costs—fail at accounting for social acceptance, a factor that can inhibit the deployment of certain technologies, like nuclear energy.

They combined an energy system and risk perception model to evaluate cost, electricity demand, environmental performance and perceived versus acceptable risk at nuclear power plants. Their results indicated that the share of total U.S. energy supplied by nuclear sources would fall from a majority of system generation in a least-cost model, to just three percent in a scenario that incorporates deep decarbonization goals, accident risk perception and public acceptance. The changes in our energy system under this no- or low-nuclear scenario are dramatic, with 97% of the United States' total energy generated by renewable sources.

"If risk tolerance concerns constrain nuclear deployment to socially acceptable levels, deep decarbonization scenarios are up to 11% more expensive than the reference scenario and require low-carbon options to be available and replace the reduced nuclear share," the researchers write.

The authors used nuclear power as a case study because there is a large amount of literature on the subject. However, other technologies may also face public opposition in a low-carbon transition, and the method can be extended to consider these, too. Cotterman and Small were joined in this study by former EPP faculty member and alumnus Ahmed Abdulla, now faculty at Canada's Carleton University, former EPP faculty member Gabrielle Wong-Parodi, now faculty at Stanford University, and Stephen Wilson of the University of Queensland, Australia.

The authors note that nuclear energy, despite being believed to be safe by many technical experts, has faced stiff public opposition. This has driven up costs and has led investors to avoid new nuclear plant construction in the U.S. Yet energy system models that employ least-cost optimization keep deploying nuclear energy, assuming that the least-cost pathways would also be the most socially acceptable.

Failure to understand that our energy system is a complex socio-technical system, defined by interactions between humans and technology, is common. The same can be said of our transportation and agricultural systems. To realistically model the role that technologies might play in the energy transition, the team had to look beyond the least-cost approach of conventional energy modeling and integrate the social sciences—human behavior and perception being key to technology adoption. As Cotterman stated, "Energy system optimization and socio-technical analyses have traditionally been evaluated separately. Our work offers an initial approach to linking these approaches and developing more realistic decarbonization pathways."

The authors modeled several energy transition scenarios. In each case, they compared the share of energy derived from each technology with and without social acceptance as a constraint. In a decarbonization scenario that does not consider public acceptance, nuclear energy would make up 73% of total energy generation, with renewables contributing most of the rest, and costs would increase by 9%. However, factor in social acceptance and nuclear energy's share drops to just 3%, requiring about 97% of our energy to come from renewables in order to reach full decarbonization, and costs increase by 11%.

Policy and energy decision makers need to make greater effort to "integrate public attitudes to energy technologies in large-scale modeling efforts," Abdulla said. "They should also seek to understand the underlying roots of public opposition and resolve them. There is no point modeling an energy transition that is 'least-cost' on paper, but difficult or costlier to implement in practice."

Having shown the crucial role public acceptance plays in actually implementing energy technologies, Cotterman and his co-authors argued that public policy and the energy sector in general must begin to orient toward the public's concerns, rather than omitting them from a situation in which they have a considerable impact.

There are many strategies to address public concerns. One involves confronting misconceptions, especially at their early stages. More important is to build trust by talking to and involving local communities in the planning process. Proper strategizing also means being flexible as analysts understand that some low-carbon technologies simply can't be deployed in certain locations or regions.

Approaches like these constitute a powerful new tool for planning our energy future, though this school of thought still has yet to permeate the industry. Cotterman, Small, Abdulla and colleagues have shown the extent to which social acceptance matters, and that the only way forward is to build energy pathways that are not just techno-economically viable, but also socially acceptable. CMU has long been a leader in the development of theory and applications involving human-technical systems, and this research will likely motivate further advances in this critical topic both here and elsewhere.

More information: Turner Cotterman et al, Applying risk tolerance and socio-technical dynamics for more realistic energy transition pathways, *Applied Energy* (2021). DOI: 10.1016/j.apenergy.2021.116751

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