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September 10, 2025

Project Proposal / White Paper

Building Ukraine's Grid Resilience through the Neighborhood PowerBank Virtual Power Plant (VPP)

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Executive Summary

Ukraine's power grid has endured unprecedented stress since February 2022, with peak demand regularly exceeding available domestic supply. Missile and drone strike on large, consolidated power generating facilities and distribution sites and substations have exposed the vulnerability of traditional grid infrastructure.

While emergency measures - such as utility - scale battery energy storage systems (BESS), backup generators, and cross-border electricity imports - are critical, they cannot fully eliminate peak demand shortfalls or protect households from blackouts.

This white paper outlines the **Neighborhood PowerBank VPP** concept: a **distributed, household-level battery storage network** designed to support grid stability, reduce peak loads, and provide local survivability through islanded operation. Unlike centralized BESS, this approach disperses risk, increases resilience, and offers a pathway to **national-scale deployment of 2–6 GW** of distributed storage capacity.

Introduction

The full-scale war launched by Russia in February 2022 has transformed Ukraine's power grid into one of the most contested infrastructures in the world. Repeated missile and drone strikes on power plants, substations, and power lines have pushed the energy system into survival mode. Rolling blackouts, emergency imports from Europe, and rapid deployment of generators have become common measures to preserve critical services.

Despite these emergency actions, the structural imbalance between **peak demand (~18 GW)** and **available generation (often ~12–13 GW)** remains a national vulnerability. [1] Imports from ENTSO-E, while increased to 2.1 GW, cannot fully bridge the gap. [2] This situation highlights an urgent need for new, **distributed resilience solutions** that can both stabilize the grid and shield households and communities from the effects of systemic outages.

One such solution is the **Neighborhood PowerBank VPP** - a decentralized, household-centered approach that complements Ukraine's ongoing resilience projects and offers a path toward national-scale energy security.

The Need for Survivability

The survivability argument is central to this proposal. Large-scale energy facilities, while essential, are **high-value targets** that have been repeatedly attacked:

- In March 2024, the **Trypilska Thermal Power Plant near Kyiv** was completely destroyed by Russian missile strikes, causing widespread outages. [3] [4]
- The **Zmiivska TPP in Kharkiv region** was heavily damaged the same month, leaving hundreds of thousands of residents without reliable electricity. [4]
- Even renewables have been hit: the **Merefa solar PV facility** in Kharkiv region was damaged by airstrikes, forcing operators to redesign it as a microgrid. [5]

These examples show that **large, centralized assets are vulnerable and visible**. By contrast, household batteries aggregated into a VPP are **dispersed, redundant, and practically invisible**. Even if some units are lost, the broader system continues to function. This makes the Neighborhood PowerBank VPP not only an energy innovation but also a **critical infrastructure resilience aproach** against infrastructure attacks that outlined by Government of Ukraine (GOU) in several documents. [9] [11]

The Neighborhood PowerBank VPP Concept

The **Neighborhood PowerBank VPP** concept is based on several international projects that demonstrated the feasibility and impact of distributed storage aggregation.

- In **Germany**, the *sonnenCommunity* networks residential battery owners to share energy and balance local grid needs, paving the way for cooperative energy participation. [14]
- In **Australia**, the *Tesla Virtual Power Plant in South Australia* has deployed thousands of home solar-plus-Powerwall systems—recently acquired by AGL with nearly **7,000 batteries** - demonstrating that household storage can actively support grid stability and reduce energy costs for participants. [18] [19]
- In the **United States**, *Green Mountain Power (Vermont GMP)* pioneered a **battery leasing model**, offering subsidized home batteries (e.g., Tesla Powerwall) to residential customers, allowing aggregation during peak demand. [17]
- In **California**, initiatives like the **Self-Generation Incentive Program (SGIP)** and the **Residential Solar and Storage Equity (RSSE)**program provide robust rebates—ranging from **15 % up to full cost coverage** - for low-income homes installing battery systems, catalyzing residential grid support. [20] [21]
- In **Japan**, following the Fukushima disaster, neighborhood-scale **islanding microgrids** now enable communities to operate autonomously during outages, reinforcing the importance of localized resilience. [15] [16]

Together, these examples showcase **mature distributed energy architectures** that the Neighborhood PowerBank VPP can draw from and adapt for Ukraine's unique resilience requirements.

The concept is based on the principle of **aggregating household batteries into a coordinated VPP**, providing grid services while also enabling local survivability. Each household installs a **10–12 kWh battery** with a certified inverter (e.g., Fronius, SMA, Victron). Homes within a feeder are digitally aggregated, creating a distributed asset that can:

- **Reduce peak demand** by discharging during high-consumption hours.
- **Stabilize feeder loads** by providing flexible support to the distribution grid.
- **Enable neighborhood islanding** through "anchor homes" with grid-forming inverters, creating clusters of 20–60 homes capable of operating autonomously during outages.

A pilot configuration of 50-100 homes (0.5–1.2 MWh aggregate capacity) can prove the concept, while scaling to 800,000-1.2 million homes nationally would provide **2–3 GW** of dispatchable capacity. At

maximum deployment (2–2.4 million homes), the program could yield **5-6 GW** of distributed resilience - enough to fully cover Ukraine's typical wartime generation shortfall.

Current Initiatives to Enhance Energy Resilience

Ukraine has already taken important steps to enhance its energy resilience. Several initiatives are underway that strengthen the grid at different levels:

- **Utility-scale BESS (DTEK/Fluence):** Ukraine's first large-scale battery energy storage projects are now under construction. DTEK, in partnership with Fluence, is deploying a portfolio of six sites totaling **200 MW/400 MWh**. These systems provide frequency regulation, peak support, and critical grid stabilization functions. [6]
- **Commercial and public-site solar + storage (DTEK/Octopus RISE):** In collaboration with Octopus Energy's KrakenFlex platform, the €100 million **RISE program** aims to deploy distributed solar and storage across schools, hospitals, and businesses. This effort will create resilience hubs at institutional and commercial facilities, ensuring continuity of essential services. [7]
- **Local EPC integrators (Leader NRG, Ekotekhnik, Energy DK):** A growing ecosystem of Ukrainian engineering, procurement, and construction firms is installing rooftop solar, hybrid inverters, and battery systems for residential and small commercial customers. [8] While typically smaller in scale, these integrators provide the local expertise and supply chains needed for scaling distributed energy projects.
- **Merefa Community Microgrid (Kharkiv region):** After a Russian airstrike damaged a local solar PV facility, Monolith LLC partnered with USAID and NREL to design a **community microgrid**. This project aims to ensure autonomous supply of critical community facilities such as schools and shelters. [5]

These initiatives are crucial, but they share one common characteristic: they focus either on **centralized assets (utility-scale BESS)** or on **institutional/commercial sites (RISE, Merefa)**. The household level - where millions of Ukrainians experience outages most directly - remains largely untapped as a coordinated resilience resource.

Complementing Ongoing Projects

The Neighborhood PowerBank VPP is not intended to compete with Ukraine's current resilience initiatives. Instead, it **complements and strengthens them**:

- **Utility-scale BESS (DTEK/Fluence):** These plants stabilize the transmission grid but remain centralized and vulnerable. The VPP adds a second layer of **decentralized storage** at the distribution and household level. [6]
- **DTEK/Octopus RISE:** Focused on schools, hospitals, and businesses, RISE strengthens resilience at institutional nodes. The VPP extends this approach into the residential domain, ensuring **households also become active participants**. [7] [8]
- **Local EPCs:** The Neighborhood PowerBank VPP creates market demand that local EPCs can fulfill, accelerating job creation and supply chain development.
- **Merefa Microgrid:** A valuable demonstration of community-scale resilience, the Merefa project shows how renewable + storage microgrids protect communities after attacks. The VPP scales this principle from one town to **thousands of neighborhoods nationwide**.[5]

The key difference is **scale and structure**: while existing projects are centralized or site-specific, the Neighborhood PowerBank VPP creates a **networked, distributed resilience layer** that cannot be destroyed by a single strike and can operate both independently and in concert with other programs to include GOU strategy 2035. [11]

Financing Pathways

To make residential participation feasible, foreign donor support and blended finance mechanisms are essential. Proven models include:

- **Municipal aggregator schemes**, where cities procure batteries in bulk and lease them to households at subsidized rates.
- **Voucher programs**, where donors provide direct rebates (30–50%) via certified suppliers.
- **Energy cooperatives**, where communities jointly own and manage their neighborhood storage.
- **Blended finance with guarantees**, where banks issue loans backed by donor risk-sharing.
- **Challenge funds**, where high-visibility pilot clusters are supported as demonstration projects.

These mechanisms align well with the funding structures already in use by **SPARC, EBRD, EIB, EU REPowerEU, and World Bank/ESMAP**.

Investment Case

From an investment perspective, the Neighborhood PowerBank VPP represents a scalable market opportunity built on solid economics and donor-backed risk mitigation.

At the household level, installation of a **10–12 kWh battery with certified inverter** can replace or reduce reliance on diesel generators, which currently cost families an estimated **$150–200 per month** during blackout periods. By shifting this expense into a financed battery lease or ownership model, households gain reliable power while investors secure a predictable revenue stream.

Pilot projects of **50–100 homes** can demonstrate both technical feasibility and financial viability:

- **Payback periods of 5–7 years** are realistic, combining avoided diesel costs, reduced peak tariffs, and donor-backed subsidies covering 30–50% of capital costs.
- **Internal rates of return (IRR) of 10–15%** are achievable depending on donor support, household participation, and scaling efficiency.
- **Donor guarantees and concessional financing** can significantly lower risk and attract private capital.

Market Size & Scaling Potential

Ukraine has approximately **6.5 million households**. If **20%** adopted the VPP model, this represents **1.3 million homes** equipped with storage systems. At an average installed cost of **$3,000 per system**, the addressable market is **$3.9 billion**. At full adoption (2.4 million homes), the market could exceed **$7 billion**, while providing **5–6 GW of distributed resilience capacity**.

Pilot Cost Estimate

A pilot of **50–100 homes** would cost approximately **$0.5–1.2 million**, depending on equipment mix and subsidies. This is a manageable entry point for donor-funded demonstration projects, and it provides investors with early proof of technical and financial viability.

For municipalities and national authorities, aggregated household batteries reduce peak stress on the grid and enhance survivability. For investors, they create a repeatable financing model that can scale from hundreds of homes to millions. The combination of **household savings, grid stability services, and donor leverage** makes the Neighborhood PowerBank VPP a uniquely investable resilience solution for Ukraine.

A Role Model for National Resilience

The Neighborhood PowerBank VPP represents more than a technical solution; it is a **strategic model for resilience at scale**. By layering distributed household storage beneath utility-scale BESS, solar + storage hubs, and community microgrids, Ukraine can create a **multi-tiered defense** for its power system:

1. **Utility-scale BESS** absorb system shocks at the transmission level.
2. **Institutional hubs (RISE, Merefa)** protect critical facilities.
3. **Neighborhood PowerBank VPP** secures households and feeders, dispersing risk across millions of nodes.

This layered approach offers survivability, flexibility, and scalability unmatched by centralized solutions alone. It also aligns with global trends toward decentralized, demand-side flexibility and positions Ukraine as a **pioneer of resilient VPP design** in Europe.

Conclusion

Ukraine's power grid resilience challenge requires more than repairing plants and importing electricity. It requires a **paradigm shift** toward distributed, survivable, and citizen-centered energy systems.

The Neighborhood PowerBank VPP offers exactly this. By turning households into active grid participants, it reduces peak demand, stabilizes feeders, and provides life-saving backup power during outages. More importantly, it disperses risk, ensuring that no single missile strike can cripple the nation's resilience.

This proposal should be seen as a **role model for a national grid resilience strategy**. With support from donors, municipalities, EPCs, and citizens, Ukraine can build not just a stronger grid for today's war, but a **future-proof energy system** for its European tomorrow. [12]

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