Resilient Energy

Energynet

The First Transactive Energy Operating System

Grid Crisis

The power grid was built as one large, fragile, centralized system. The grid cannot absorb renewable sources at scale, because their output is intermittent, destabilizing, and expensive to integrate. The grid does not have the power for electric vehicles at scale. Power is lost every time it is transmitted over distance and stepped through transformers. Large power storage is unaffordable. Eliminating large base generators further destabilized the grid. Because the grid is centralized, it is exposed to attack — both physical (kinetic) and cyber.

Microgrids

The solution is to produce, store, and manage power close to where it is used. A microgrid does exactly that. The goal is resilience: maintaining an acceptable standard of living even as the wider grid and economy decline. Microgrids should mutually support each other to reduce the cost of resilience. Managing a microgrid is difficult, managing the interactions between microgrids doubly so. Until now no management solution existed.

Transactive Energy

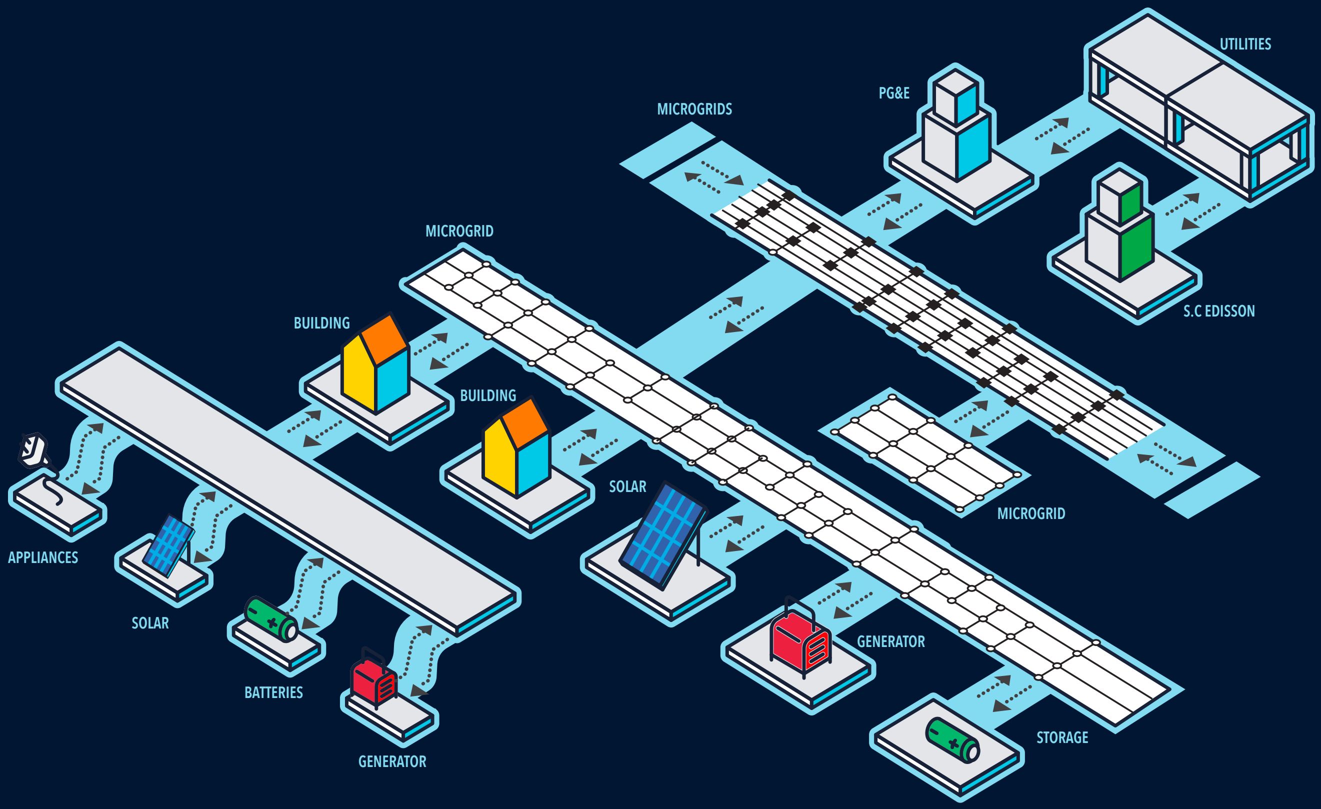
Transactive Energy uses markets instead of central control to manage power systems. Each participant — a home, a building, a data center — can both use power and produce it. Participants have unique needs, policies, and preferences. Participants decide when to buy and sell power among themselves. A market determines the price and quantity. The market does a better job than central control allocating power over time.

When local power is scarce, the price rises, so participants use less or sell what participants have. When local power is plentiful, the price falls, so participants use more or buy to store. Each participant acts on its own, in real time and for the future; the result is a microgrid that balances itself.

Meet the Energynet

The First Transactive Energy Operating System

- The Energynet operates markets in time, so participants both respond to real-time supply & demand and plan ahead.
- The Energynet interoperates with the existing grid and can even support the grid.
- The Energynet is a fractal of microgrids, managing devices, buildings, towns, and countries.
- The Energynet is completely autonomous, managing power based on the operator's policies preferences.



Power Management

An Energynet node

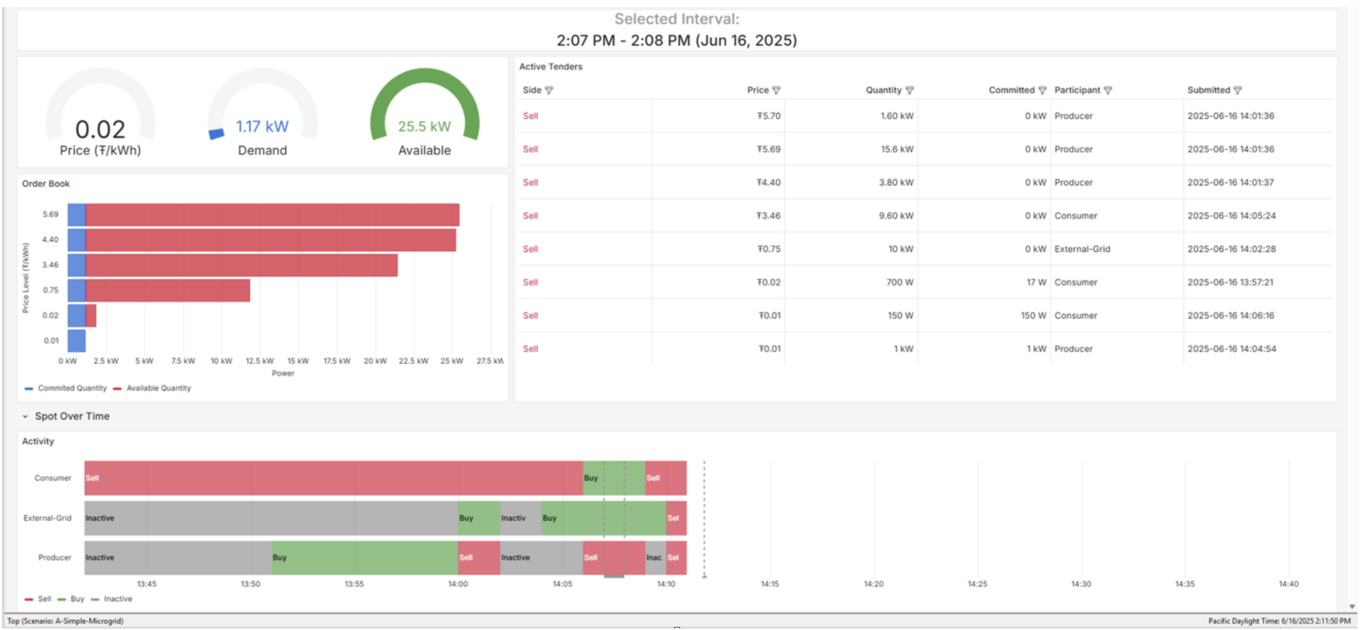
is a set of load, storage, and production devices. A node can be a single device or a building. A node can comprise of other nodes forming a microgrid. Nodes trade with other nodes in the same microgrid.

Microgrids

are nodes that trade with other nodes as any other nodes. The local market sets the local price of power now and in the future. Each node manages power by responding in real time to power availability and price.

At any moment, a node can sell excess power, consume power normally, or reduce consumption when power is scarce and the price is high. A node gracefully manages its devices based on power it has already purchased, the real-time price level, the devices it needs to operate, and local production. Each node constantly evaluates its own cost of producing power against the market price, both in real time and in the future. Calculating the cost of production accounts for the true cost of ownership, the time of production, and the environment, and it is the basis for pricing every purchase and sale a node makes.

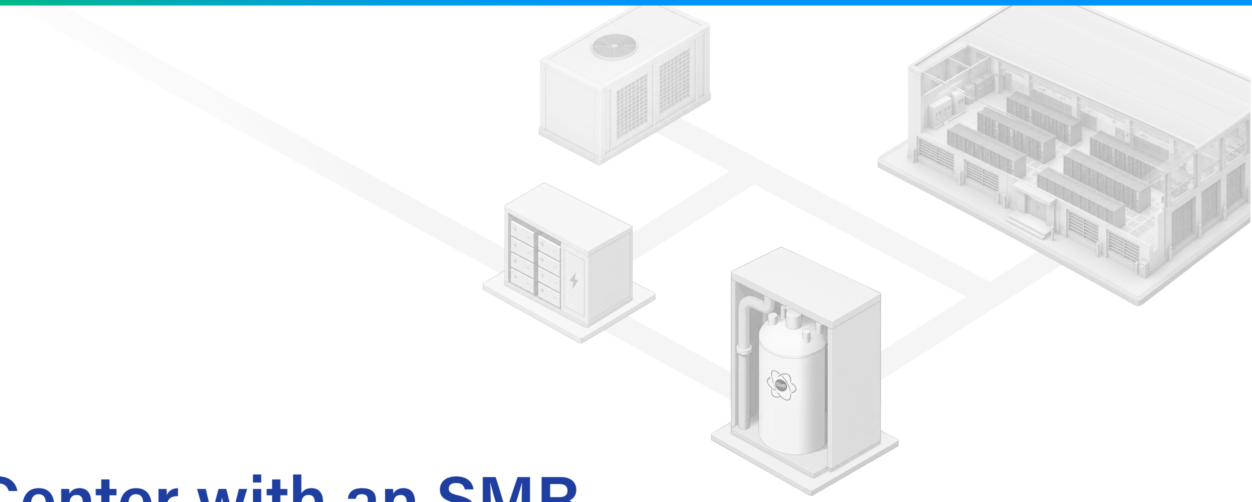
When consumption must drop, the Energynet computes in real time a sophisticated recipe of load and production devices. The Energynet simulates the effect that reducing load will have on the market, and based on the operator's policy, decides how best to respond. During power shortages, the Energynet distributes the available power based on each node's priority and commitments. The Energynet offers the operator a rich set of options for adding and prioritizing events, setting charge and discharge policies, scheduling events, and even defining special events such as island mode.



Side	Price	Quantity	Committed	Participant	Submitted
Sell	₮5.70	1.60 kW	0 kW	Producer	2025-06-16 14:01:36
Sell	₮5.69	15.6 kW	0 kW	Producer	2025-06-16 14:01:36
Sell	₮4.40	3.80 kW	0 kW	Producer	2025-06-16 14:01:37
Sell	₮3.46	9.60 kW	0 kW	Consumer	2025-06-16 14:05:24
Sell	₮0.75	10 kW	0 kW	External-Grid	2025-06-16 14:02:28
Sell	₮0.02	700 W	17 W	Consumer	2025-06-16 13:57:21
Sell	₮0.01	150 W	150 W	Consumer	2025-06-16 14:06:16
Sell	₮0.01	1 kW	1 kW	Producer	2025-06-16 14:04:54

Spot market: *Live price, demand, and the order book for immediate trades*

Forward market: *Contracted power, prices, and quantities for the days ahead*



EXAMPLE

AI Data Center with an SMR

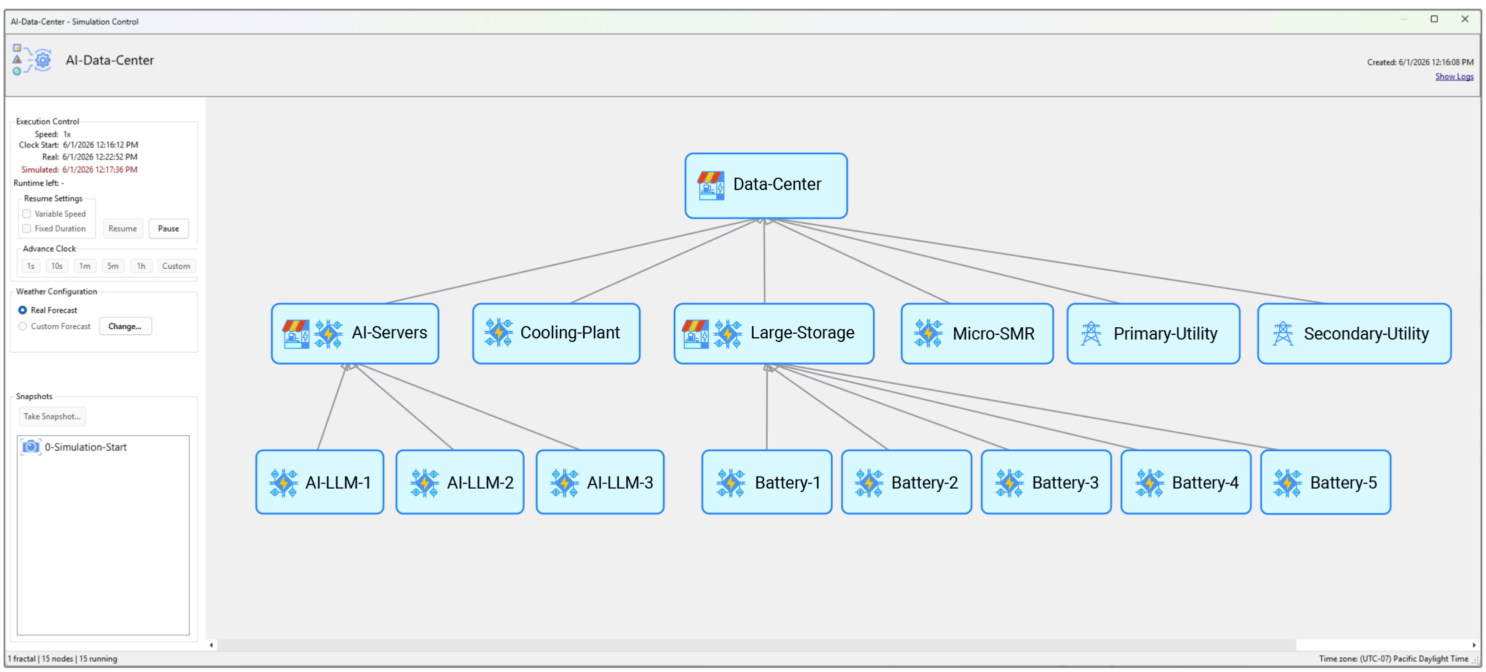
The AI Data Center

is powered in part by a small modular reactor (SMR). The data center contains a microgrid of AI servers, a cooling plant, and a microgrid of battery banks. The data center draws on the SMR and two utility connections for backup.

The Energynet

operates three microgrids and three markets. Following policies, the Energynet in every node autonomously manages any combination of utility connection and distribution, battery state, and AI load.

The operators can configure the individual node and market policies at any time. While the combinatorial spectrum of these devices is astronomical, there is no central logic and no central program managing the data center.



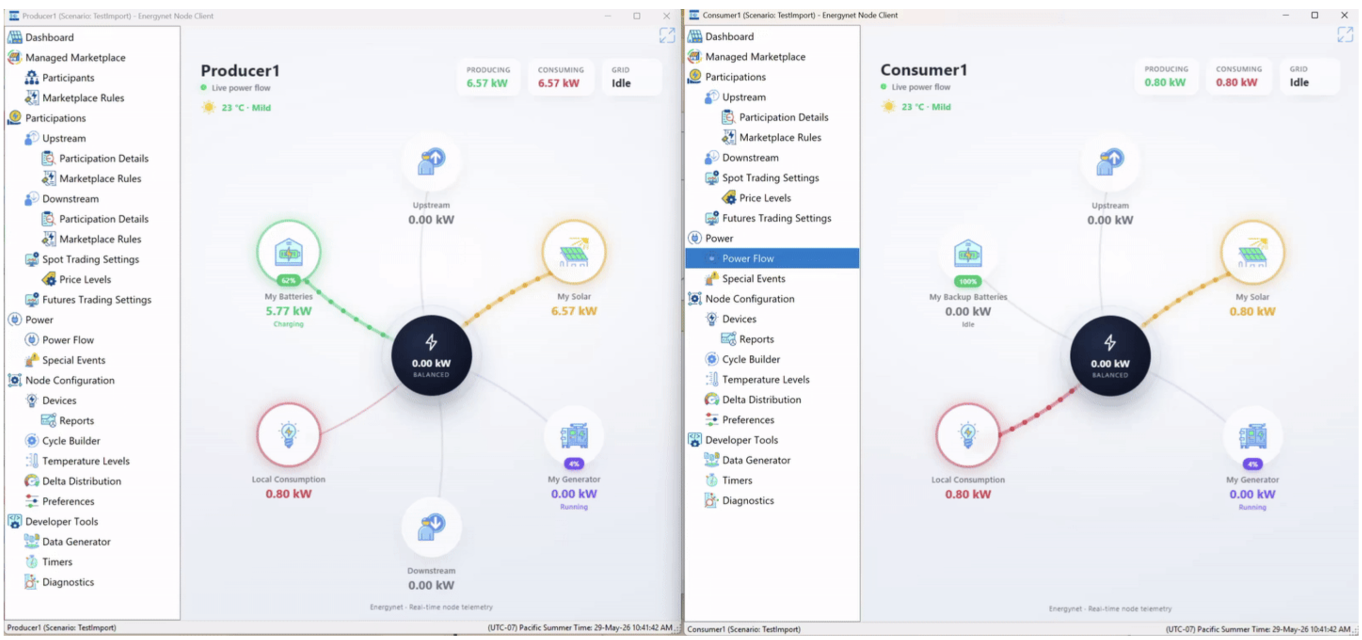
Fractal example: *Modeling an AI Data Center*

Simulations

The operator can simulate a single node, a single microgrid, or many interconnected microgrids. A simulation can cover a period from hours to years, and it reflects every device policy and market interaction in that period. The operator uses these simulations to tune policies for specific goals, such as lower cost or greater resilience.

The simulations cover all normal operation: trade policies, power-management change, individual device policies, market prices, weather, scheduled events, connectivity, spot and forward markets across multiple levels, true cost of ownership, billing, and quantified resilience. The simulations also cover extreme events: device failures, utility disconnects, soft islanding, power shortages, blackouts, price shocks, extreme weather, emergency policies, market closures, and custom events of the operator's own design.

The Energynet ships with a library of device simulators. The Energynet includes simulators for storage systems and batteries, generators, and solar systems, plus a growing number of load devices. Each load device carries curves for different variations of power mode, temperature, and solar radiation. The Energynet uses these simulators to build a node's cycle curves, detect peak load, measure run-time deviation from predictions, and calculate a stable power target using a Robust Multi-Stage Model Predictive Control (MPC).



Simulation example: *Two nodes trading*

Simulations can run through time at more than 100x speed, allowing the operator to quickly evaluate policy changes, trading strategies, and device changes. The Energynet can reproduce conditions for any date and time, past or future. A weather simulator lets the operator control and replay the weather.

To run these scenarios, the Energynet provides a rich user interface to design and run simulations. Simulations can run many nodes in a microgrid and multiple interconnected microgrids. The operator can design scenarios, capture and restore snapshots, and import and export simulations.

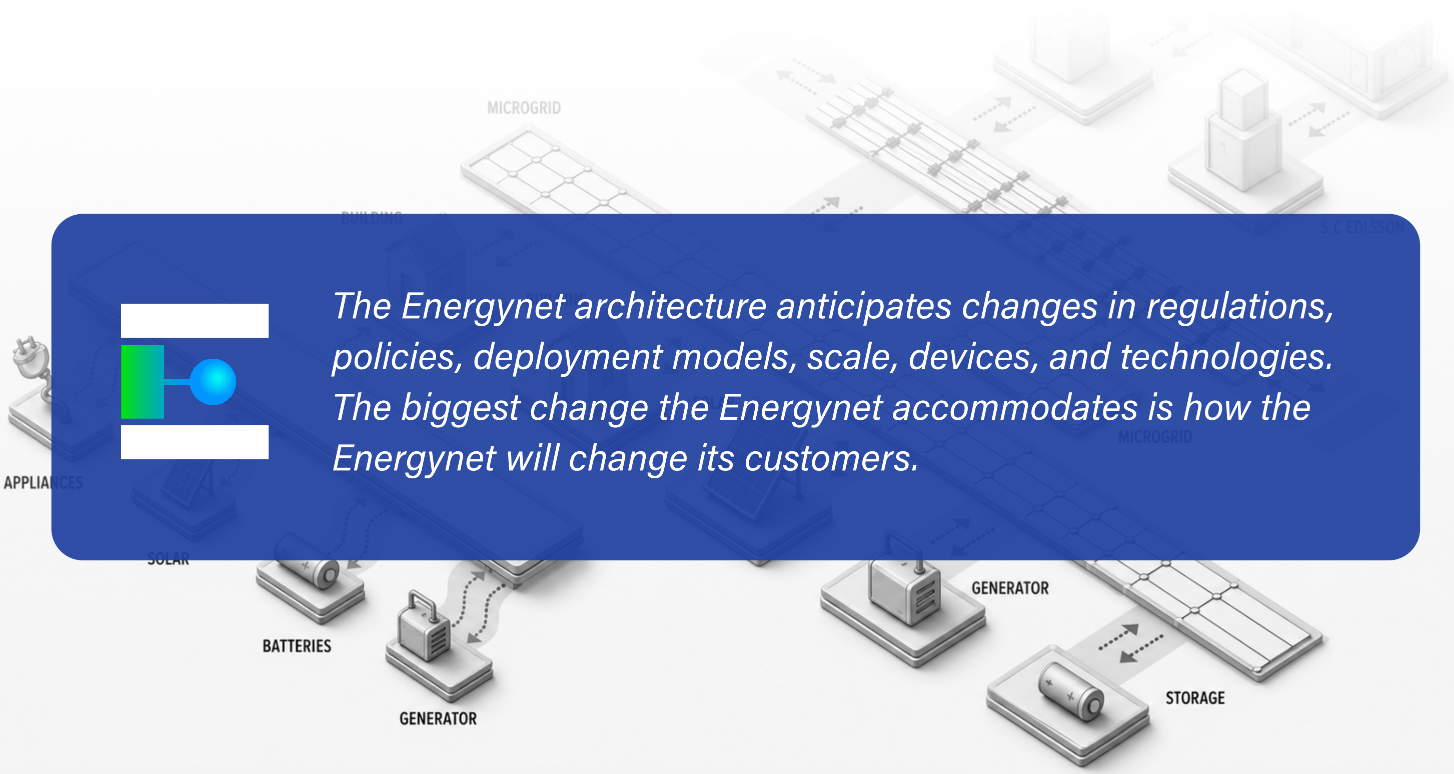
www.resilientenergy.com/demos

Why This Is Hard and Why It Works

Managing microgrids requires deep knowledge across many fields: energy, physics, engineering, finance, economics, and software engineering. No ready-made software existed to build it, so Resilient Energy built the core technology itself: distributed transactions, reliable and secure messaging, and long-running workflows at massive scale.

The Energynet is the product of five years of comprehensive use case analysis and design validation.

Energynet analysis: *Hundreds of use cases and interactions*



The Energynet architecture anticipates changes in regulations, policies, deployment models, scale, devices, and technologies. The biggest change the Energynet accommodates is how the Energynet will change its customers.

Energynet

Built by

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a pioneer in smart buildings and smart-energy standards, contributor to the U.S. national smart grid roadmap with NIST, and founder of the Energy Mashup Lab.

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