

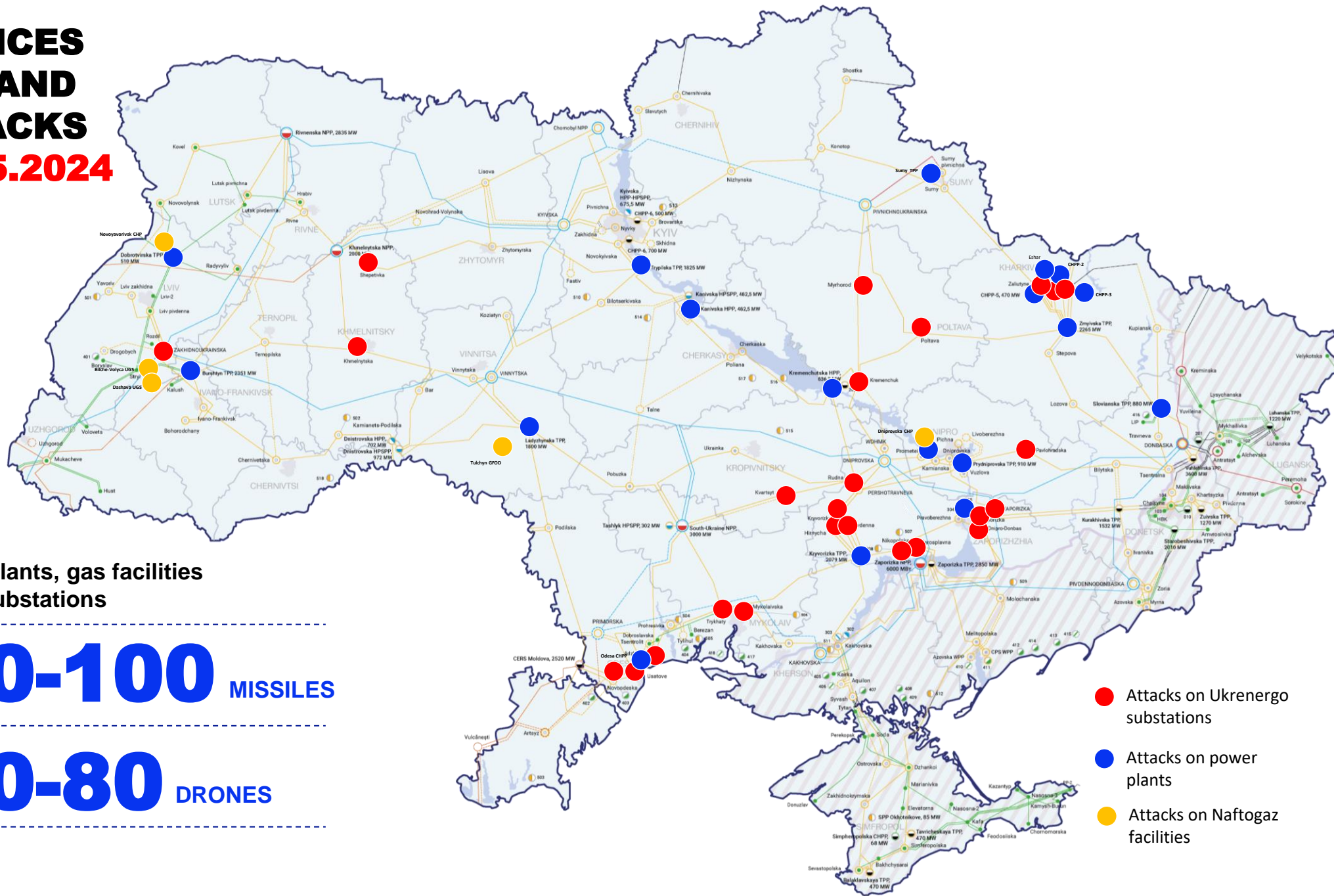


ADDRESSING UKRAINE'S ENERGY CHALLENGE

28 May 2024

CONSEQUENCES OF MISSILE AND DRONE ATTACKS

30.01 – 18.05.2024

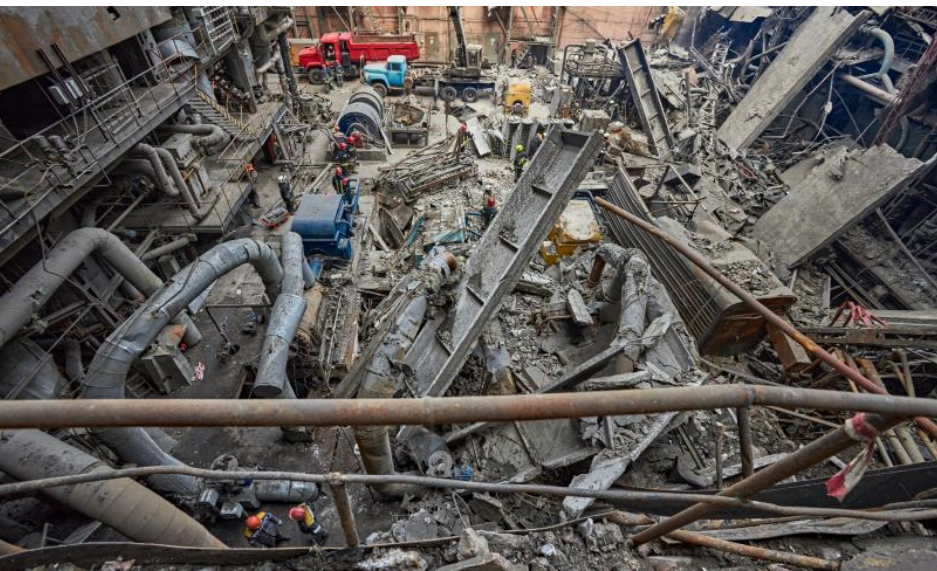


90-100 MISSILES



70-80 DRONES

DAMAGED THERMAL POWER PLANTS (KEY FLEXIBLE GENERATION)



DAMAGED HYDROPOWER PLANTS (KEY FLEXIBLE GENERATION)



DAMAGED HIGH-VOLTAGE SUBSTATIONS (KEY TRANSMISSION NODES)



URGENT NEEDS OF EQUIPMENT FOR UKRAINIAN POWER SECTOR*

Voltage transformers



8
pcs

Power unit transformers



20
pcs

Generators



11
pcs

Circuit breakers



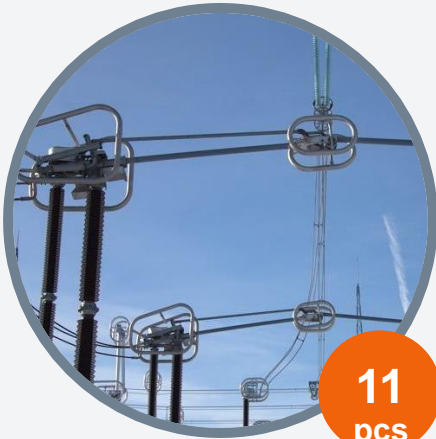
19
pcs

Autotransformers



24
pcs

Disconnectors



11
pcs

Current transformers



12
pcs

Hydrogenerators



3
pcs

Turbines



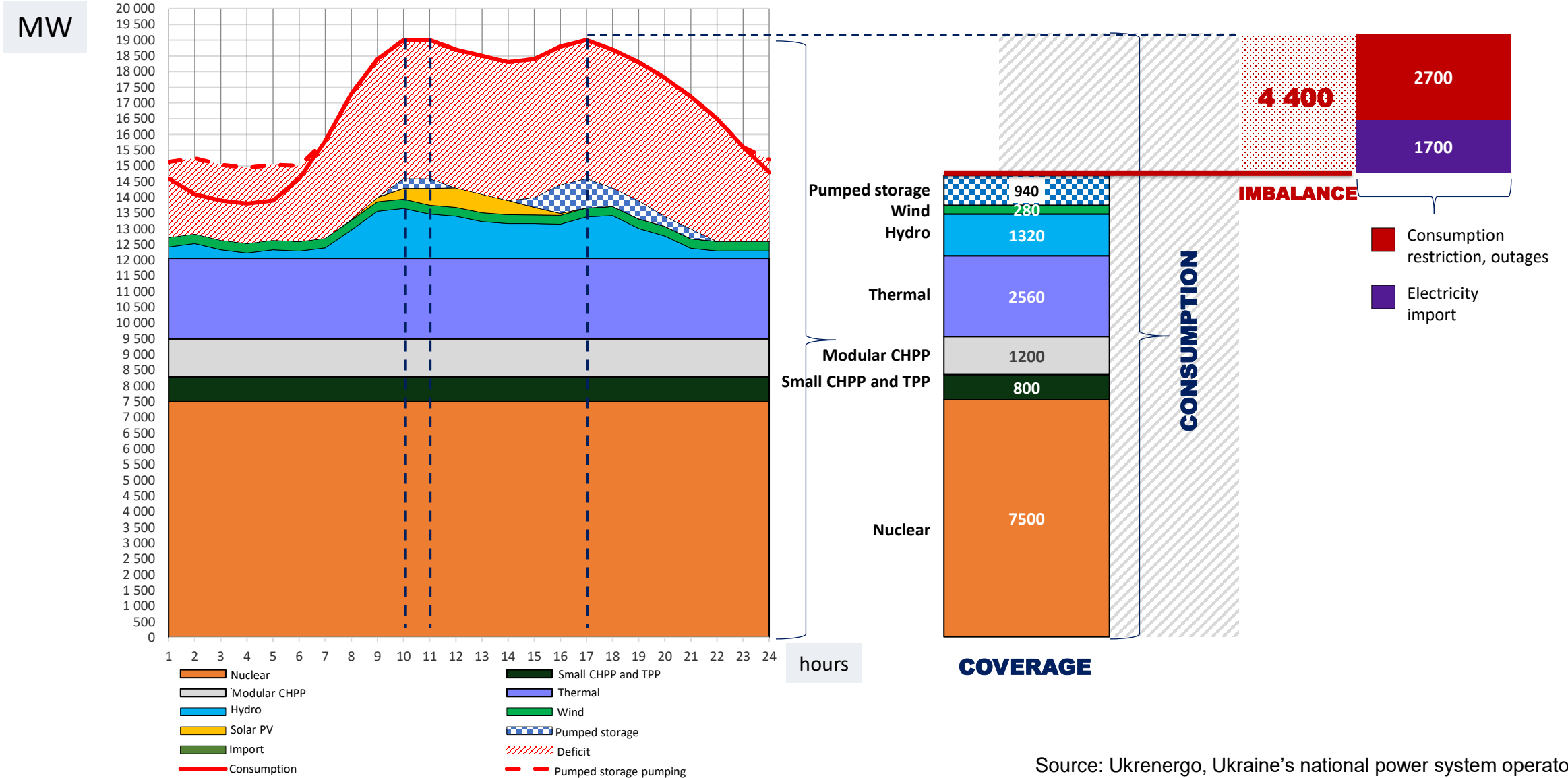
2
pcs

*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





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

ENERGY SECTOR PRIORITIES

What is needed:

- I PRIORITY** resources to protect and restore energy facilities
- II PRIORITY** +2.5 GW of flexible generation and cogeneration (gas pistons and biofuel CHP)
- III PRIORITY** +0.5 GW of import capacity
- IV PRIORITY** +8.3 GW of renewables, +1.8 GW of storage systems
- SUMMARY** +\$15.5 bln investments over the 5-year horizon

What we ask from you:

- Air defence and passive protection of energy objects
- Funding and in-kind donations to restore damaged energy equipment
- Funding and in-kind donations of necessary equipment
- Permission for Ukraine to import more electricity
- Support with attracting concessional funding and engaging private capital

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

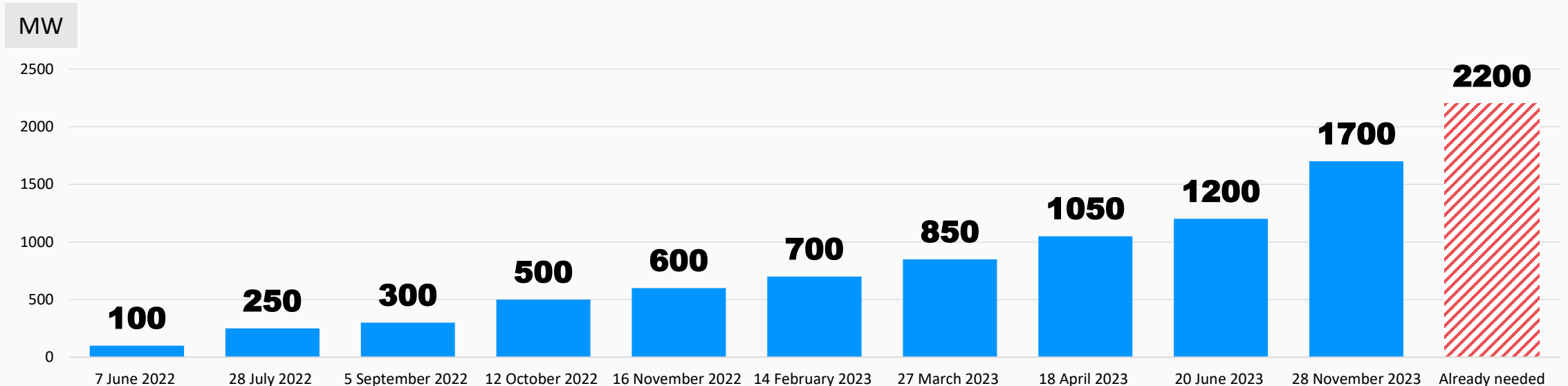
III PRIORITY EXPANSION OF ELECTRICITY IMPORTS TO UKRAINE TO COVER THE DEFICIT

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



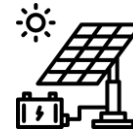
Wind energy



General need
in wind generation
4.5 GW



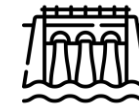
Solar energy



General need
in solar generation
3.8 GW



Dnistrovskaya pump storage plant



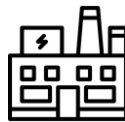
Completion of three
hydro units (#5-7) with
total capacity of
1 GW

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	Dnistrovskia 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

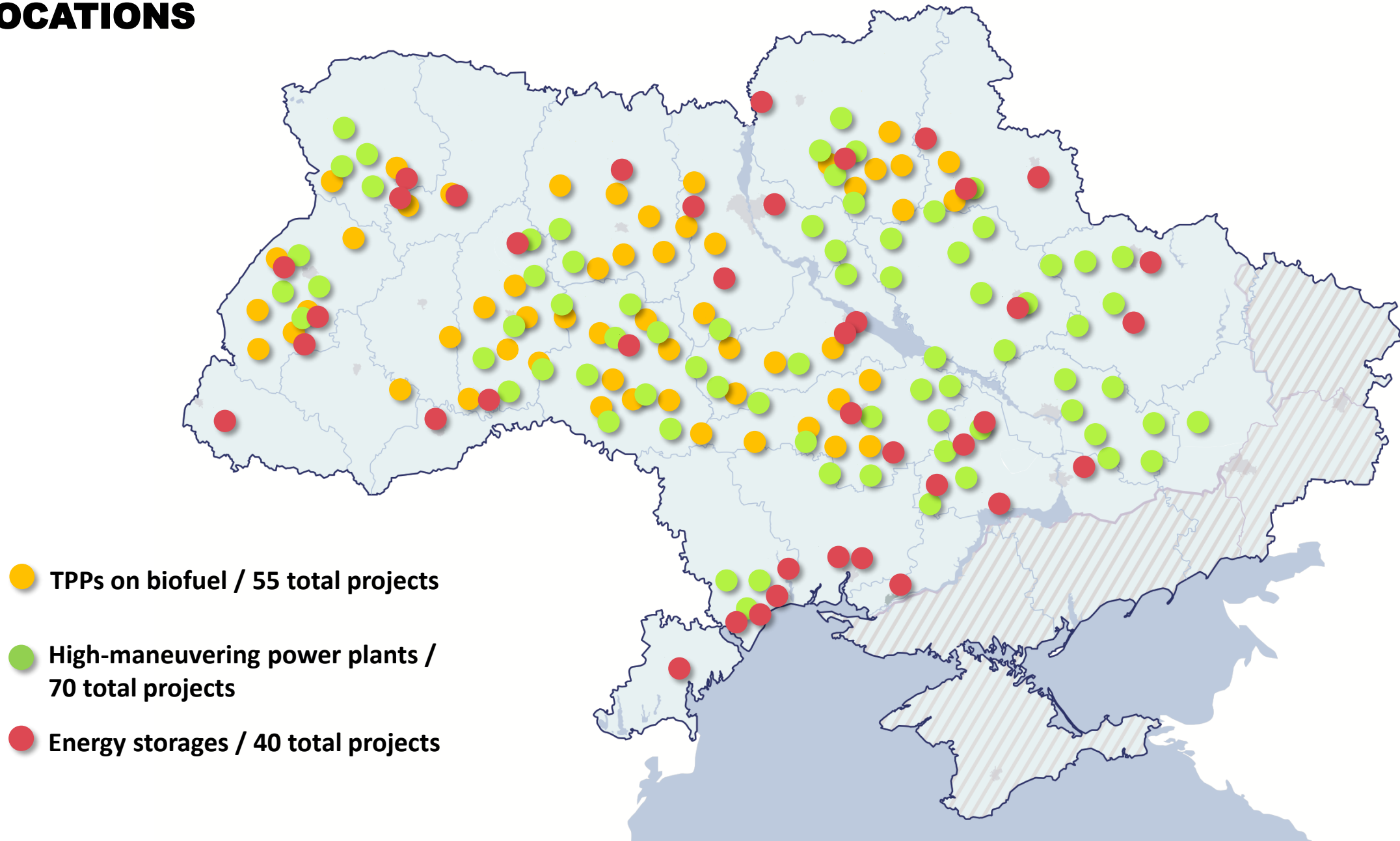
FIRST-LEVEL PROTECTION



SECOND- LEVEL PROTECTION



IDENTIFIED INVESTMENT LOCATIONS



BIOFUEL PLANT (10 MW PROJECT MODEL)



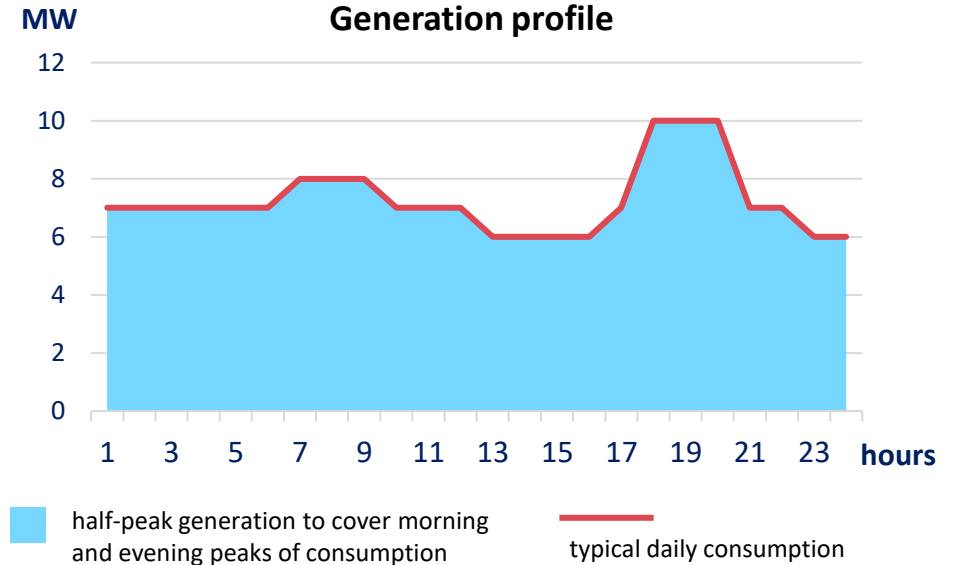
Project investment
35 mln USD



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)



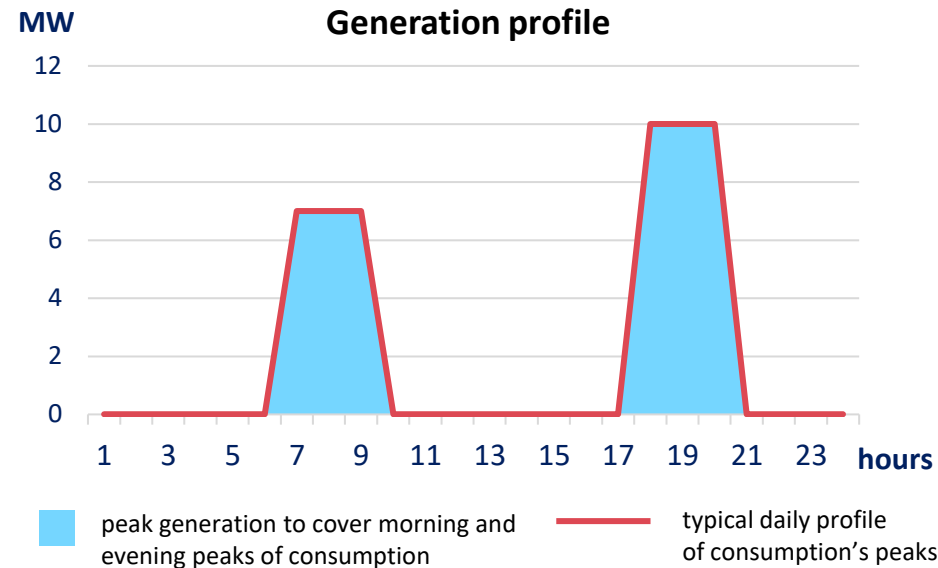
Project investment
11 mln USD



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)



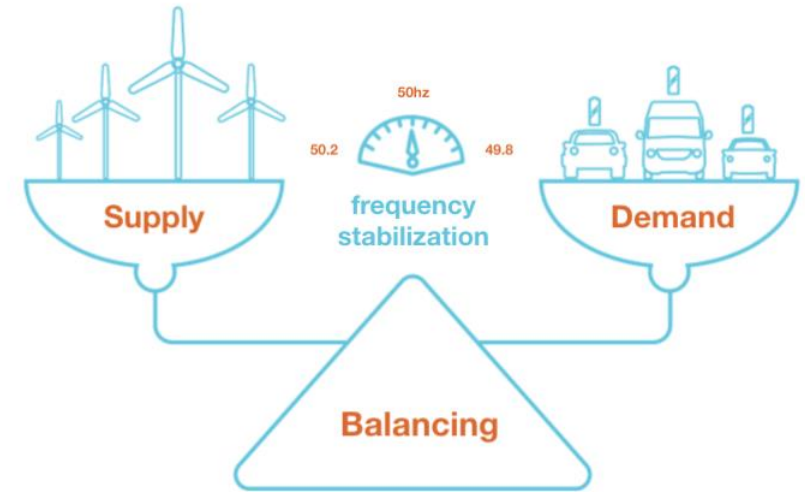
Project investment
9 mln USD



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!