Ukraine: Energy Storage and Ancillary Services Market Development Support

Role of Smart grids Technologies in Ukraine

Ukrenergo, November 4, 2024

KGID JEJU 2024

ESMAP
Energy Sector Management Assistance Program

THE WORLD BANK
IBRD • IDA

KOREA GREEN GROWTH TRUST FUND

감사합니다!

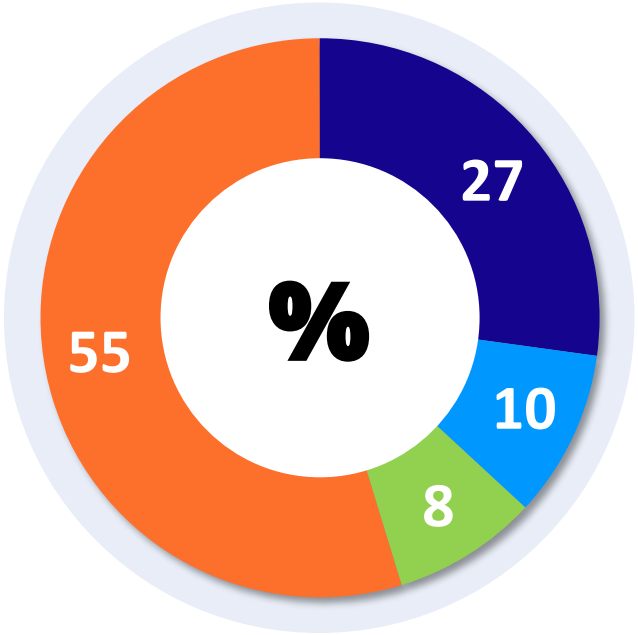
Thank you!

NPC UKRENERGO – COMPANY OVERVIEW

UKRENERGO
National power company

- a state-owned company, one of the largest transmission system operators in Europe
- operates synchronously with the power system of Continental Europe

Approximate energy mix of Ukraine 2022



≈20 000 km
total length of high-voltage lines

94 **substations 220-750 kV** (in the controlled territory)

109 bln kWh
Annual transmission volume (in the conditions of war)

entsoe
ENTSO-E member

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IMPACT OF ATTACKS ON UKRAINE'S POWER SYSTEM INFRASTRUCTURE IN 2024

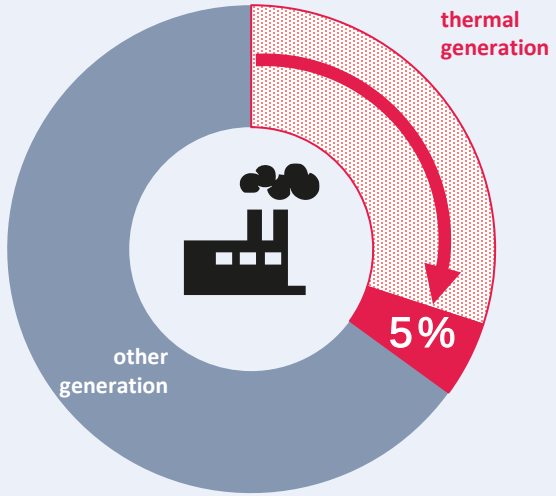
FROM OCTOBER 2022 TO MARCH 2023 – **16 MISSILE AND 18 DRONE ATTACKS**

197 missiles **46 drones**

SINCE JANUARY 2024 TO OCTOBER 2024 – **9 MISSILE AND DRONE ATTACKS** against Ukraine's power system

As a result, energy infrastructure facilities were hit by:

120-140 missiles **110-120 drones**



From 30% to 5%

decreased the share of thermal generation in total electricity production during that period

all large thermal and hydropower plants were damaged

Damage caused to the energy sector of Ukraine:

USD 11 billion in 2022/2023

(according to World Bank and UNDP)

Total direct and indirect losses:

USD 56 billion

(according to KSE estimates)

The repair and reconstruction of our facilities is currently being implemented

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russian attacks

by russian missiles/drones

HIGH-VOLTAGE AUTOTRANSFORMERS

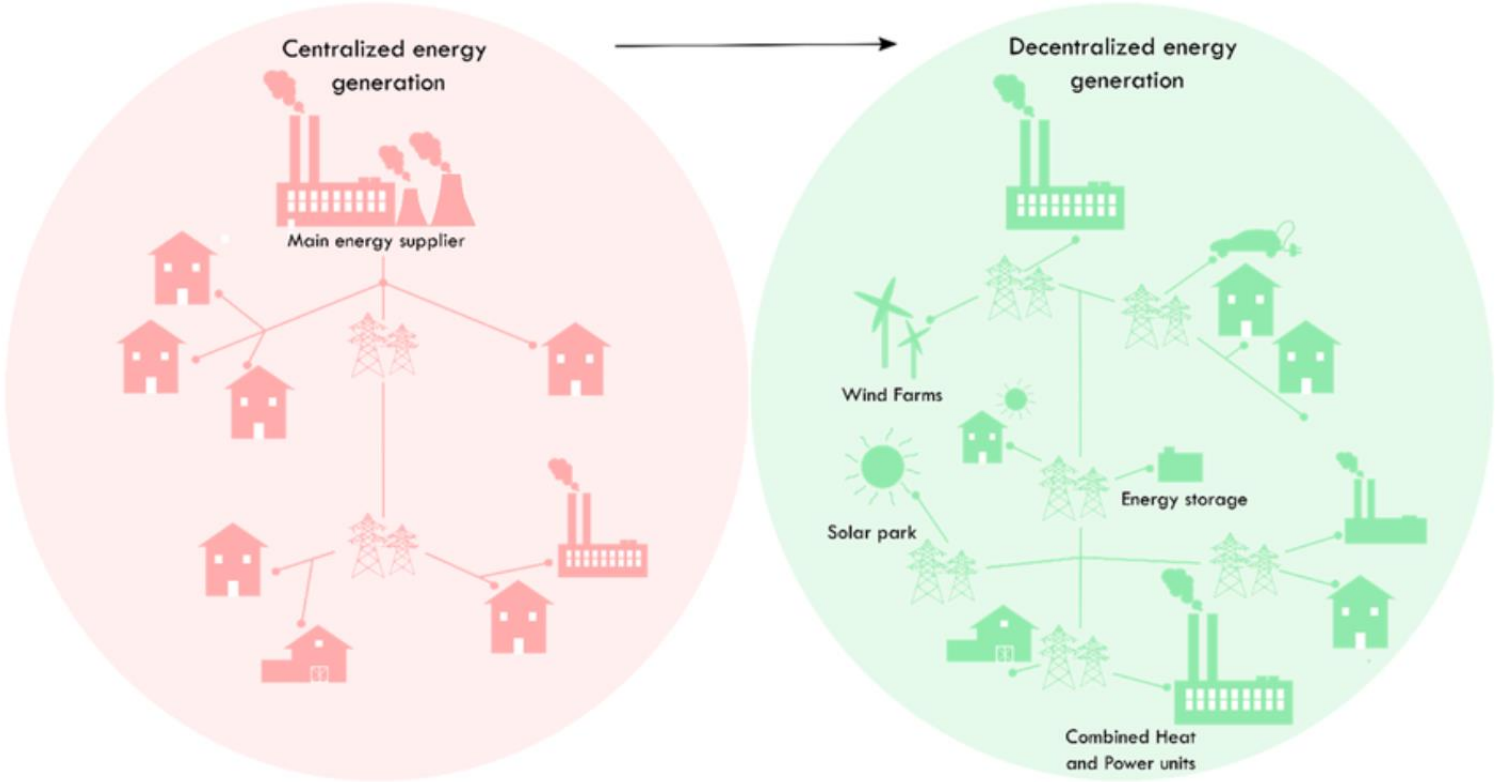
Damaged autotransformers at different Ukrenergo’s substations

The Impact of the Ongoing War on Ukraine's Power System: Mid-2024 Update:

- Nearly 73% of thermal generation plants have been destroyed
- Over 50% of the transmission grid has been damaged or destroyed.

The rapid development of decentralized generation

How to keep the light, water and heat in houses?



The rapid development of decentralized generation

How to keep the light, water and heat in houses?

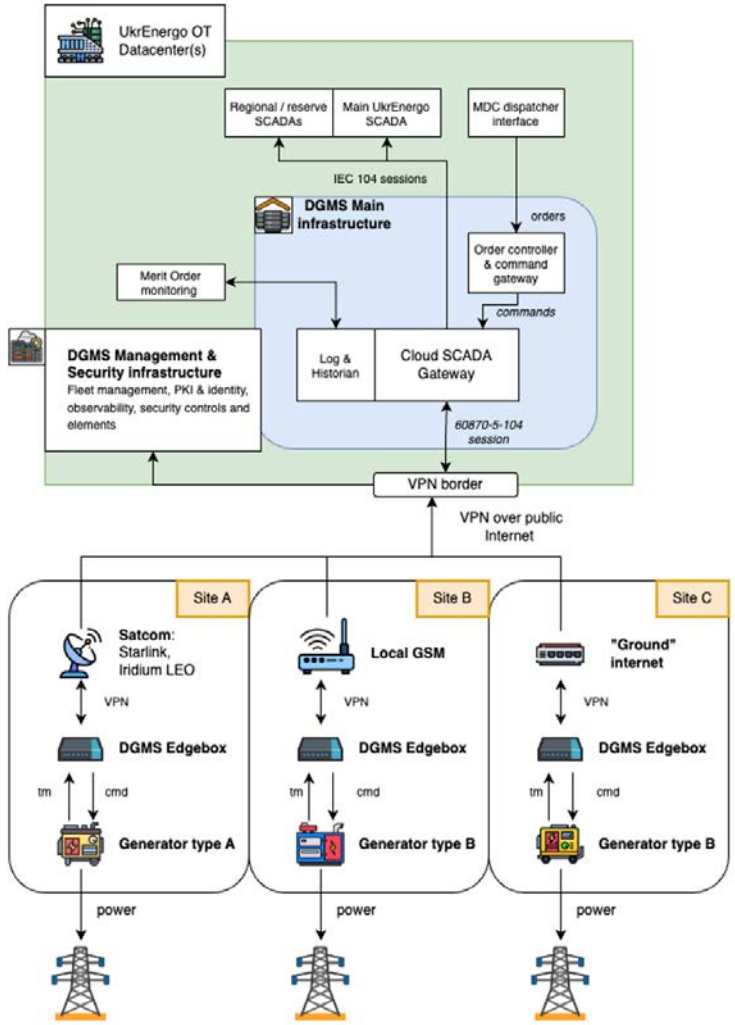
The main challenge is how to control a huge amount of units

DGMS – Distributed Generation Management System

Based on the idea of MIL-STD-3071 TACTICAL MICROGRID COMMUNICATIONS AND CONTROL

Key benefits:

- Working concept based on our RDAS
- Split secure two-level architecture
- Easy and quick deployment
- Scalability
- Possibility to integrate with SCADA/AGC systems
- Network infrastructure in the box



(Diagram 1: Simplified solution architecture)

The increasing of the electricity import from ENTSO-E

How to keep the light, water and heat in houses?

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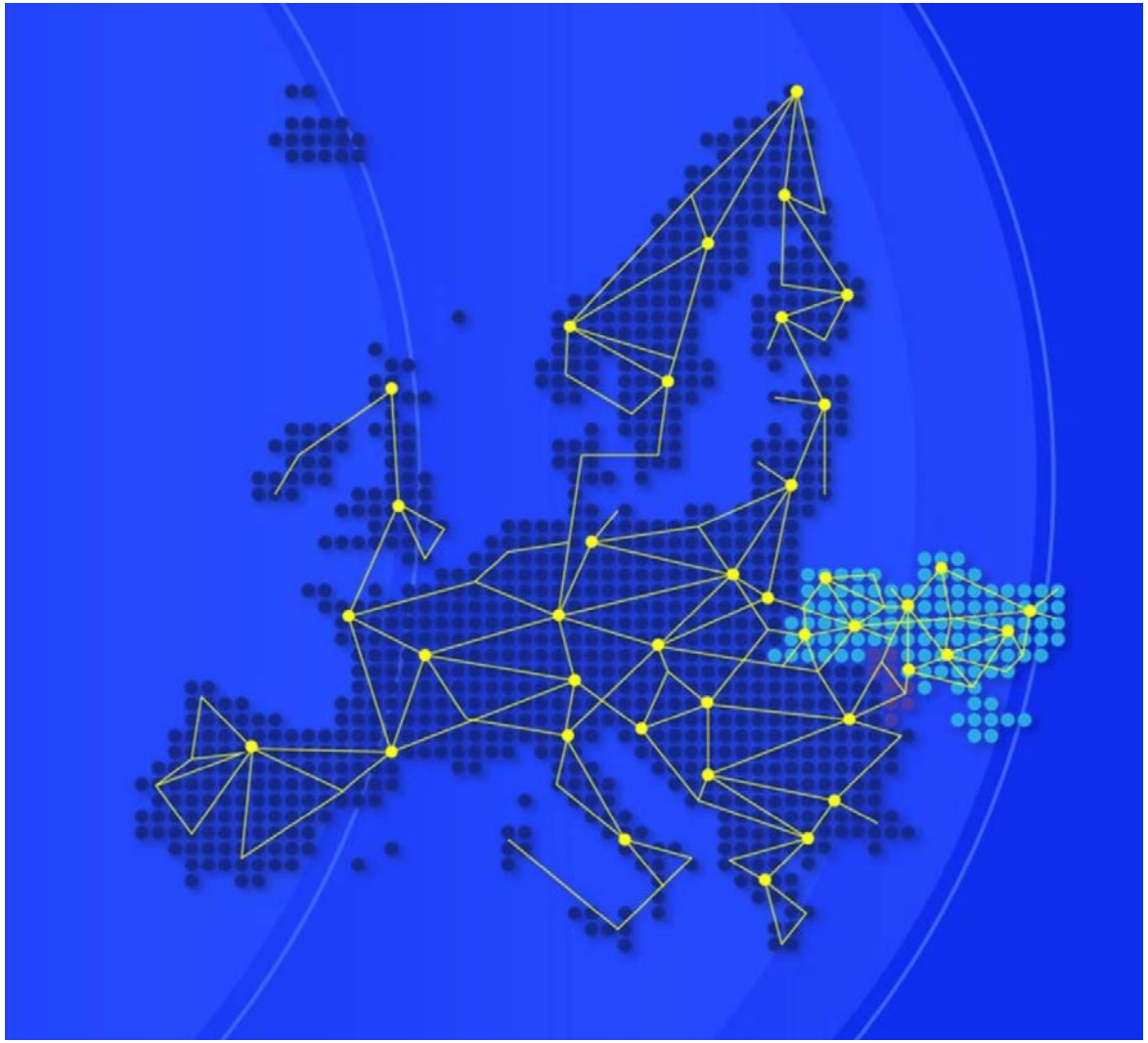

The increasing of the electricity import from ENTSO-E

How to keep the light, water and heat in houses?

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The main challenge is to mitigate the risks for the ENTSO-E grid security operations.

As of today, the permitted cross-border power flow is **1700 MW**, and we are working to increase this capacity.

One of the tasks is to implement effective solutions to increase the damping of low-frequency oscillations.

BESS effectiveness in increase damping of low frequency oscillations in the updated model of the interconnected UA/MD and CESA svstems

Introduction

▪ In 2021, in the frame of the Additional Studies on UA/MD and ENTSO-E CE synchronous operations were carried out. One of the results of these studies are the recommended list of countermeasures to increase the damping of low-frequency inter-area oscillations that may occur during synchronous parallel operation of the Ukraine/Moldova and the ENTSO-E CE power systems.

▪ Among others it has been shown that STATCOMs located in the Ukrainian HV network and equipped with POD (Power Oscillation Damper) can significantly improve the damping. In the conclusion, it was stated that also other power electronic devices (FACTS devices) can be used for this purpose. In particular, it was suggested to introduce a BESS solution that could be deployed very quickly and that could be adapted to provide a damping contribution to the grid. This solution should be considered temporary until the end of hostilities and the proper definition and availability of the STATCOM location.

▪ In 2022 study with the overall goal of assessing the effectiveness of BESS in increasing the damping of troublesome inter-area low-frequency oscillations and to determine the recommended installed powers and locations of BESS in the Ukrainian the power system has been finished.

Research Objectives

- Evaluate the effectiveness of BESS in enhancing the damping of low-frequency oscillations during synchronous operation of Ukraine/Moldova and ENTSO-E.
- Investigate the impact of the new interconnection line (Rzeszow–Khmelnytska NPP) and the retuning of excitation and power system stabilizers (AVRs/PSSs).
- Study the potential of FACTS devices (particularly SSSC) for improving grid stability.

Key Measures and Methods

BESS (Battery Energy Storage System):

- Location and installed capacity: 66.8 MW and 80 MW.
- Testing oscillation damping under various export scenarios.

SSSC (Static Synchronous Series Compensator):

- Locations: Rzeszow and Khmelnytska NPP substations.
- Analysis of the impact on inter-area oscillation damping through reactance compensation.

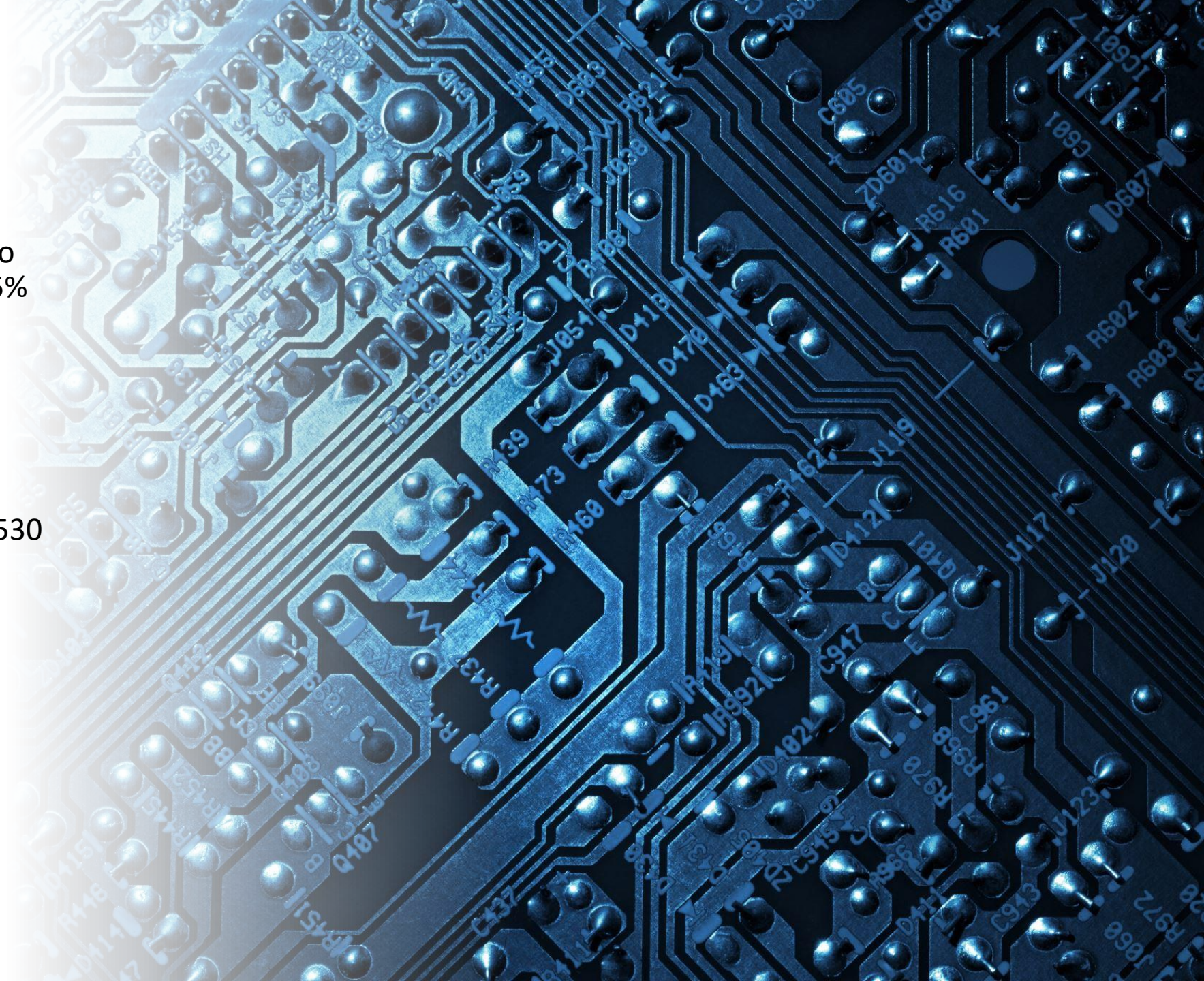
Research Findings

BESS increases export capacity up to 1530 MW with a damping level of 5%

SSSC:

- Without active POD circuits: an export capacity up to 1340 MW
- With active POD circuits: up to 1530 MW

Combined use of BESS and SSSC enables export up to 1710 MW



Conclusions and Next Steps

- Improvements in damping from the Rzeszow–Khmelnytska NPP line and AVRs/PSSs retuning enhance stability and export capacity.

- **BESS and SSSC** together provide the highest damping (5.35%) and increased export potential.

- Next step: Further study of BESS and SSSC deployment as temporary stability measures until hostilities end.

- World Bank is financing one of the largest Battery storage-hydro projects in Europe in Ukraine with IBRD and CTF loan to Ukrehydroenergo.

- Ukrenergo has launched auctions for ancillary services with 5-year contracts for private participants.

Q&A/AOB