WHITE PAPER

The Internetification of Energy Distribution

EnergyNet, Distributed Grid Architecture, and the Role of Demand Control Technology in the Energy Transition

Prepared by

Kurt Richardson, Ph.D.

Inergy Systems

April 2026

Executive Summary

The global electricity grid stands at an inflection point comparable to the telecommunications revolution of the late 1990s. The centralized, synchronous, hierarchically managed power distribution system that electrified the twentieth century is increasingly strained by the realities of distributed generation, bidirectional power flows, intermittent renewables, and the electrification of transport and heating.

EnergyNet, an open-architecture framework developed by ViaEuropa and documented in a 2025 arXiv paper by Birgersson et al., proposes a radical restructuring of energy distribution modeled directly on the architecture of the Internet.

> *This paper identifies a strategic convergence between EnergyNet's distributed grid vision and the demand control technology developed by* ***Inergy Systems****. Where EnergyNet addresses the supply-side and distribution architecture of a decentralized energy future, Inergy's demand controllers provide the complementary demand-side intelligence required to make such a system efficient, economical, and resilient. Together, these technologies represent a complete framework for the next-generation energy ecosystem.*

1. The Case for a Distributed Energy Grid

1.1 The Legacy Grid: An Architecture Under Stress

For over a century, electricity has flowed in one direction: from large centralized power plants through high-voltage transmission lines, stepped down through substations, and delivered radially to passive consumers. This architecture — the **Plain Old Grid System (POGS)** — was optimized for predictable, top-down power flows with centralized protection coordination and synchronous coupling across the entire network.

This model is now encountering fundamental structural limitations. Rooftop solar photovoltaics, battery energy storage systems, electric vehicles, and heat pumps are proliferating at the grid edge. Power flows have become bidirectional and intermittent. The legacy grid was not engineered for this reality: distribution capacity fills, protection coordination breaks down under reverse power flows, frequency and voltage control become increasingly challenging, and single points of failure at substations create systemic vulnerability.

The 2025 cascading blackout that left over 60 million people across Spain, Portugal, and southern France without power illustrated these vulnerabilities in stark terms. A fault that should have been isolated instead propagated through the synchronously coupled system, demonstrating the catastrophic potential of an architecture that lacks inherent fault containment.

1.2 The Internet Analogy

The parallels to telecommunications in the 1990s are instructive. Before the Internet, telephony operated on a circuit-switched model: dedicated circuits were established between callers through centralized switches, consuming resources for the duration of each call regardless of whether data was actually flowing. This was the Plain Old Telephone System (POTS). The transition to packet-switched networks — where data is broken into discrete packets independently routed across a decentralized network of networks — transformed telecommunications from a scarce, expensive utility into an abundant, affordable commodity.

EnergyNet's thesis is that energy distribution faces an analogous inflection point. The centralized, circuit-switched model of electricity must give way to a packet-like model: distributed generation and storage managed through software-defined routing, open protocols, and local-first coordination. Jonas Birgersson, the Swedish tech entrepreneur behind EnergyNet and previously credited with bringing broadband to Sweden in the late 1990s, has described this as the "internetification" of energy distribution.

2. The EnergyNet Architecture

2.1 Core Design Principles

EnergyNet is built on three foundational principles drawn directly from Internet architecture:

- **Galvanic Separation and Local Autonomy.** Each microgrid operates as an electrically independent domain, separated from the wider grid by power electronics that function as an energy firewall. This prevents cascading failures and allows each domain to operate autonomously when disconnected. Birgersson describes this as "Schrödinger's microgrid": simultaneously on and off the traditional grid, with software determining the connection state in real time.
- **Software-Defined Energy Routing.** Rather than hardwired circuits, energy flows are managed by software that dynamically routes power based on real-time conditions, local generation availability, storage state, and demand profiles. The Energy Router is the hardware nexus of this system, converting between AC and DC, managing bidirectional flows, and enforcing policy-based distribution.
- **Open Protocol Interoperability.** The Energy Protocol (EP) serves the same role for energy distribution that the Internet Protocol (IP) serves for data networks. Developed by the nonprofit Energy Engineering Task Force and released with a zero-license model, EP provides a vendor-neutral, open standard allowing diverse hardware and operators to interoperate. No electricity is transferred until both parties agree through the protocol.

2.2 Technical Components

Energy Router

The central hardware device in EnergyNet. It sits behind the traditional utility meter and provides galvanic separation between the local microgrid and the external grid. Internally, it manages a DC backplane interconnecting local generation (solar PV, small wind), storage (batteries, EVs), and loads. The Energy Router Operating System (EROS) governs all local decision-making, including load prioritization, storage dispatch, and interconnection management.

ELAN and EWAN

The Energy Local Area Network (ELAN) connects devices and resources within a single building or facility, analogous to a home LAN. The Energy Wide Area Network (EWAN) interconnects multiple ELANs across a neighborhood, district, or city using DC microgrids in ring or mesh topologies for redundancy. Ring topology — which would cause short circuits in a traditional AC grid — is both safe and beneficial in EnergyNet because all connections are software-negotiated and galvanically isolated.

Energy Network Management System (ENMS)

The operator-scale control plane handling fleet management of Energy Routers, software updates, security monitoring, anomaly detection, and system-wide optimization. EnergyNet operators fill a role analogous to Internet Service Providers, coordinating distribution and managing market-based energy exchanges.

2.3 Deployment and Early Results

The first EnergyNet deployment is underway in Lund, Sweden, as part of the CoAction Lund initiative funded by Vinnova and the Swedish Energy Agency. The commercial pilot encompasses 10 apartment buildings with 270 residential units. Each building has rooftop solar and 100 kWh of battery storage (1 MWh total), interconnected via dedicated DC “freedom cables” in a ring topology. Initial results demonstrate the ability to install substantially more solar capacity than the traditional grid would permit, since the local microgrid absorbs and shares excess generation without stressing upstream distribution.

3. The Demand-Side Gap in Distributed Energy Architectures

3.1 Why Distribution Alone Is Not Enough

EnergyNet represents a transformative advance in energy distribution architecture. However, distribution is only half of the energy equation. A decentralized grid that generates, stores, and routes energy locally still requires intelligent management of when, how, and how much energy is consumed at the endpoint. Without demand-side coordination, even a well-architected distributed grid faces inefficiencies: local storage may be depleted prematurely during peak demand, generation and consumption may be temporally misaligned, and economic optimization opportunities through demand billing rate structures may go unrealized.

This is the **demand-side gap**: the architectural space between the distributed energy supply infrastructure and the appliances, HVAC systems, water heaters, EV chargers, and other loads that actually consume electricity. Closing this gap requires a technology layer that operates at the premises level, making real-time decisions about load prioritization and demand threshold management.

3.2 The Role of Demand Control Technology

A demand controller is a hardware device installed at the premises that continuously monitors aggregate energy consumption in real time. It intelligently orchestrates the operation of high-consumption loads — air conditioning, water heating, electric dryers, pool pumps, and EV chargers — ensuring that peak demand stays below a configurable threshold. It achieves this by strategically cycling loads, temporarily adjusting setpoints, and deferring non-critical operations, all while maintaining occupant comfort.

Inergy Systems has developed and deployed demand control technology for over three decades, with deep expertise in residential and light commercial applications. The Inergy demand controller integrates with existing building electrical systems, works alongside solar PV and battery storage installations, and enables customers to access utility demand billing rate structures that offer substantially reduced per-kWh charges in exchange for maintaining demand below a specified limit. Customers routinely achieve 25% or greater reductions in energy costs, with typical installation costs below $2,500 and payback periods as short as two to three years.

4. Convergence: EnergyNet and Inergy Demand Control

4.1 Architectural Complementarity

EnergyNet and Inergy's demand control technology are naturally complementary. EnergyNet provides the infrastructure layer: Energy Routers, DC microgrids, the open protocol, and network management systems. Inergy's demand controllers provide the endpoint intelligence layer: real-time load management ensuring each premises operates efficiently, stays within demand constraints, and contributes to overall network stability.

In a converged deployment, the demand controller at each premises functions as the **load-management agent within the ELAN**. It communicates demand state and flexibility capacity to the Energy Router, which factors this into its routing and storage dispatch decisions. Supply-side distribution and demand-side management operate as a coordinated whole.

4.2 Key Integration Scenarios

Scenario	Converged Behavior

Peak Demand Shaving	Inergy controllers hold each premises below its threshold, reducing aggregate ELAN peak demand and preserving battery reserves for shared EWAN use.
Solar Overgeneration	Controllers pre-cool buildings, pre-heat water, or accelerate EV charging to absorb excess local PV generation before export or curtailment.
Grid Disconnection	During islanding, demand controllers extend microgrid autonomy by enforcing stricter limits and prioritizing critical loads, reducing battery drawdown.
Market Participation	In EP-based energy markets, demand controllers provide granular load flexibility as a measurable, verifiable, tradeable network resource.
EV Charging Coordination	Demand controllers manage charging schedules to prevent coincident spikes while the Energy Router coordinates capacity across ELAN and EWAN.

4.3 Economic Model

The economic case for convergence is compelling at every scale:

- **Household Level.** Demand control reduces monthly energy costs by 25% or more, independently of EnergyNet. Combined with ELAN solar and storage, additional savings from reduced grid import, local surplus sharing, and time-differentiated rates.
- **Building and Community Level.** Aggregated demand control reduces the aggregate peak demand reported to the utility, lowering demand charges for the entire property. Within an EWAN, coordinated control smooths the load profile, reducing peak-capacity infrastructure needs.
- **Grid Operator Level.** Premises-level demand management reduces upstream distribution stress, deferring costly substation upgrades. For EnergyNet operators, it reduces peak throughput requirements on Energy Routers and EWAN interconnections.

5. Strategic Implications and Market Opportunity

5.1 The U.S. Market Context

While EnergyNet's initial deployment is in Europe, the underlying market dynamics apply with equal or greater force in the United States. Grid congestion, rising demand from data centers and electrification, aging distribution infrastructure, and increasing climate-driven resilience requirements create urgent need for distributed solutions.

The U.S. market also has a structural characteristic that makes demand control particularly valuable: widespread availability of **demand billing rate structures** from utilities, particularly in the Southwest. These offer dramatically reduced per-kWh charges for customers who maintain peak demand below specified thresholds. Inergy Systems has built its business model around enabling this, and the capability becomes even more powerful in an EnergyNet context where local generation and storage provide additional flexibility.

5.2 Inergy's Strategic Position

- **Proven Technology.** Over three decades of field-proven demand control deployments provide a mature, reliable base requiring no fundamental R&D; for distributed grid integration.
- **Demand-Side Expertise.** Deep knowledge of utility rate structures, demand billing mechanics, and consumption patterns provides a differentiated capability that pure distribution players lack.
- **HVAC Channel Partnerships.** Established HVAC relationships provide a scalable distribution channel aligned with building-level energy deployments.
- **EP Integration Pathway.** The open Energy Protocol creates a clear path for Inergy controllers to communicate demand state, flexibility capacity, and load-shedding availability to Energy Routers and the ENMS.

5.3 Resilience and National Security

A grid composed of galvanically separated, locally autonomous microgrids with endpoint demand intelligence is inherently resistant to both physical attack and cyber disruption. Cascading failures are architecturally impossible. Loss of any single component degrades service gracefully rather than catastrophically. Local autonomy enables continued operation during extended grid outages, with demand control extending autonomous operation by managing storage depletion rates.

For defense installations and critical infrastructure, the combination of EnergyNet distribution architecture with Inergy demand control provides a resilient energy assurance framework that operates independently of centralized grid infrastructure.

6. Recommended Development Roadmap

- **Phase 1 — Protocol Assessment (Near-Term).** Evaluate the Energy Protocol specification and identify data elements for demand controller integration: demand state reporting, flexibility capacity signaling, load-shedding acknowledgment. Develop a technical interface specification for Inergy-to-EP communication.
- **Phase 2 — Pilot Integration (Mid-Term).** Establish a demonstration deployment integrating Inergy demand controllers with an EnergyNet-compatible microgrid in a Southwest U.S. residential community where demand billing rates and high cooling loads maximize the value proposition.
- **Phase 3 — Product Development (Mid-Term).** Develop an EP-enabled Inergy demand controller that natively communicates with Energy Routers, enabling automated demand

response, local market participation, and coordinated storage management.

- **Phase 4 — Market Expansion (Long-Term).** Position Inergy as the demand-side integration partner for EnergyNet deployments in the U.S., leveraging HVAC channel partnerships and utility rate expertise to accelerate adoption of converged distributed energy systems.

7. Conclusion

The centralized electricity grid served its purpose for a century, but the convergence of distributed generation, electrification, storage, and digital control is rendering its architecture fundamentally inadequate. EnergyNet offers a compelling, architecturally rigorous blueprint for the next-generation distributed grid, modeled on the decentralized, protocol-driven architecture that transformed telecommunications and data networking.

However, a distributed grid without distributed demand intelligence is incomplete. **Inergy Systems' demand control technology fills this gap precisely**, providing real-time, premises-level load management that enables each node in a distributed energy network to operate within its economic and physical constraints while contributing to overall network efficiency and resilience.

The opportunity is to establish Inergy's demand control technology as a foundational component of the distributed energy ecosystem — not merely as a cost-saving device for individual households, but as a network-level resource that enables the full potential of architectures like EnergyNet.

> *The technologies are complementary. The market timing is favorable. The integration pathway through the open Energy Protocol is clear.* ***The internetification of energy distribution is underway. Intelligent demand management must be part of the architecture from the beginning.***

References

[1] Birgersson, J., et al. (2025). "EnergyNet Explained: Internetification of Energy Distribution." arXiv:2509.08152. September 2025.

[2] ViaEuropa. (2025). "EnergyNet White Paper Series." blog.slowpower.wtf/energy-net-white-paper-1.

[3] Roberts, D. (2026). "Making the Electricity Grid Work Like the Internet." Volts Podcast. January 14, 2026.

[4] CoAction Lund / Smart Energy International. (2025). "EnergyNet Introduced for Smarter Power Distribution and Sharing." May 2025.

[5] IEEE. (2025). "Status and Prospects of the EnergyNet Technology: A Next-Generation Distributed Energy Network." IEEE Conference Publication.

[6] P2P Foundation. (2023). "Energy Internet." wiki.p2pfoundation.net.