Oxy-fuel combustion: A threat or an opportunity for solar?

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OBJECTIVE

Evaluate the impact of oxy-fuel combustion on solar PV deployment in grids with high renewable energy penetration.

BACKGROUND

- Variable renewable energy poses challenges for system operators due to supply-demand imbalances and increasing curtailment; carbon capture and storage technologies like oxy-combustion may help overcome these challenges
- California's grid, with high solar PV penetration and ambitious decarbonization goals, serves as a case study for evaluating oxy-combustion deployment

METHODS

Oxy-fuel combustion

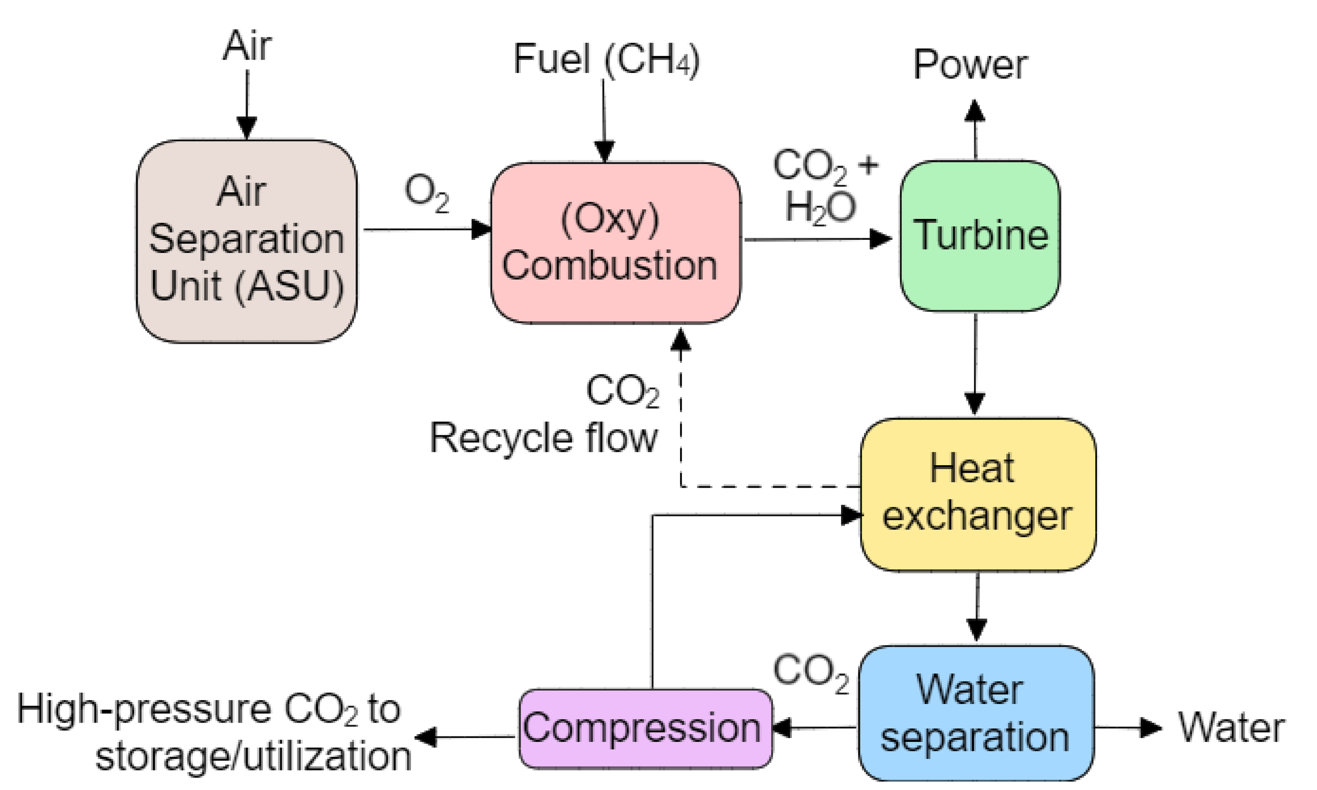
$$CH_4\,(\text{fuel}) + 2\,O_2 \rightarrow CO_2 + 2\,H_2O$$

Instead of air

+ Simplified carbon capture: High-purity CO_2 stream obtained
+ NO_x production is significantly reduced

Promising oxy-combustion design: **Allam Cycle by NET Power**

- High-pressure CO_2 is used as working fluid in a closed-loop cycle, retaining all emissions
- First utility-scale project of 300 MWe operational in 2026, in Texas (NET Power, 2023)



Simplified diagram of Allam Cycle by NET Power

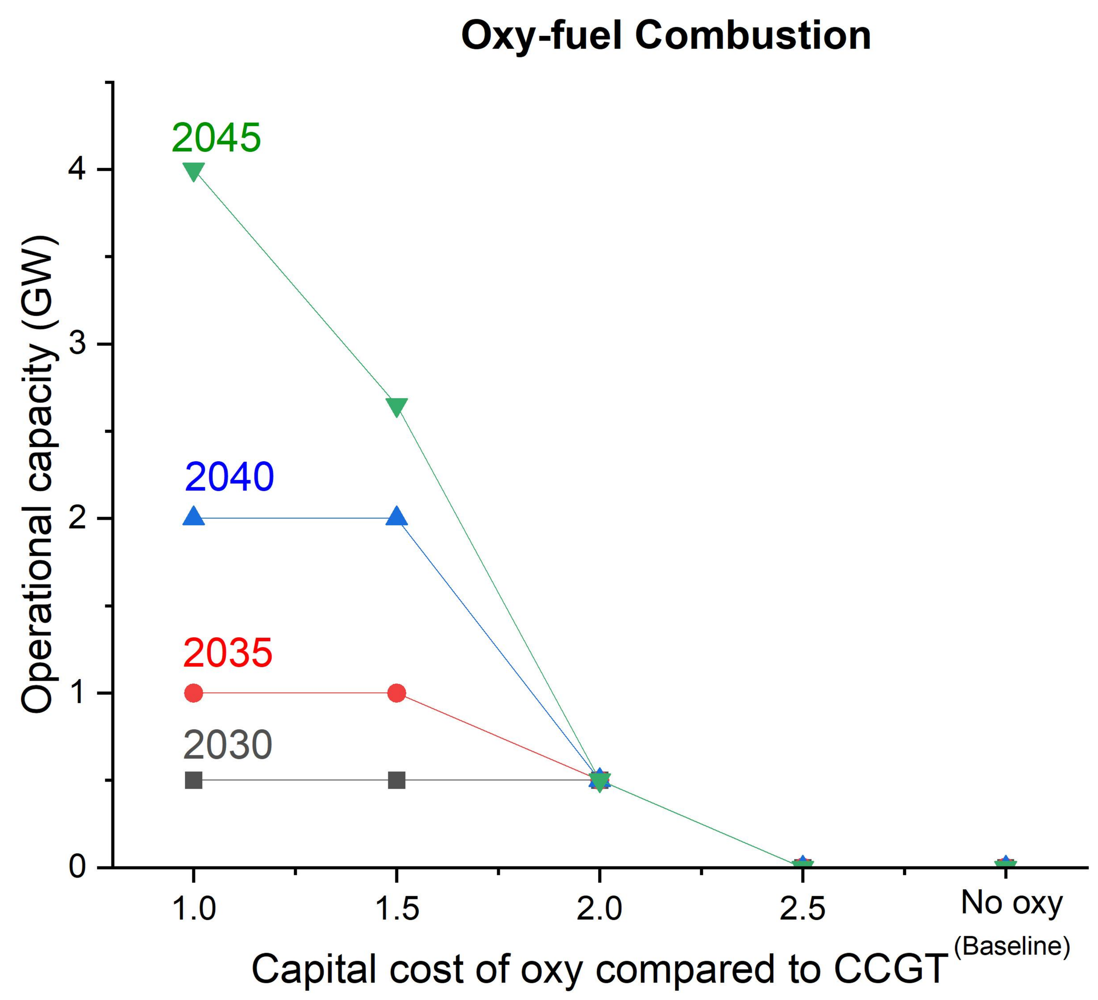
- RESOLVE, a capacity expansion model, was used to simulate California's grid from 2030 to 2045
- "Baseline" scenario (*without oxy-combustion*) used California's Preferred System Portfolio

Plausible scale up for oxy-combustion in California

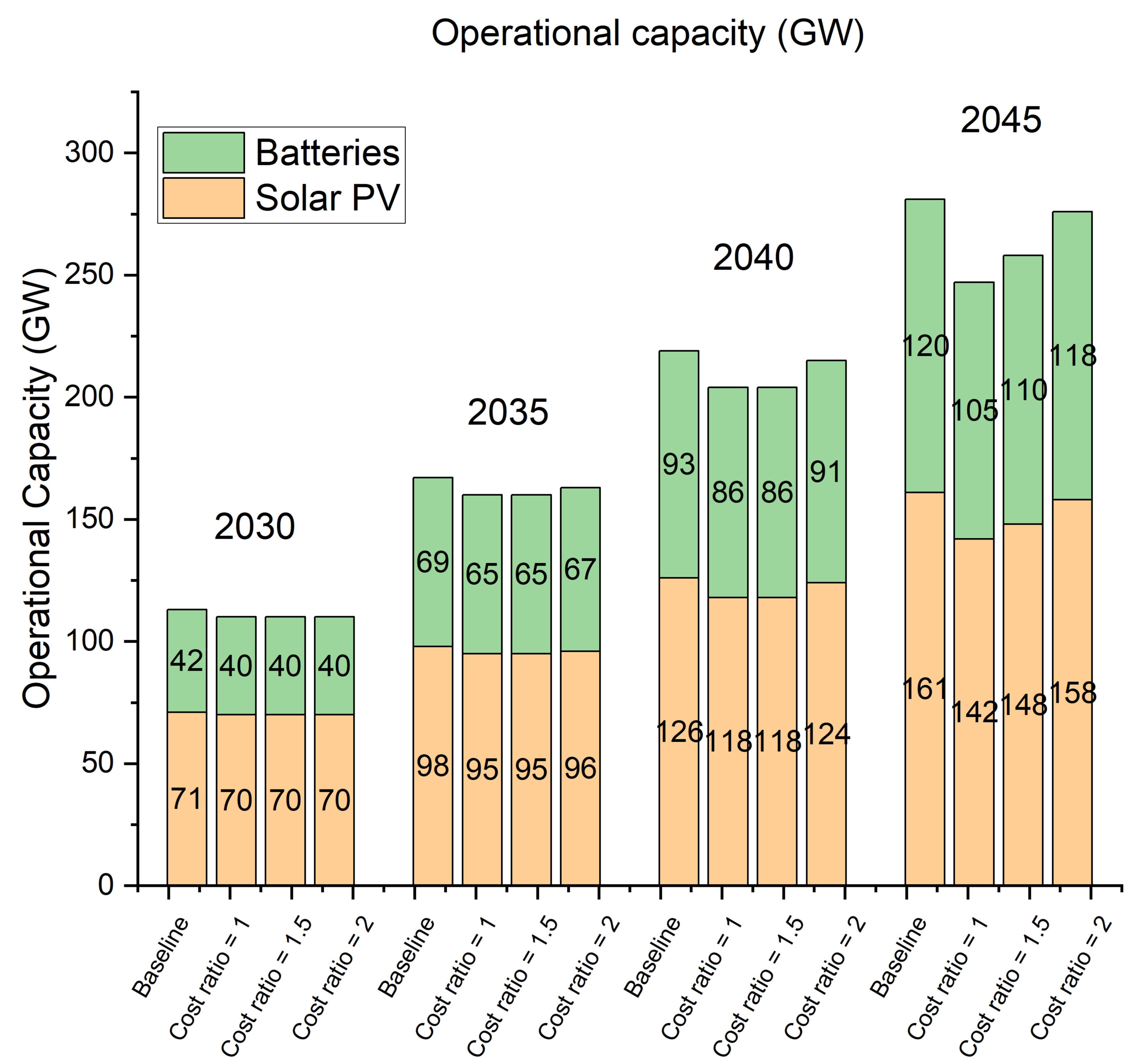
Year	Maximum Operational Capacity (GW)
2030	0.5
2035	1
2040	2
2045	4

- The cost range considered was from 1 to 2.5 times combined cycle gas turbine (CCGT) cost

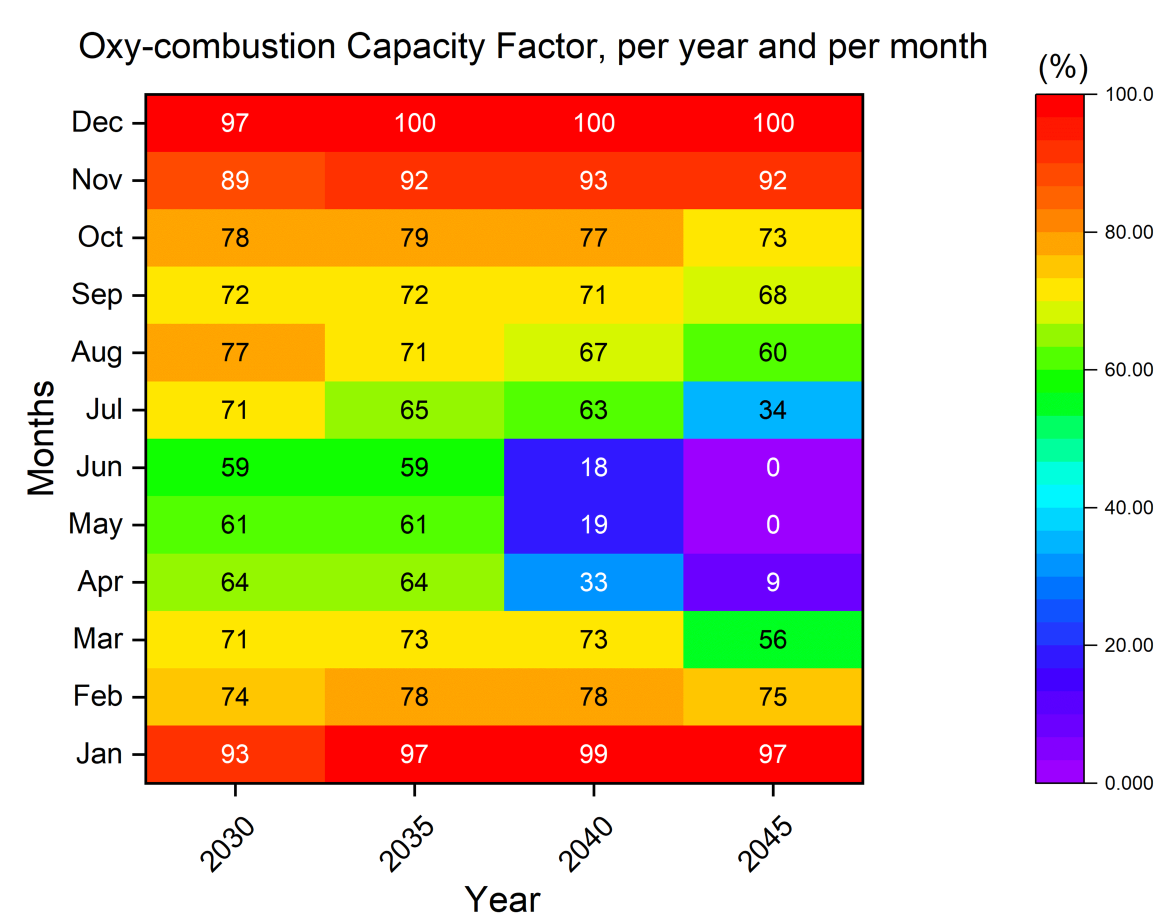
RESULTS AND DISCUSSION



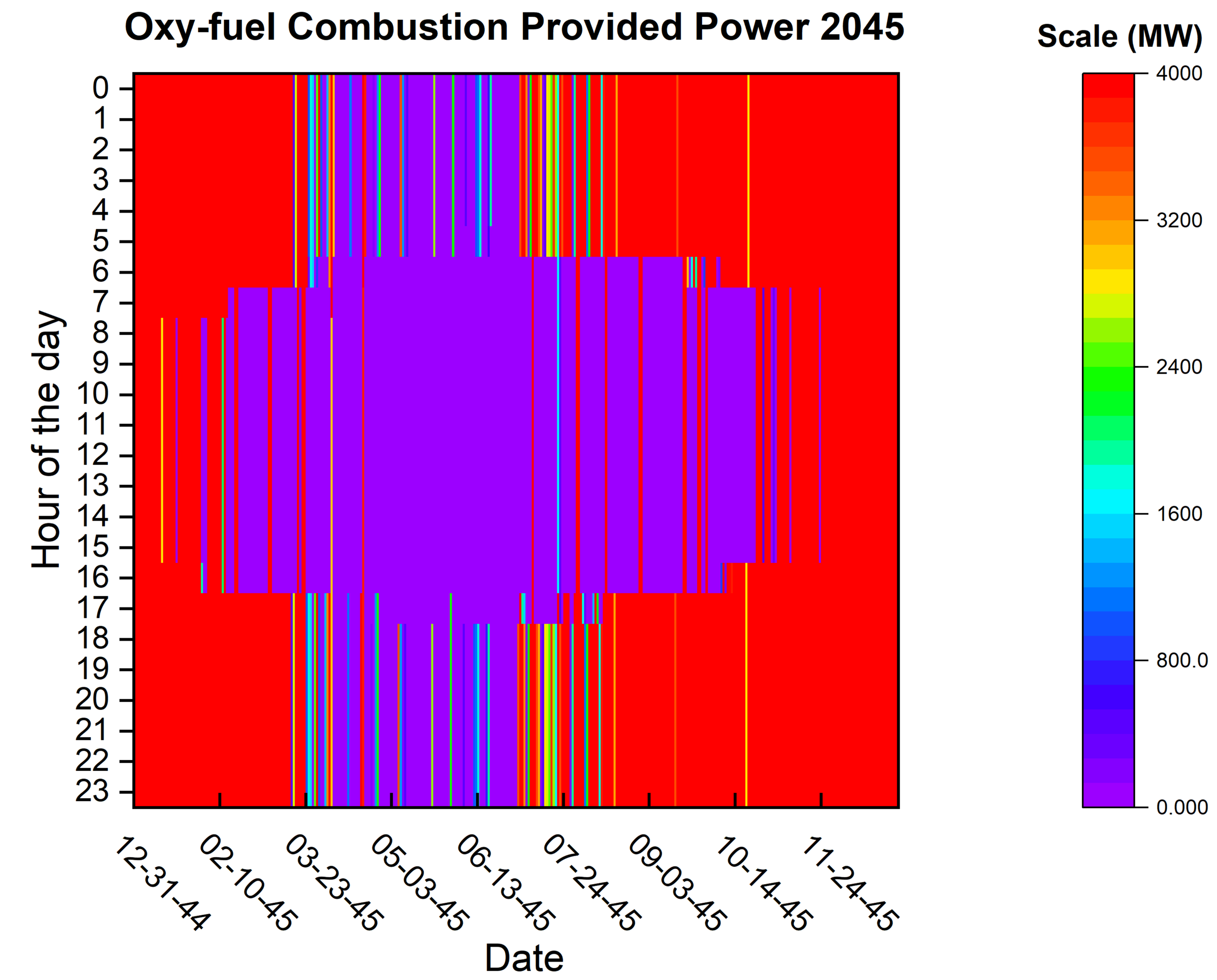
- When the cost is equal to combined cycle gas turbine, oxy-fuel is built to maximum operational capacity offered



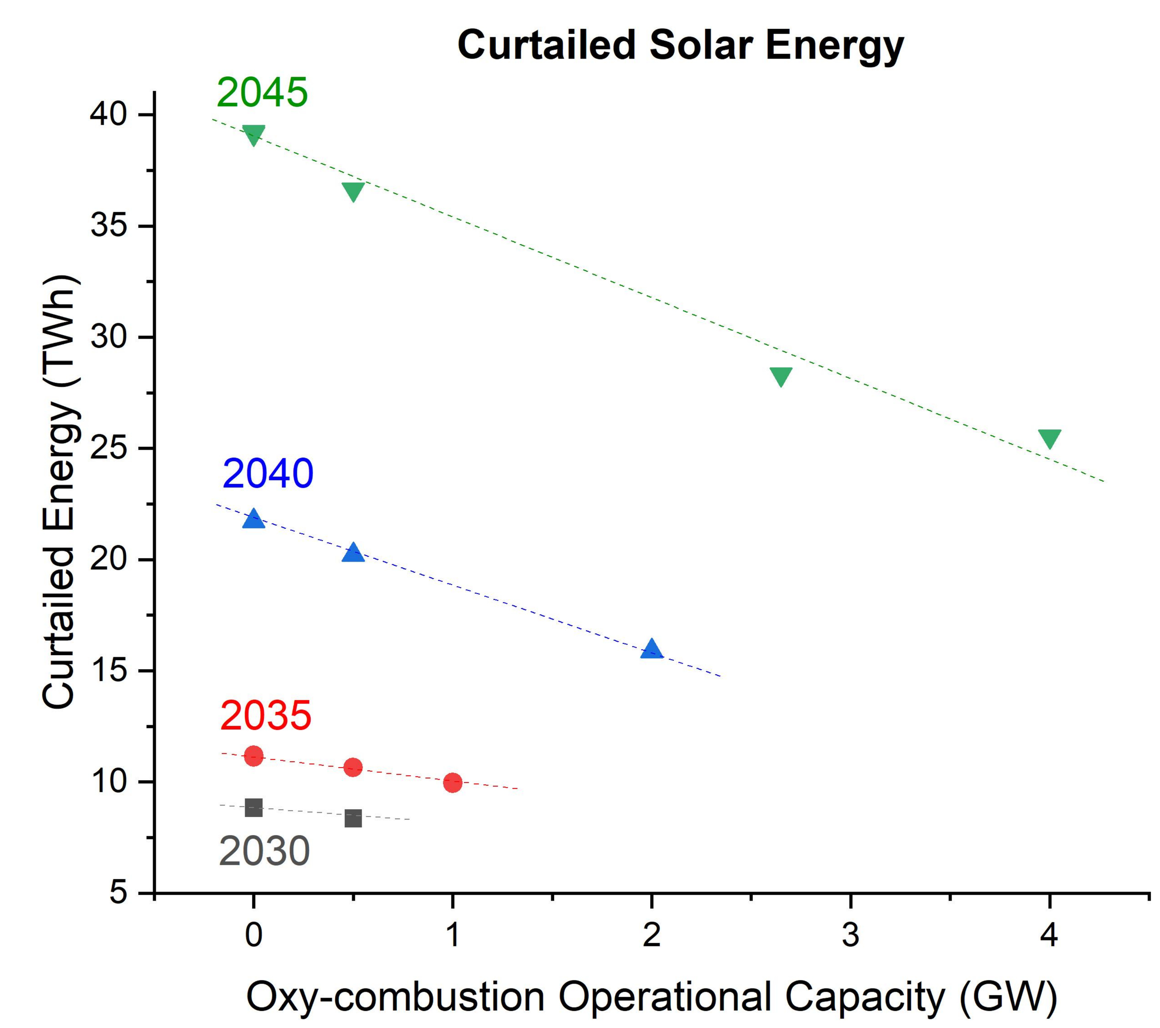
- Solar PV and batteries capacities are reduced when oxy-combustion is being selected, even at limited scales



- Higher capacity factors are selected in winter
- For spring and summer months, capacity factors are lower and reach 0% for May and June in 2045



- The use of oxy-combustion complements solar availability



- Reducing solar PV capacity for meeting winter supply-demand imbalance reduces curtailment

CONCLUSIONS

- Oxy-combustion could reduce solar energy curtailment by up to 35% in 2045
- Oxy-combustion reduces the immediate need for batteries and solar, easing the transition and complementing solar development

ACKNOWLEDGMENTS

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