



# Merefa Community Microgrid: Supporting Distributed Energy Resource Deployment in Ukraine

## Introduction

The National Renewable Energy Laboratory (NREL) is supported by the U.S. Agency for International Development (USAID) and the Net Zero World Initiative as it helps Ukraine deploy and integrate renewable energy projects. USAID and NREL partner to deliver clean, reliable, and affordable power to developing countries through policy, planning, and deployment support, as well as providing global technical toolkits. Net Zero World is led by the U.S. Department of Energy in collaboration with nine U.S. government agencies, including the USAID, partner countries around the world, and philanthropies, co-creating and implementing tailored technical and investment pathways to accelerate just transitions toward clean, resilient, renewable, and net-zero energy systems.

NREL is helping develop distributed energy resources in Ukraine and is actively engaged in projects in several communities nationwide. The Merefa Community Microgrid is one of the first projects of the initiative co-designed with Monolith LLC (Monolith), a local renewable energy developer. Andriy Pavlov and Oleksandr Moroz, along with other members of the Monolith team, made valuable contributions to this work. Dr. Yulia Rybak and the local government also provided key support for this initiative.

## Background

Russia's invasion of Ukraine in February 2022 continues to bring destruction, affecting the economy as well as local infrastructure. In fact, critical energy infrastructure is a frequent target of attacks. The World Bank estimates damages to the Ukrainian energy sector at \$10.6 billion USD as of December 2023. Recovery needs are calculated at a daunting \$47 billion USD—a heavy burden for a war-torn economy (World Bank, 2024). To support the resilience of Ukraine's energy system, the Ukrainian government has prioritized decentralization and diversification of energy resources through the deployment



Consequences of the attack on the solar PV in Merefa, Ukraine. May 28, 2022

Photo credit: Andriy Pavlov, Monolith

of distributed energy resources. The Ukraine Facility Plan underscores this commitment, with a strategic goal aimed at increasing the share of renewables to support the energy transition, increase decentralization, and bolster energy security (Ministry of Economy, 2024).

Merefa is located south of Ukraine's second-largest city of Kharkiv. There, Monolith operates a merchant solar photovoltaics (PV) plant that supplies 10% of annual power consumption within the Merefa Territorial Community. In May 2022, the solar PV system suffered an attack by two Iskander missiles, damaging 1,312 PV modules and significantly reducing electricity production (Monolith, 2023). Nevertheless, the solar PV system is still operational at reduced capacity. Monolith approached Net Zero World to help convert the existing PV system into a microgrid, aiming to provide resilient power to the community.

## Technical Solution

Researchers used NREL's REopt® model to determine cost-effective system sizing and operation for the Merefa Community Microgrid and used the Energy Resilience Performance

Model to estimate the probability of serving critical loads during the loss of grid power. PV system power output was estimated using NREL's System Advisor Model™, and weather data for Merefa, Ukraine, came from NREL's National Solar Resource Database. Monolith provided the capital and maintenance cost estimates used in the model.

The conceptual design, co-developed by NREL and Monolith, contains a total of 6.06 MW-DC PV, including 4.4 MW of assets already in operation or under construction; a 2.5-MW, 4-hour battery energy storage system; and two 532-kW natural gas reciprocating engine generators, as well as balance-of-plant equipment (NREL, 2024). A subsequent feasibility study will refine equipment sizes and costs. The total estimated capital cost is \$9.85 million USD, with total estimated annualized operations and maintenance costs of \$1.02 million USD per year. Revenues from the microgrid for participating in wholesale markets are estimated to be \$0.65 million USD in the first year.

In the event of grid power loss, the microgrid will provide enough power to cover customers'

critical loads: the estimated probability of serving critical loads during a 96-hour outage is 87%. The Merefa Community Microgrid is a front-of-the-meter solution that will serve customers through a dedicated distribution circuit. The microgrid is tied to the local distribution system operator and will purchase distribution system operator power when wholesale electricity prices are low and sell power to the market when prices are high (or when the Merefa Community Microgrid experiences periods of excess solar energy). The microgrid can also be expanded in the future. Additional PV, battery storage capacity, and generators will potentially allow the microgrid to serve other facilities within the community.

## Outcome

The microgrid in Merefa will serve several critical functions in the community. Given the power deficit resulting from the destruction of generating facilities across Ukraine, particularly in the Kharkiv region, the microgrid is positioned to provide a partial solution for the community. Additionally, the microgrid plays a critical role in strengthening the community's resilience to power outages, particularly benefiting customers whose operations can be considered vital for the livelihood of the community. Expanding the existing PV system and establishing the microgrid will also require additions to the workforce, fostering job opportunities within the region. Lastly, the successful launch of the microgrid in Merefa makes a strong case for replication across Ukraine, aligning with the government's vision for energy decentralization and diversification.

## References

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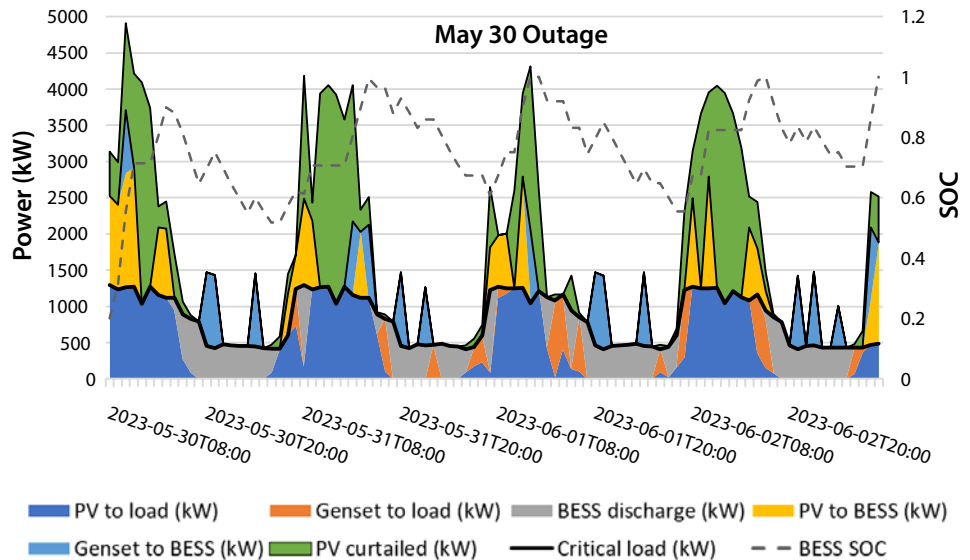
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Global horizontal solar irradiance data for Ukraine

Credit: map illustration by Billy Roberts, NREL



Microgrid dispatch during a simulated four-day power outage, starting on May 30.

Note: BESS = battery energy storage system; SOC = state of charge

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