

## UA energy infrastructure restoration needs

Since the beginning of the full-scale Russian military invasion of Ukraine, energy infrastructure has been one of the major targets for hostile bombs and missiles. On 10-12 October, the enemy launched the biggest missile and drone attack on power infrastructure in Ukraine since February, which was probably also the biggest military attack on energy infrastructure in world history. On 17-19 October, Russia once again attacked grid infrastructure all over Ukraine with missiles and Iranian kamikaze drones. On 22 October, Russia targeted the energy grid in the western part of Ukraine that resulted in catastrophic damages to the stable and reliable functioning of energy infrastructure of Ukrenergo.

The scale of destruction is unseen and by the rough estimates, around 40 percent of Ukrenergo's substations is damaged. After each attack, Ukrenergo's specialists put all available resources to stabilize the system and restore power supply. However, damages to infrastructure and power equipment are so severe that Ukrenergo was forced to apply emergency restrictions of electricity supply to consumers. Additionally, the emergency stock of equipment and materials required for restoration is exhausted.

The top priority for replenishment is the autotransformers fleet. As of today, the need, including the replenishment of the emergency stock is the following:

- AT 750 kV - eleven phases;
- AT 330 kV - sixteen units;
- AT 220 kV - six units.

The amount of other damaged primary equipment (high voltage circuit breakers, disconnectors, surge arresters, measurement transformers, and shunt reactors) is tremendous as well.

Just a few figures for a clearer picture:

- current transformers 750 kV - 21 phases;
- circuit breakers 330 kV – 15 units in 3-phase set;
- circuit breakers 110 kV - 25 units in 3-phase set;
- disconnectors 110 kV with one earthing switch - 33 units in 3-phase set;
- voltage transformers 220 kV - 15 phases, etc.

Another priority is the relay protection and automation devices. The current demand constitutes at least of:

- 13 sets of distance and overcurrent protection;
- 20 sets of circuit breaker control automatics;
- 6 sets of differential busbar protection;
- 10 sets of command transmission equipment.

As for thermal power plants, the needs are also substantial. In particular:

- circuit breakers 110 kV - 6 units in 3-phase set;
- circuit breakers 330 kV – 3 units in 3-phase set;
- disconnectors 110 kV with one earthing switch - 9 units in 3-phase set;
- current transformers 110 kV - 6 phases;
- voltage transformers 110 kV - 3 phases, etc.

The hydropower system is at risk as well and JSC Ukrhydroenergo needs the replenishment of its emergency stock of autotransformers 330 kV (7 units) and power transformers 330 kV (4 units) and 110 kV (7 units).

In accordance with Ukrenergo's projection, the full replenishment of the damaged equipment might take up to several years.