CARNEGIE SCIENCE

KEY POINTS FOR DECISION-MAKING

- **Oahu's costly electricity system enables a cost-effective transition to wind and solar generation.** Oahu's reliance on imported petroleum fuels for electricity creates extremely high costs. Many islands experience this situation.
- **Land use of a fully renewable system in Oahu would be large but may be feasible.** Trade-offs that reduce land use may increase system costs.
- **Hydrogen storage reduces the cost and land use of a wind-and-solar-reliant electricity system for Oahu.** Hydrogen storage saves energy over long durations, allowing it to be used during resource droughts, decreasing the need for wind and solar capacity.
- **Switching to wind, solar and storage may lower electricity costs in areas that generate electricity using oil.**

Photo: Luke McKeown

RESEARCH BRIEF

Switching from CO_2-emitting oil to carbon-neutral wind and solar can reduce electricity costs on islands

Electricity costs in Hawaii are the highest, and carbon dioxide emissions per kWh are among the highest, in the United States.We explored the cost-effectiveness and climate benefits of reducing the reliance of Oahu on imported petroleum for electricity generation.

The potential for Oahu to meet its electricity needs using wind and solar generation paired with both short- and long-duration energy storage was explored using a macro-energy model. The investigation showed that a transition to a wind-and-solar-reliant electricity system could lower electricity costs compared to Oahu's current petroleum-based system.

A wind-solar-battery system would cost $0.25 per kWh, while the petroleum system's costs ranged from $0.21 per kWh to $0.30 per kWh from October 2022 through September 2023, fluctuating with the cost of petroleum fuel. This renewable system would require 332 km² (21%) of Oahu's land.

To further reduce costs to $0.17 per kWh, and to decrease land use to 265 km² (17%), we combined hydrogen energy storage (a long-duration storage technology) with short-duration battery storage.

This research suggests that other isolated regions with similar energy profiles and a reliance on imported petroleum fuels for electricity could also benefit from switching to wind-and-solar-generation combined with both short- and long-duration energy storage.

Research summary

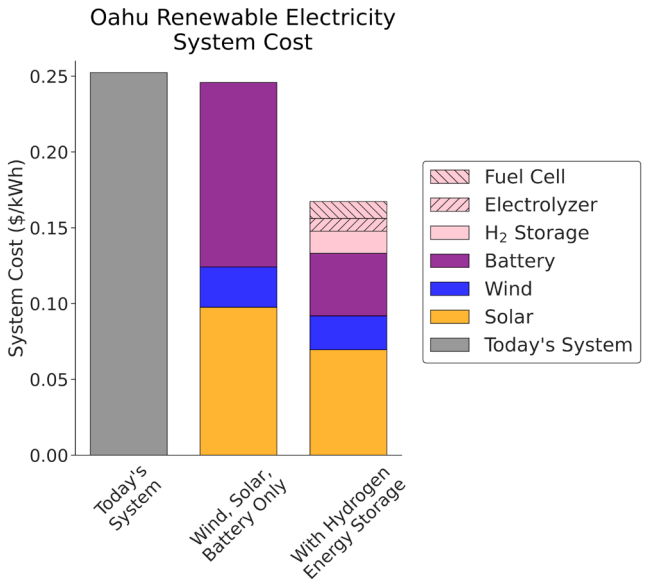

Fig. 1. Costs for least-cost electricity systems. The cost of a 100% reliable wind, solar, battery system is comparable to the average cost of today's petroleum-dominated electricity system on Oahu. A system that also incorporates hydrogen energy storage for long-duration storage drastically reduces the cost of a fully reliable, renewable electricity system for Oahu.

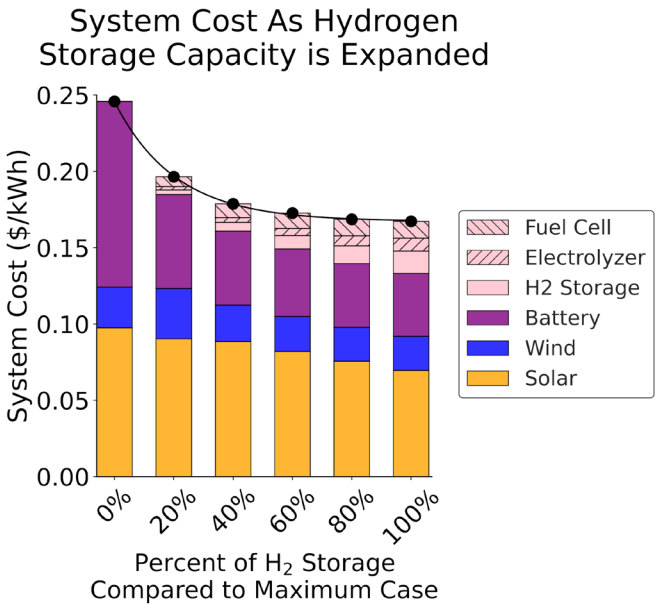

Fig 2. Costs for least-cost systems with constraints on hydrogen storage capacity. The greatest reduction in system cost occurs from the initial deployment of hydrogen storage capacity (from 0% to 20% of the hydrogen capacity built in the unconstrained case). Inclusion of even small amounts of hydrogen storage greatly decreases the system cost.

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