

Markets, Planning, and the Clean Energy Transition

Why the case for liberalized markets is stronger now than it was 30 years ago

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UC Davis and NBER

Where I'm going

1. Why we liberalized in the first place — and what the argument really was
2. Reliability and capacity: the last redoubt for regulatory planning
3. Three shocks that have remade the industry in ten years
4. Why efficient pricing matters *more* now, not less
5. How the reliability-planning paradigm is straining from the new shocks
6. Some closing principles

The case for liberalization, 30 years ago

Liberalization: What is it?

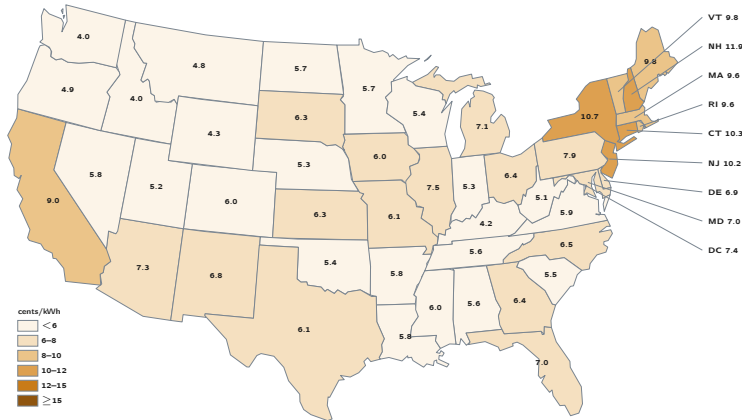
- In many parts of the world it means **privatisation** of state-owned monopolies.
- Vertical **separation**. Independent transmission companies provide open access.
- **Retail** competition is a mixed bag in many parts of the world.
- Generation shifts from **cost based** to **market based** compensation.
 - Market prices set payments for deregulated generation; value based vs. cost-based.

The core argument was as much about investment as operations

- Bring the discipline of the market to **big-money, long-lived, irreversible** investment decisions.
- Don't leave those decisions to a process that can be *misinformed* — forecasts, technology bets, fuel prices — and/or unduly *politically motivated*.
- Efficiency gains at existing plants were a bonus. The main prize was changing *who decides* and *who pays if the decision is wrong*.

This framing matters for the rest of the talk: if you accept it, then the value of markets rises and falls with how much building is going on.

Same technology, same rules, different results



All sectors. US average 6.7; range 4.0 to 11.9. Nearly three to one, across states running the same technology under the same regulatory doctrine.

Reliability and capacity: the last redoubt of regulatory planning

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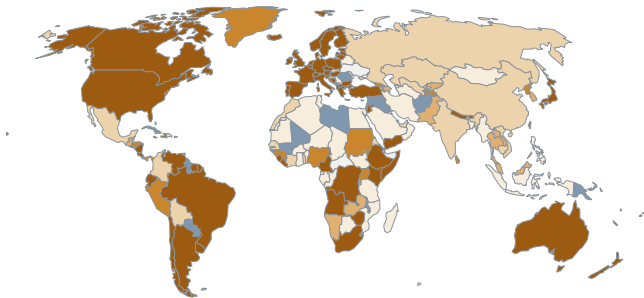
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- Line between **energy** and **capacity** was always blurry.
- This boundary is now completely fuzzy — one of the most contested boundaries in electricity policy these days.

Three shocks in ten years

Shock 1 — renewables get really cheap

- Wind and solar have gone from policy-supported niche to the default new-build option across most of the world.
- Two consequences that matter more than the cost number itself:
 - **New players.** The investor base is broader and less utility-like.
 - **Smaller scale.** Especially distributed solar — projects measured in kW, not hundreds of MW.
- And the supply curve changes shape: large blocks of **zero marginal cost** capacity, available only when the weather says so.

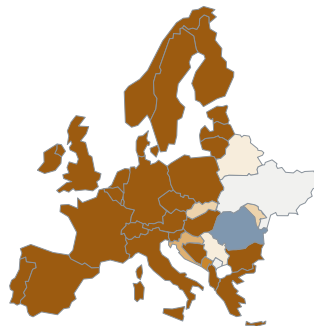
Where the new electricity came from, 2014–2024



Renewables' share of the growth in generation:

■ covered *all* growth and displaced other sources ■ 75–100%

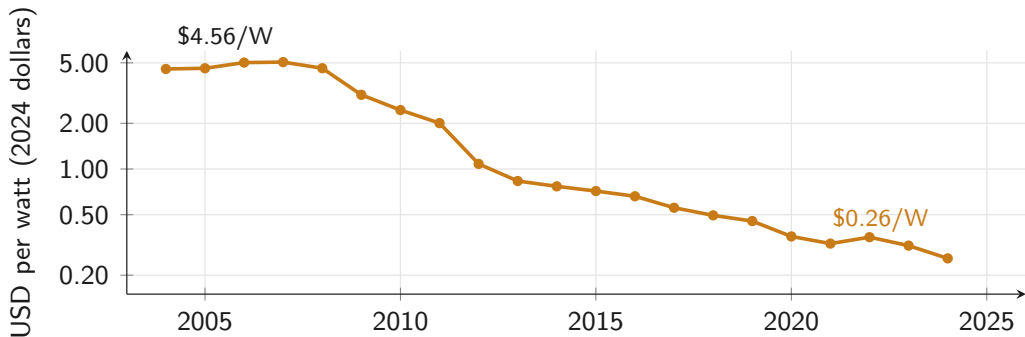
■ 50–75% ■ 25–50% ■ 0–25% ■ renewables fell ■ no data



Europe, enlarged

In 73 of 194 countries — the US, Germany, Japan, Brazil, Australia, NZ — renewables supplied *more* than all the growth.

The cost collapse behind all of it

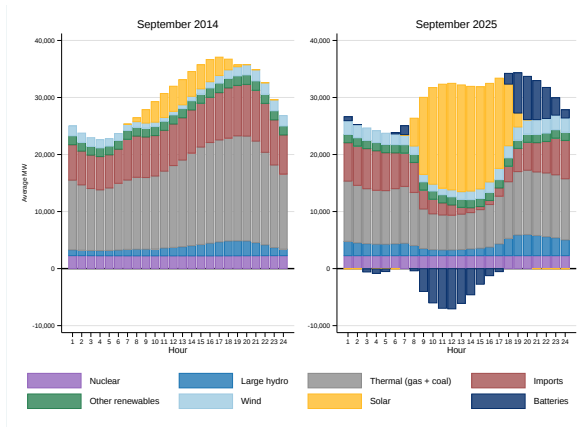


Crystalline-silicon PV **module** price, constant 2024 dollars, log scale — down **94%** in twenty years.
Modules are now about a third of a utility-scale project, so installed cost per MW has fallen less steeply.

Shock 2 — batteries get cheaper

- Batteries neutralise several of the properties that always made short-term electricity markets fragile: no demand response, no ability to shift energy across hours, violent price behaviour at the margin.
- Storage is **modular** and **fast** — deployable in small increments on timescales conventional generation cannot match.
- It is also the resource that most thoroughly **blurs the line between energy and capacity** — which is where the second half of this talk lives.

And they are already doing real work: California

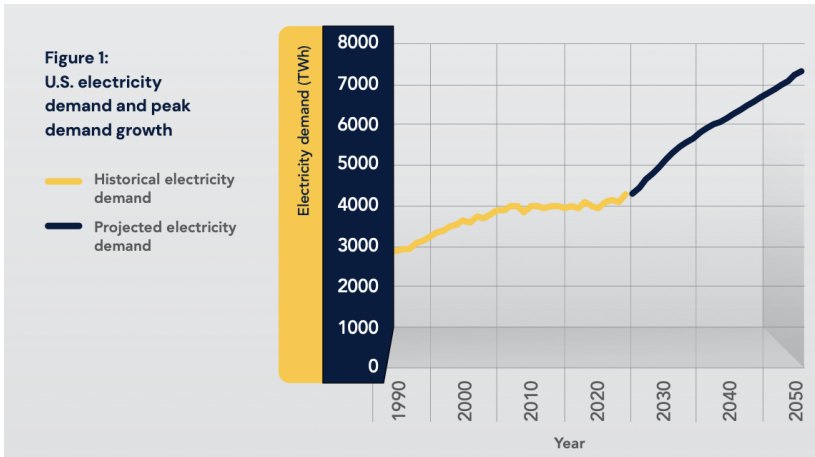


Average hourly generation, CAISO. By 2025 batteries **charge** through the solar peak — the negative bars — and **discharge** into the evening ramp.

Shock 3 — demand growth is back

- Roughly twenty years of flat load in the US and much of Europe has ended: data centres, transport electrification, process heat.
- That changes the stakes of everything in Part 1. When nobody is building, “who bears investment risk?” is a hypothetical question.
- Current fight is whether incumbent loads have “a right” to lower prices if the new loads are the ones that trigger the scarcity.

Demand growth in one picture



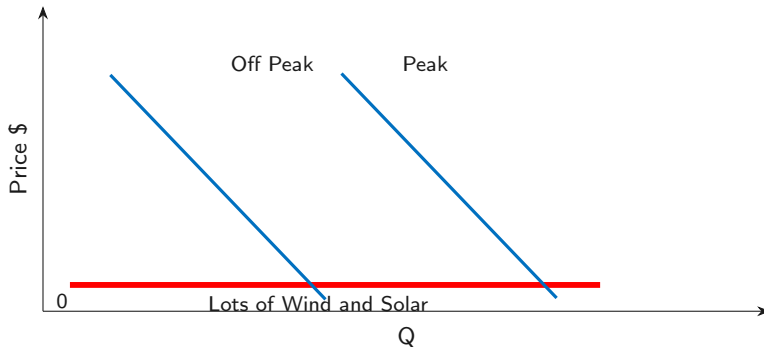
Two decades of essentially flat demand, and then a projection that bends sharply upward. Whatever you make of the forecast, it is the number everyone is now planning against.

Why efficient pricing matters more now

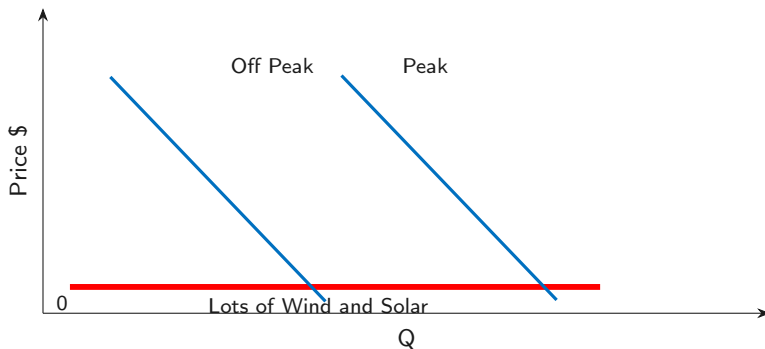
A common argument

- “Zero-marginal-cost, intermittent, weather-driven supply means electricity **spot** markets can no longer do the job. We need to expand the role of planners through capacity markets or obligations.”
 - You hear versions of this in the US, in Europe, in Australia.
- **My argument**
 - Each of these three shocks makes market incentives **more** valuable relative to planning, not less.

Is electricity the internet?

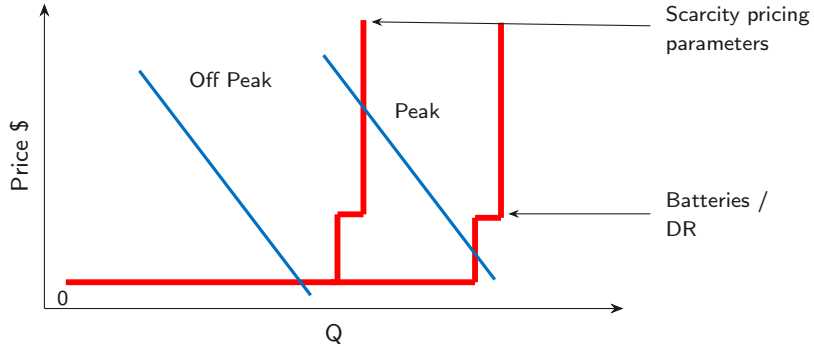


Is electricity the internet?



- No! Renewable generation has **Capacity Constraints**, Digital content does not.

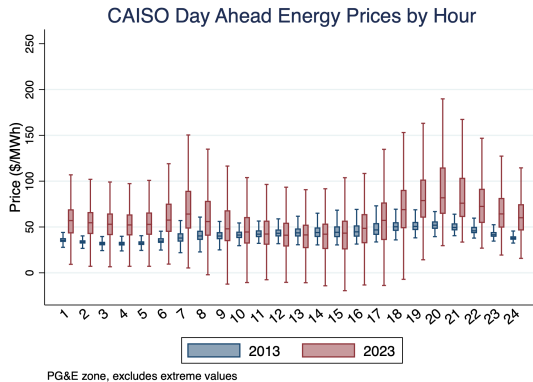
...and that is why scarcity pricing matters more, not less



The efficient price is heading for the extremes (in most of the world)

- With a lot of wind and solar, the efficient price is **zero** for a growing number of hours — and there is nothing wrong with that.
- The rest of the time it is set by some form of **scarcity**, not by the fuel cost of a marginal thermal plant.
- The comfortable middle — price $\approx$ the running cost of a gas turbine — is the part that is disappearing.

Energy prices are more volatile

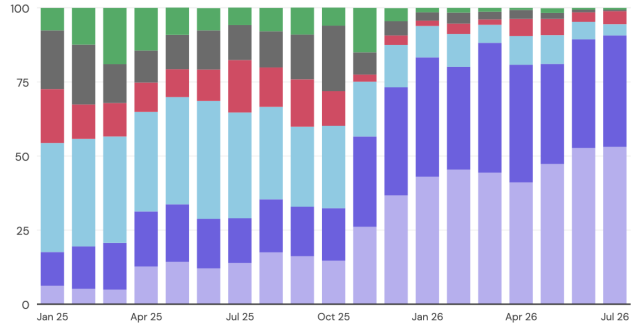


CAISO day-ahead, PG&E zone. The **level** barely moved from 2013 to 2023; the **spread** within each hour exploded.

Demand or batteries are already setting the price most of the time in some places

Share of dispatch intervals (%)

Batteries (charging) Batteries (discharging) Gas Gas peakers Coal Wind & solar Other



Source: AEMO WEM dispatch case data, Modo Energy

Note: Technology of the offer tranche closest to the clearing price; charging offers are withdrawal tranches. Batteries average 84.8% in 2026, against the ERA's 86%.

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- Today: wind, solar, four-hour storage, eight-hour storage, demand response, geothermal, peakers, interconnection, efficiency — at every scale from the transmission grid to the roof.
- Each with different risk, duration, siting, and correlation properties.

The planning paradigm under strain

Capacity and Resource Adequacy Obligations

- Many electricity markets utilise some form of mechanism that compensates suppliers to provide **capacity or reliability**, in addition to compensation for generating energy.
- This kept a role for planning, and helped assuage concerns over the shortcomings of energy price signals.
- Also justified (by) more aggressive ceilings on spot energy prices
 - If political pressure restricts energy prices, capacity and reliability payments can make up the “missing money.”
- But this model is facing strain in the face of the three technology shocks.

Points of disillusion from the US experience

- One-year streams of **hedging or capacity payments** do not finance investments.
 - Even if they are locked in three years in advance.
 - Vertical integration and/or hedging is still necessary, RA contracts can crowd out other hedging.

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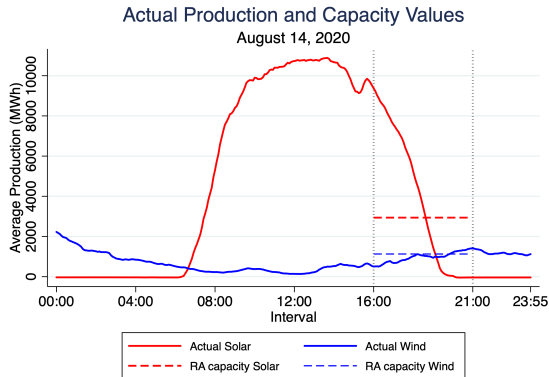
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- Firms keep buying the “wrong” capacity — the cheapest qualifying **firm capacity** is rarely the planner’s preferred resource.
- **Firm capacity** correlates only loosely with delivered reliability.

The counting problem, and what it attracts

- Before anyone can discharge an obligation, somebody must *rate* what counts: how many “firm” MW is a wind farm, a solar farm, a four-hour battery, a demand-response programme, a gas plant that breaks down?
- The standard answers — capacity factors, ELCC — look at historical output over a chosen window.
- Complex, opaque, consequential, and therefore extremely vulnerable to lobbying. The rating formula becomes the policy.
- The only reliable way to measure the reliability contribution of a resource is to measure its output in the moment.
 - This is exactly what spot energy prices are designed to do.

What strain looks like: California



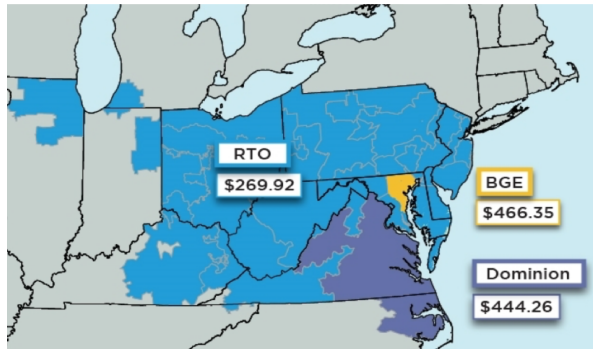
The day of the rotating outages. What wind and solar were **rated** at through the 16:00–21:00 net peak, against what they delivered.

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What strain looks like: PJM

- Capacity prices clear at roughly **ten times** their 2022 level.
- Constrained zones clear far above the rest of the pool.
- The capacity market is facing its first test of whether its version of scarcity prices can spur investment.



States threaten to leave PJM without expanded role in grid operator

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Remember When Capacity Markets Were the Solution to Missing Money?

Closing principles

Summary: The three technological shocks of the last decade

1. A dramatic decrease in the cost of renewable energy.
2. An even more dramatic — and more surprising — decrease in the cost of battery storage.
3. The return of load growth.

New Zealand is well positioned to take advantage of these trends

- **Hydro backbone** provides an ability to integrate large amounts of variable renewable sources.
- **Batteries** can help manage remaining local and extreme swings in output and demand.
- During **normal years** these attributes can make the system a globally attractive source of green energy.
 - Ample capacity and resources to prevent reliability problems during **dry years**, but prices inevitably rise.
 - Question remains: are requirements that will raise prices during normal years justified by the hypothetical benefits they might provide during dry years?

Keep decision making authority as close as possible to the people with the strongest incentive to get the decision right.

Three decisions that belong with whoever bears the risk

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The downside of replacing choices with standards

- An aluminium smelter, a data centre, a dairy processor, and a household have wildly different tolerances for price risk and for interruption.
- A single reliability standard, or a single regulated tariff, has to pick one answer and impose it on all of them.
- Whatever it picks is too much reliability for some and too little for others — and the cross-subsidy runs in a direction nobody chose and few can see.
- Markets are not better because they are tidier. They are better because they let those differences express themselves.

Summing up

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- The strength of markets is in discovering information about costs and preferences, and providing the right incentives to act on that information. Those strengths are more valuable now than ever.
- We can still confront climate change: Environmental needs and goals can be set by policy,
 - Don't hide or backdoor policy goals by distorting market designs. Make the goals explicit and let market choices determine the best way to meet those goals.

Thank you

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