NEW ENERGY OPTIONS

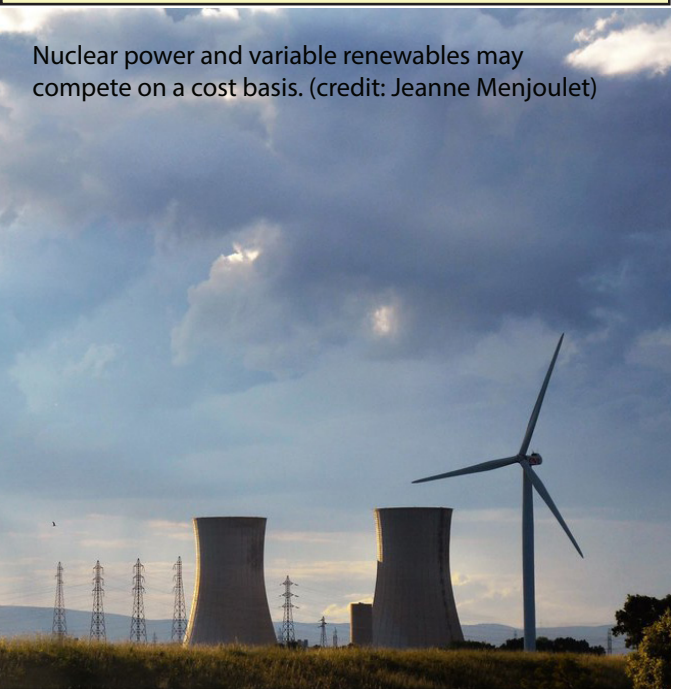
RESEARCH BRIEF

SEPTEMBER 2020

KEY POINTS FOR DECISION-MAKING

For electricity systems powered by high levels of renewable energy -

- **Firm resources such as nuclear power offer benefits. But cost reductions in firm resources could result in a decreased presence of variable renewable resources such as wind and solar in the system.**
- **Firm generators dominated by fixed costs (as are nuclear power plants) would not likely fill gaps between demand and variable electricity generation in a cost-effective manner.**
- **Positive economic return from energy technologies with high fixed costs often depends on high utilization, so these technologies tend to compete for generation.**



Nuclear power and variable renewables may compete on a cost basis. (credit: Jeanne Menjoulet)

Would firm generators facilitate or deter variable energy in a carbon-free electricity system?

To mitigate impacts of climate change, countries across the world have set ambitious goals to reduce greenhouse gas emissions. These policy decisions may lead to early investment choices that support particular technologies for low- or zero-carbon electricity production over alternatives. While a diversified resource portfolio provides system benefits, technologies within an electricity system could compete with each other on a cost basis, especially when the technologies have similar technological and economic characteristics.

As penetration of firm, zero-carbon resources, such as nuclear power, and variable renewable energy, such as wind and solar, increases in the electricity mix, the "baseload" and "gap-filling" roles traditionally played by fossil fuel generation have also become more fluid. These nuances in electricity system planning need to be considered when policy making addresses a goal to transition to a reliable, affordable, and deeply decarbonized electricity grid.

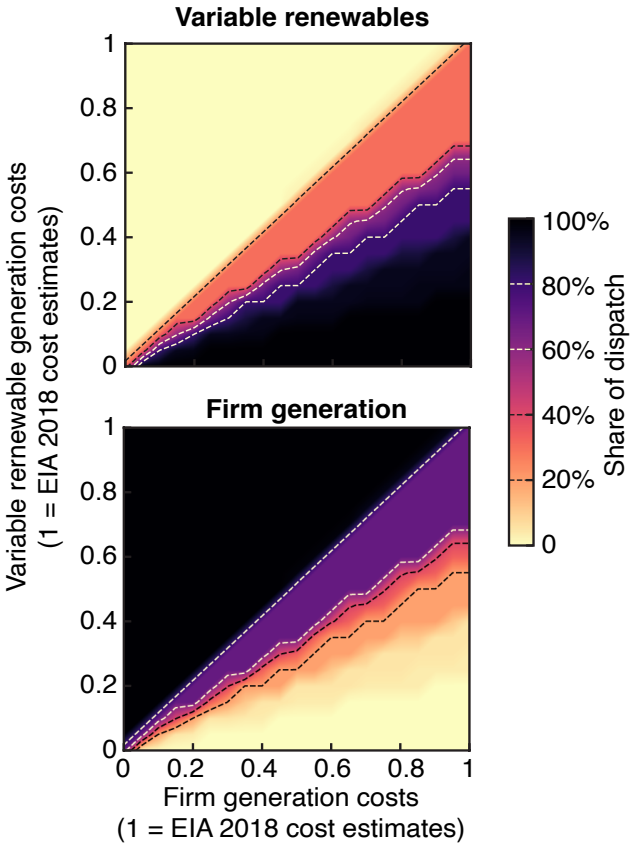
We used a simple and transparent electricity system model, considering only geophysical and technoeconomic parameters, to demonstrate the fundamental dynamics between firm generators and variable renewable generators in a least-cost, fully reliable, and carbon-free electricity system.

Summary

In an idealized electricity system constructed without existing assets, firm generation technologies and variable renewable energy compete on a cost basis. As the cost of firm generation decreases, the penetration of firm generation increases in the generation mix. Similarly, as the cost of variable renewable energy decreases, the penetration of variable renewable energy increases.

Many existing firm, zero-carbon generation technologies can be capital-intensive. Flexible operation of these technologies can support grid reliability, but often implies infrequent utilization, and thus may not provide sufficient revenues to justify investments in these projects.

In addition to diversifying the technology portfolio in an electricity system, it is equally important to diversify the functions of these technologies, to maximize benefits both to the system and to individual technologies. Creative solutions in energy innovation, project finance, market structure, and policy design can all help the electricity grid effectively transition to a zero-carbon future.



Shares of dispatched electricity as a function of cost. Reductions in the cost of firm electricity generation decrease shares of variable renewables in the generation mix. Similarly, reductions in the cost of variable renewables decrease shares of firm generation.

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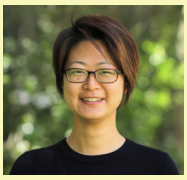
ABOUT THE AUTHORS



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A solar PV farm generates electricity in California, U.S. (credit: Steve Davis)

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