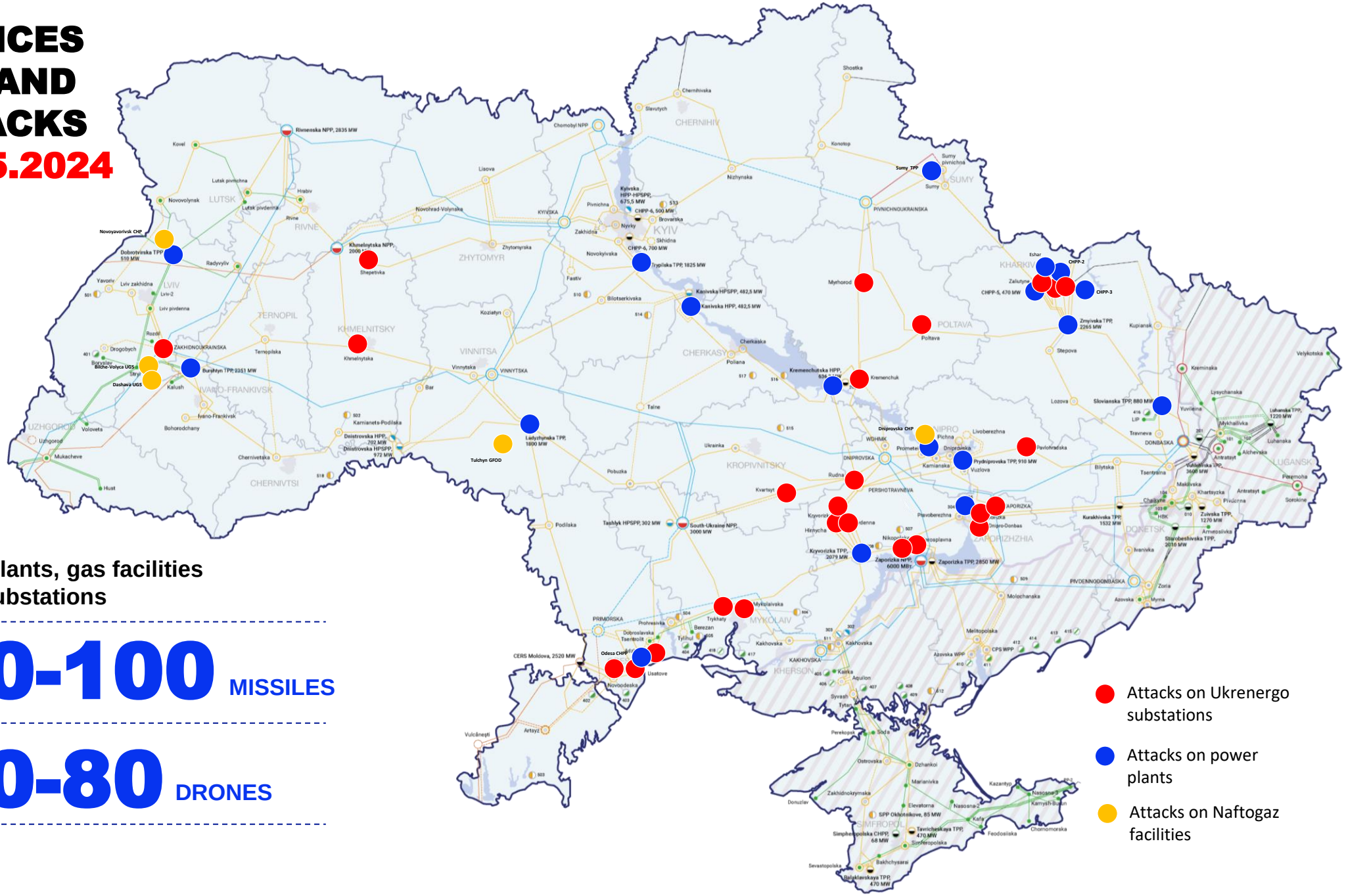
Cabinet of Ministers of Ukraine

ADDRESSING UKRAINE'S ENERGY CHALLENGE

28 May 2024

CONSEQUENCES OF MISSILE AND DRONE ATTACKS

30.01 – 18.05.2024



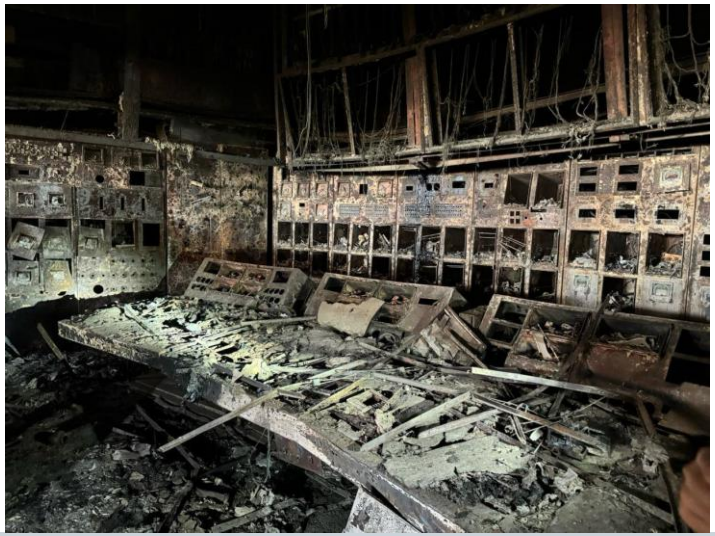
Attacks on power plants, gas facilities and high-voltage substations

90-100 MISSILES

70-80 DRONES

- Attacks on Ukrenergo substations
- Attacks on power plants
- Attacks on Naftogaz facilities

DAMAGED THERMAL POWER PLANTS (KEY FLEXIBLE GENERATION)



DAMAGED HYDROPOWER PLANTS (KEY FLEXIBLE GENERATION)

ДніпроГЕС-1.10.02.2023.
Будівля машинного залу.

Канівська ГЕС. 31.10.2022.
ВРП 110/330 з вимикачами, електричні захисти В-Резерв ком 1 КРУВ-10

DAMAGED HIGH-VOLTAGE SUBSTATIONS (KEY TRANSMISSION NODES)

URGENT NEEDS OF EQUIPMENT FOR UKRAINIAN POWER SECTOR*

Voltage transformers

Power unit transformers

Autotransformers

Generators

Circuit breakers

Disconnectors

Current transformers

Hydrogenerators

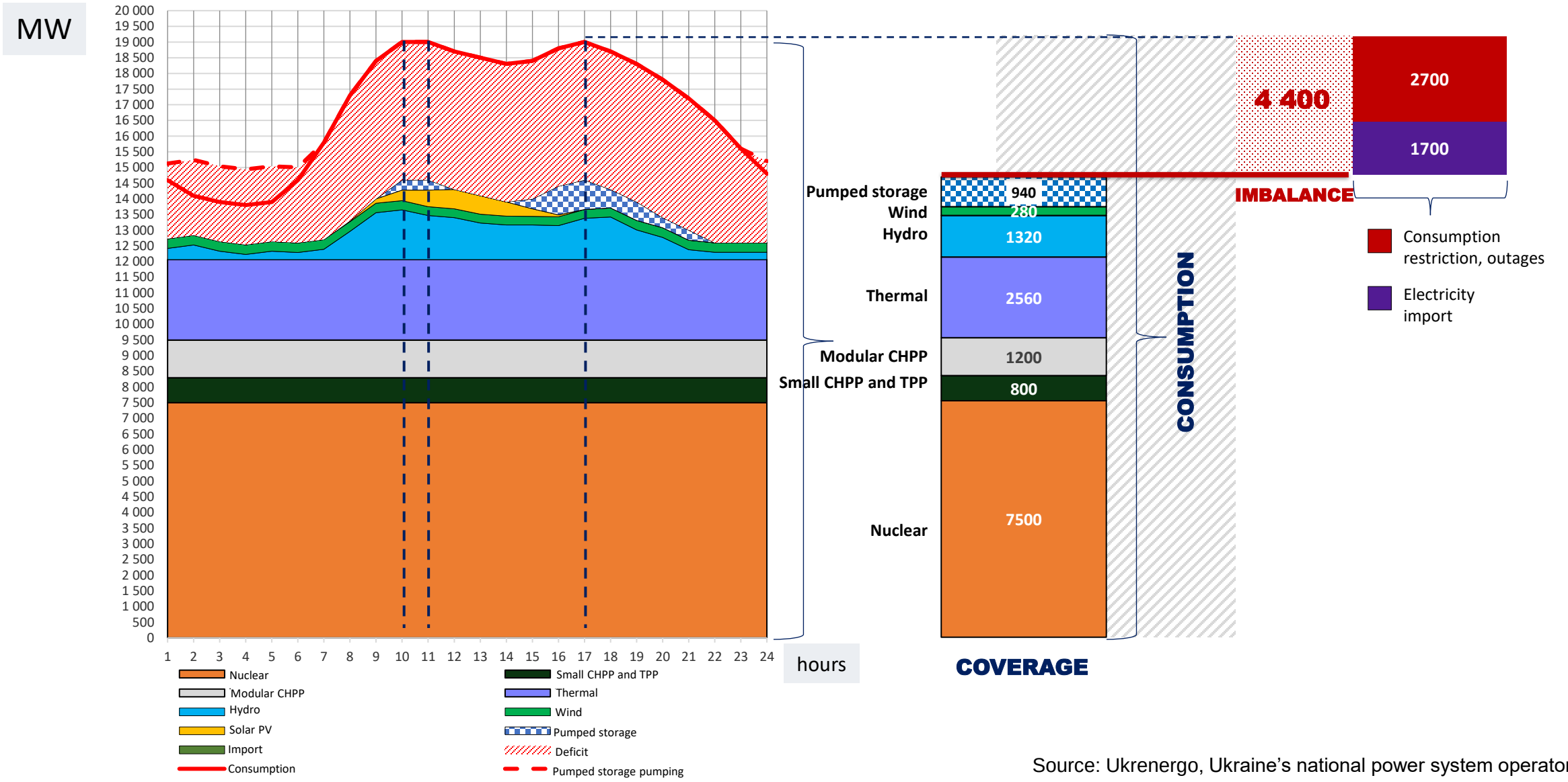
Turbines

*Detailed lists and classified updates are provided in regular briefings with G7+ Ambassadors

FORECAST CAPACITY BALANCE

The coldest day scenario, heating season 2024/2025

Temperature: -10 -15 °C



Source: Ukrenergo, Ukraine's national power system operator

FOUR PRIORITIES FOR UKRAINE'S ENERGY SECTOR TO COUNTERACT RUSSIAN AGGRESSION

ENERGY SECTOR PRIORITIES

What is needed:

		What we ask from you:
I PRIORITY	resources to protect and restore energy facilities	• Air defence and passive protection of energy objects • Funding and in-kind donations to restore damaged energy equipment
II PRIORITY	+2.5 GW of flexible generation and cogeneration (gas pistons and biofuel CHP)	• Funding and in-kind donations of necessary equipment
III PRIORITY	+0.5 GW of import capacity	• Permission for Ukraine to import more electricity
IV PRIORITY	+8.3 GW of renewables, +1.8 GW of storage systems	• Support with attracting concessional funding and engaging private capital
SUMMARY	+$15.5 bln investments over the 5-year horizon	

I PRIORITY RESOURCES TO PROTECT AND RESTORE ENERGY FACILITIES

Air defence and passive protection of the energy objects

Transfer of more air defence systems to Ukraine:

- MIM-104 Patriot
- SAMP/T

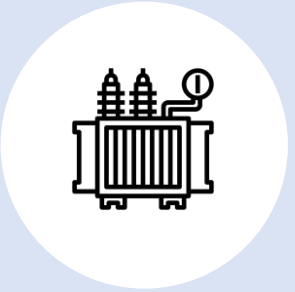
Support construction of passive protection of electricity, gas and oil industry facilities:

- **I level** (from missile and drone debris)
- **II level** (from direct hits of kamikaze drones)
- **III level** (confinement against missiles)

Funding and aid for emergency restoration/replacement of damaged energy equipment

Ukrainian energy companies funds, state budget funds

Equipment, loans and grants from Energy Support Fund, IFIs, USAID, UNDP, JICA



Transfer of decommissioned power equipment to Ukraine

II PRIORITY MANEUVERING GENERATION AND COGENERATION

Gas-fired maneuvering power plants

General need
1.4 GW

Used for fast balancing of the power system

Biofuel combined heat & power plants

General need
1.1 GW

Used for both electricity supply and heating supply

In the big cities – small plants up to 2-5 MW each
In industrial regions – up to 100 MW each

Received gas turbine power plants from international partners

Brought into operation:
1 installation of 1 MW

IRPIN

1 installation of 28 MW

BOIARKA

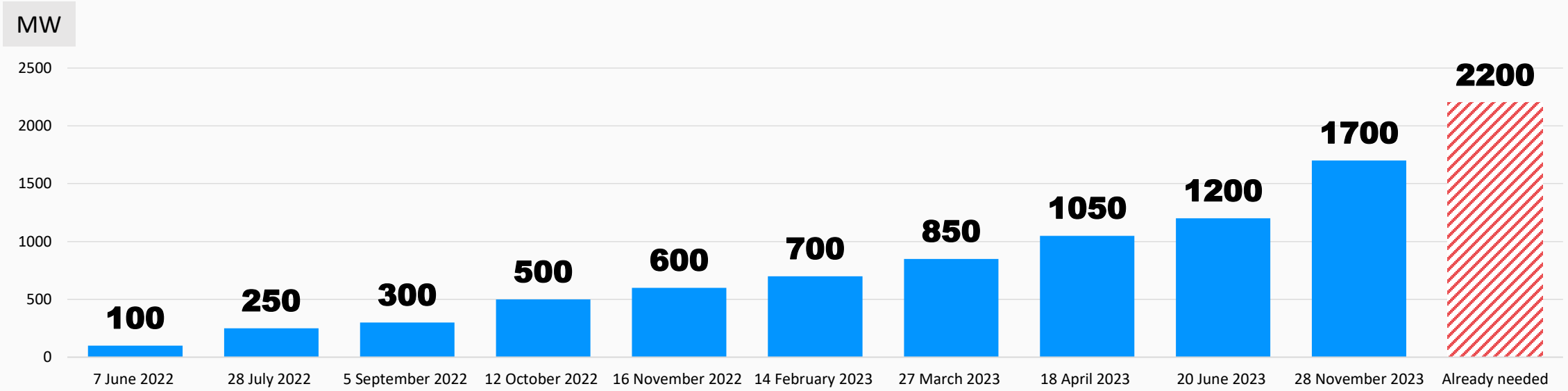
III PRIORITY EXPANSION OF ELECTRICITY IMPORTS TO UKRAINE TO COVER THE DEFICIT

1 As for now, the technical restrictions are on the side of the ENTSO-E TSOs adjacent to Ukraine, which does not allow increasing the amount of allowed imports

2 It is extremely important for Ukraine to increase the allowed capacity of imports up to at least 2200 MW

3 Therefore, it is necessary for the TSOs to solve all their technical obstacles as soon as possible

Chronology of the expansion of the allowed amount of electricity imports to Ukraine



IV PRIORITY NEEDS IN RENEWABLES AND ELECTRICITY STORAGE SYSTEMS

Energy storage

General need
0.8 GW

the ability to produce power for at least 4 hours

Wind energy

General need
in wind generation
4.5 GW

Solar energy

General need
in solar generation
3.8 GW

Dnistrovska pump storage plant

Completion of three hydro units (#5-7) with total capacity of

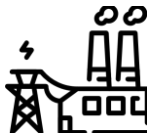
1 GW

SUMMARY NEEDS OF ADDITIONAL FUNDING FOR NEW GENERATION

IN NEXT 5 YEARS UKRAINE NEEDS:

1. New grants from partner governments to restore the electricity sector

2. Loans from IFIs not only for state-owned but also for private companies






Gas-fired plant	Biofuel	Energy storage	Wind	Solar	Dnistrovska pump storage plant
1.4 GW	**1.1 GW**	**0.8 GW**	**4.5 GW**	**3.8 GW**	**1 GW**
1.5 bln USD	**3.9 bln USD**	**0.7 bln USD**	**4.0 bln USD**	**2.7 bln USD**	**1.7 bln USD**

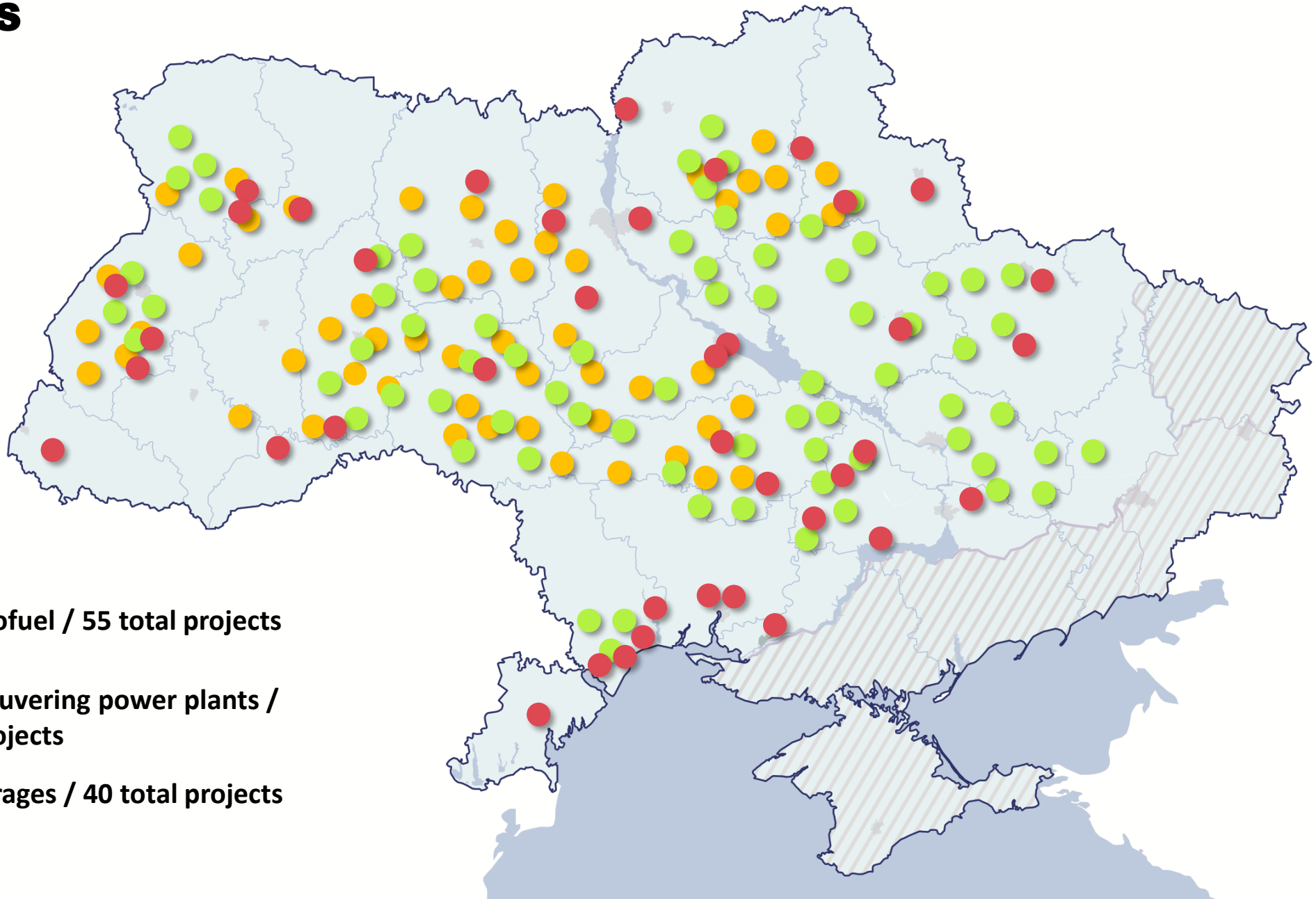
The required amount for the construction of 12.6 GW of the new generating capacities is 15.5 bln USD

ADDITIONAL INFORMATION

FIRST-LEVEL PROTECTION

SECOND-LEVEL PROTECTION

IDENTIFIED INVESTMENT LOCATIONS



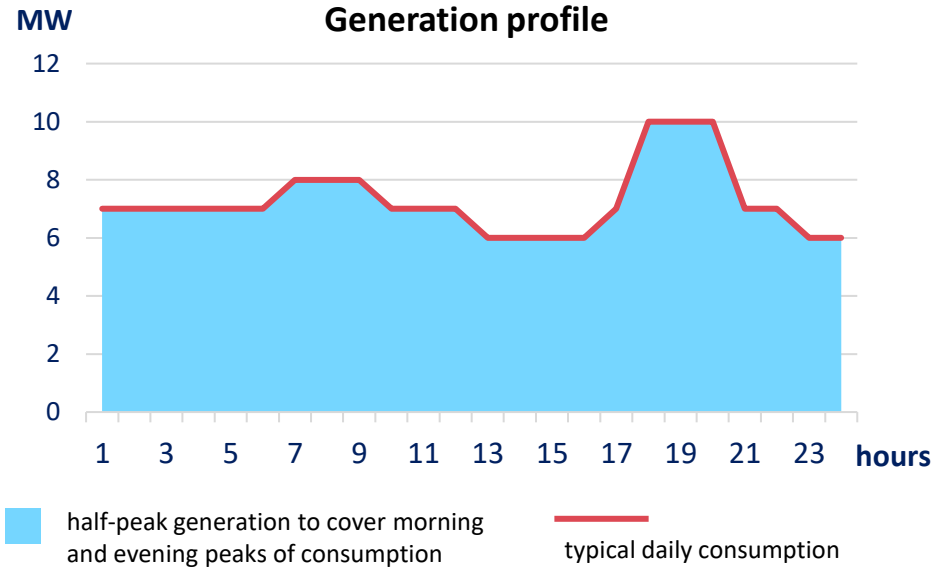
- TPPs on biofuel / 55 total projects
- High-maneuvering power plants / 70 total projects
- Energy storages / 40 total projects

BIOFUEL PLANT
(10 MW PROJECT MODEL)

Project investment
35 mln USD

Construction period
2-3 years

Fuel
Agro pellets, woodchips, solid household waste, biogas



GOALS MET:

- Phase-out of coal-based power generation;
- Creation of network of geographically-wise allocated biofuel power plants of total capacity **1.1 GW** to provide power to local cities and municipalities;
- Decreasing Ukraine need to import expensive coal and gas;
- CO2 emission reduction (biofuel vs fossil fuel);
- Decreasing solid municipal waste unused;
- Efficient disposal of agricultural and livestock wastes;
- Creation of additional competition in the energy market.

Commentary

Economic effect derived from assumption of selling power at average market rates and utilizing near costless source for fuel

INVESTMENT METRICS (FOR SAMPLE PURPOSE)*:

- **Investments = 35.0 mln USD**
- **Annual OPEX = 4.2 mln USD**
- **Annual Income = 8.0 mln USD**
- **Non-Discounted Payback Period = 9 years**
- **Useful life = 40 years**

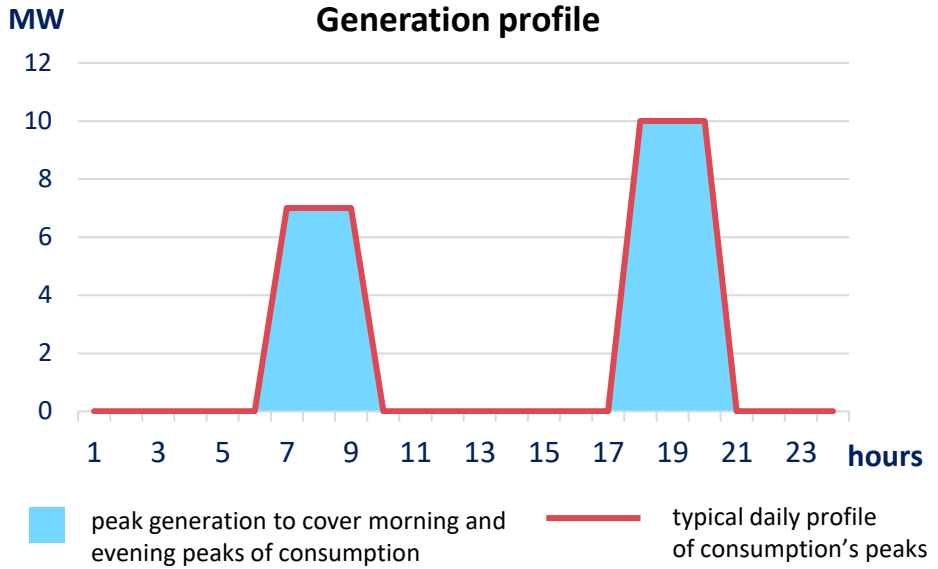
* taken into account only the income from the electricity trade; the thermal energy trade will improve the project metrics

HIGH-MANEUVERING POWER PLANT (10 MW PROJECT MODEL)

Project investment
11 mln USD

Construction period
2-3 years

Fuel
Biogas (depending on price dynamics), natural gas or hydrogen



GOALS MET:

With the goal to increase the degree of RES integration for its forecasted growing capacities in the most cost-effective way and in the shortest time possible, Ukraine power system needs to build up the total of **1.4 GW** of high-maneuvering generation capacities to be spread across the country in pre-selected locations

New high-maneuvering power plants:

- At least 4 times per day startups with a control range of at least 80% of the installed capacity and startup time not exceeding 15 minutes since dispatch command;
- Decrease the need to maintain respective balancing capacities stand-ready at old coal-fired power plants.

Commentary

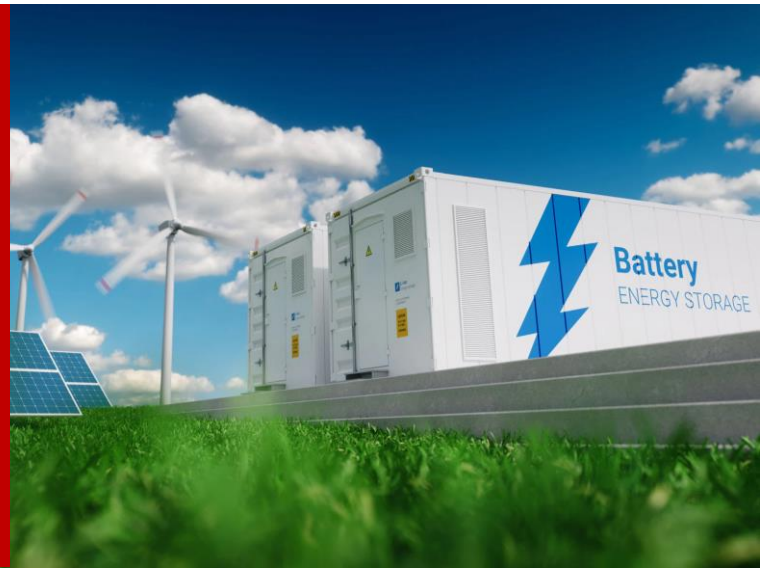
Economic effect is derived from the assumption that at peak hours, the electricity is sold only at high prices (> 200$ per MWh)

INVESTMENT METRICS (FOR SAMPLE PURPOSE):

- **Investment = 11 mln USD**
- **Annual OPEX = 0.7 mln USD**
- **Annual Income = 2.7 mln USD**
- **Non-Discounted Payback Period = 5 years**
- **Useful life = 70 years**

* taken into account only the income from the electricity trade; the thermal energy trade will improve the project investment metrics

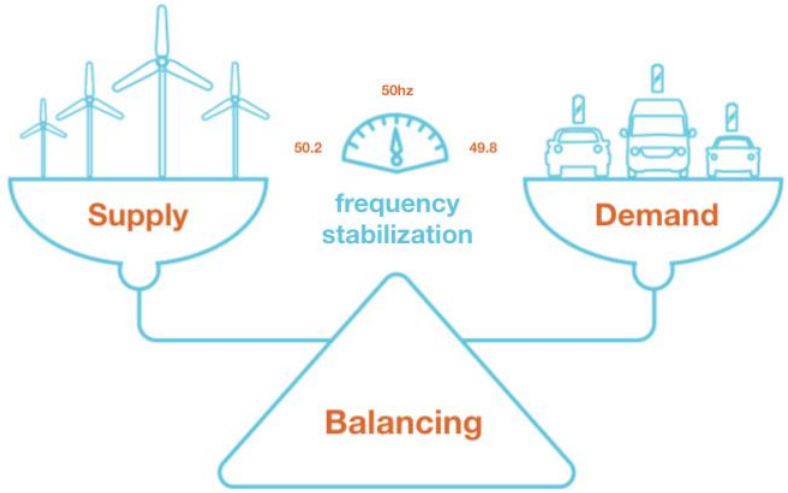
ENERGY STORAGE
(10 MW PROJECT MODEL)



Project investment
9 mln USD

Construction period
1 year

Energy storage technology
Battery energy storage systems (BESS) using lithium-ion or sodium-sulfur (Na-S) types



Energy storage systems are envisaged by Ukrenergo's Generation Adequacy Report in order to increase sustainability of Ukraine's Integrated Power System.
The goal is to build the network of energy storage facilities with installed capacity ranging from 5 to 35 MW with the total **capacity of 800 MW**, which can discharge for 2-4 hours to balance the system with high share of intermittent solar and wind power generation.

GOALS MET:

- Quick compensation of generation imbalance within ±740 MW range;
- Decreased need to keep on standby costly coal- or gas-fired capacities;
- Ability to increase RES use and integration;
- Meeting ENTSO-E requirement in terms of frequency and balance control

Comments

Economic effect is based on assumption that accumulated energy and readiness to turn on is sold as ancillary service for frequency containment reserves (FCR) and frequency restoration reserves (FRR) purposes

INVESTMENT METRICS (FOR SAMPLE PURPOSE):

- **Investments = 9 mln USD**
- **Annual OPEX = 3.1 mln USD**
- **Annual Income = 5.2 mln USD**
- **Non-Discounted Payback Period = 5 years**
- **Useful life = 10 years**

THANK YOU
FOR YOUR SUPPORT!