EPRI

P201 Back Pocket Insights

## KEY INSIGHTS

- **Net zero energy systems may rely on high fixed-cost resources** including wind, solar, and battery storage.
- **High fixed cost resources may recover most of their revenue in energy markets** despite being revenue positive on the margin at near-zero prices.
- **The opportunity cost of capacity investment and dispatch may lead to non-zero price hours at any time without curtailment**.
- **Systems with overbuilt renewables may have significantly more curtailment** and therefore more zero-price hours.

This brief is based on the EPRI 201-D deliverable: "Opportunity on the Margin: Electricity Prices Under Deep Decarbonization"

# Opportunity on the Margin: Electricity Prices Under Deep Decarbonization

by Geoffrey Blanford & Chris Roney

In current power systems, wholesale electricity prices are typically set by the variable cost of the marginal generating unit, though pricing reflects many factors, including cross-temporal and product opportunity costs, degradation, shortage and congestion pricing, and forward markets. **Systems relying more on variable renewable energy and battery storage are characterized by higher fixed costs and lower variable costs.** How electricity prices could shift in response to these changes remains uncertain and could be affected by resource characteristics, market design decisions, demand and demand response, and reliability constraints, among many other factors.

This study investigated the LCRI Net Zero 2050 All and Limited Options scenarios for their modeled effects on price formation and revenue recovery through energy and capacity markets.

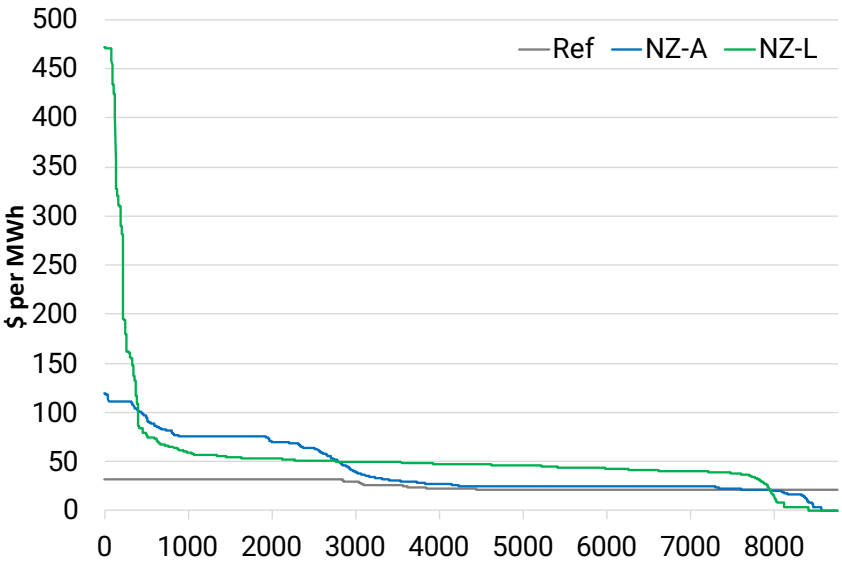


**Figure 1. Sorted Hourly Energy-only Prices under Reference, NZ All Options, and NZ Limited Options**

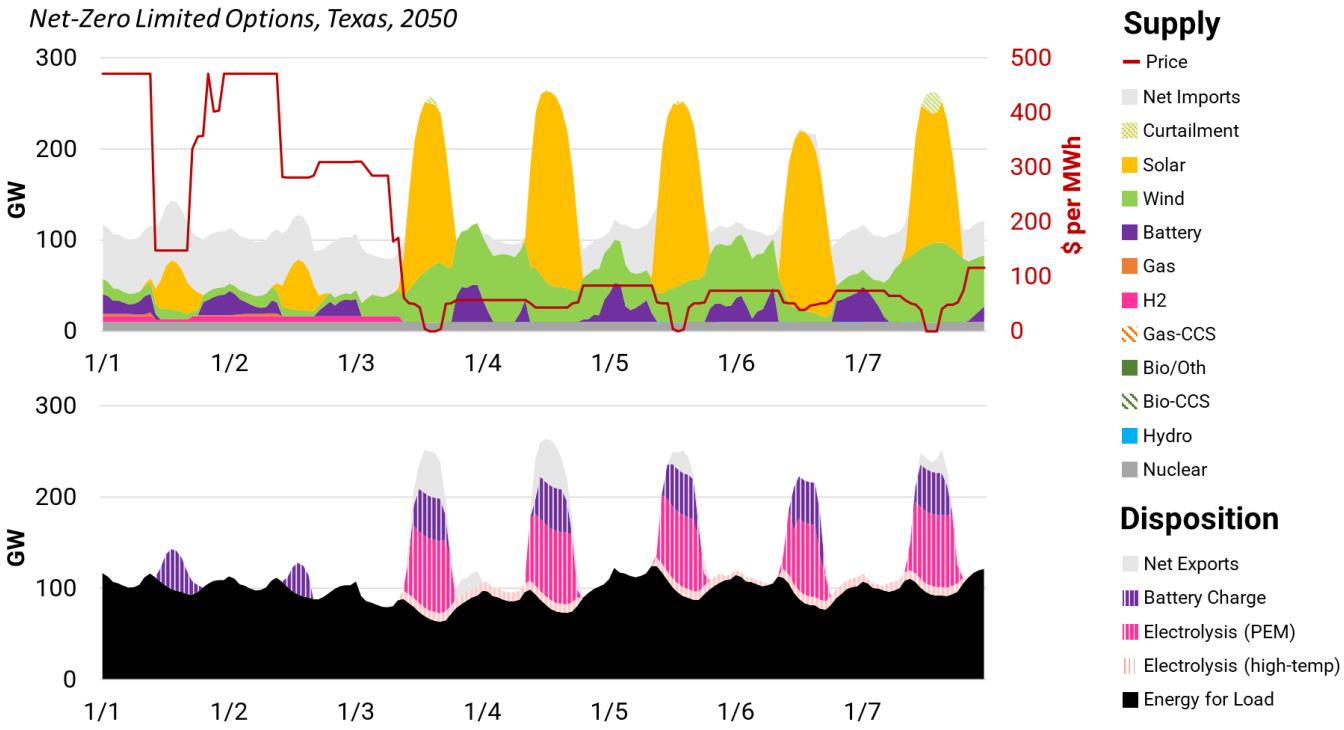


**Figure 2. Regional supply and disposition of load for one week in Texas in 2050 under Net Zero Limited Options Case. Marginal wholesale energy market price shown in red.**

Modeling net zero energy systems can illustrate some of the potential uncertainties in future electricity prices:

- **Net zero energy systems may have higher peak prices and more zero-price hours.** Carbon prices increase variable costs for dispatchable resources and deployment of zero-variable cost renewables, leading to a wider price distribution (Figure 1).
- **The opportunity cost of battery** charge and discharge **and hydrogen** production and **may drive modeled energy prices** in many hours (Figure 2).
- **Zero price hours coincide with voluntary curtailment** of wind and solar (Figure 2).
- Modeling **a modestly overbuilt system** (5% additional renewables), **shows many more zero-price hours** (see full report), indicating that anticipating load requirements and generation profiles remain important.
- **Capacity market prices reflect the annualized cost of a combustion turbine** at ~$52/kW-y, though the shape of payments to those resources depends on scenario (see full report).

While modeled price dynamics may differ from actual market operations, model results showing sustained non-zero energy prices in a system consisting primarily of renewables and storage reflect the implied opportunity cost of storage dispatch and capacity investment. The uncertain shape of energy prices in a deeply decarbonized energy system raises questions about how various resources may bid into energy markets, how those markets may be redesigned, and how systems can maintain both sustainable revenue and reliability.

## FOR MORE INFORMATION

Read the full report: EPRI (2024), "Opportunity on the Margin: Electricity Prices Under Deep Decarbonization." *3002028541*.

## CONTACT

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