



# **The impact of the armed conflict in Ukraine on the Ukrainian and European nuclear R&D&I landscape**

## **Techno-Economic Study**

## **Executive summary**

The Executive summary was consolidated by the SNETP based on the study delivered by ENCO in the context of the EU (Euratom Programme) funded collaborative project SNETPFORWARD.

The study is available on the SNETP Members Area.

The ongoing armed conflict in the Ukraine since 24th of February 2022, has negatively impacted the country's nuclear sector. Through this techno-economic study on the impact of the Ukrainian conflict, SNETP aims to establish a greater understanding of the scale of the effect on the country's nuclear Research, Development, and Innovation (R&D&I) platform, understand resulting gaps, and to identify the degree and type of support by European countries required to fill those gaps.

Before Russia's occupation of Crimea and the political unrest in the Donbass region of Ukraine which started in 2014, Ukraine's nuclear industry included more than 5000 organizations (state authorities, regulatory authorities, state, and private enterprises, as well as research and educational institutions). The activities of those organizations varied considerably but involved all phases of the fuel cycle (excluding enrichment and fuel fabrication). But also the safe management of radioactive waste (RAW), provision of industry support services, manufacture of specialist equipment and supply, as well as the supply, storage, and transportation of radioactive substances and ionizing radiation sources utilized within industry and medical institutions. Given the situation in Ukraine since 2014, it is not fully understood how many of those organizations remain in operation.

The State Agency of Ukraine on Exclusion Zone Management (SAUEZM) manages the **Chornobyl Exclusion Zone** (ChEZ) and exercises state governance in the field of RAW management. The ChEZ was occupied by Russian forces in spring of 2022. Whilst not direct impact to stored nuclear, radioactive, or contaminated materials was identified, the inspections identified significant damage to the nuclear and radiation safety infrastructure of the Zone, with an estimated repair cost of more than €100 million. The corrective measures related to recovering nuclear and radiation safety within the Chornobyl Exclusion Zone are currently underway with extensive support from the International Donor Community.

Ukraine's Joint Stock Company National Nuclear Electricity Generation Company Energoatom operates 15 nuclear units of VVER type at four sites, from which the Zaporizhzhia NPP came under Russian control in 2022. Following a series of serious incidents at the site of ZNPP, including the loss of cooling water supplies due to the destruction of the Kakhovka Dam and draining of the Kakhovka reservoir in June 2023, all six units of the ZNPP have been in shut-down mode. The available electrical capacity from nuclear generation in Ukraine is currently reduced to 7835 MW.

Despite the armed conflict in Ukraine, Energoatom maintains focus on implementing its long-term strategy, to optimise the operational life of the existing NPP Units, ensure its independence from Russian manufacturers, and introduce new nuclear technologies for the future. Over and above the intention to procure the two VVER-1000 Units sold by Bulgaria and a further seven AP1000 Units from Westinghouse, Energoatom maintains its interest in the future application of SMR Units.

Ukraine has several Nuclear Research Institutes working with industry to ensure its long-term sustainability, and to support the appropriate application of developing technologies and methodologies. The National Academy of Sciences of Ukraine (NASU) is the main center for the development of science and technology through the coordination of a system of research institutes, by fourteen separate departments. The impact of the armed conflict on state scientific institutions, particularly those involved in supporting Ukraine's nuclear sector and supporting the safe operation of nuclear installations and energy facilities, has been significant.

Kyiv Institute for Nuclear Research (KINR) has incurred substantial damage caused to its scientific and technical infrastructure as a result of impact from shelling. The KNIR Research Reactor is currently in shut down mode with all fuel in safe storage. The Kharkiv Institute of Physics and Technology (KIPT) suffered extensive infrastructure damage, the loss of scientific equipment, insecurity of site supplies. Institute for Safety Problems of Nuclear Power Plants (ISPNNP), situated in the city of Chornobyl, suffered significant damage and losses during the first month of the armed conflict. Also the KINR and especially KIPT and

ISSNP were significantly affected by the reduction in the numbers of scientists due to the war and resulting martial law (migration to safer areas of Ukraine or in some cases, abroad, mobilisation to the armed forces of Ukraine and security services).

Many of Ukraine's universities offer an education in engineering, but few specialise in Nuclear Science and nuclear energy-related engineering subjects. This study considers the seven most important universities in Ukraine, from which prior to 2022, many of the most accomplished scientists and engineers working within Ukraine's nuclear sector graduated. Those are the Kyiv National Technical University, the Kyiv National University, the Kharkiv National University, the Vinnytsia National Technical University, the L'viv National Polytechnic University, the Odesa Polytechnic National University, and the Ukrainian State University of Science and Technologies.

Whilst all educational institutions have been, and continue to be affected by the war, the Kharkiv National University and the National University of Kyiv, have been impacted the most. Excluding Lviv and Vinnytsia Universities, there is a common problem related to the outflow of lecturers, whilst excluding Kharkiv, the number of students has remained static but increased in safe areas such as Vinnitsa and Lviv. As with the Research Institutes, the Universities rely heavily on the state budget to cover overheads and capital investments, which during the current situation in Ukraine is proving impossible.

To come to concluding remarks and recommendations, given the lack of state resources due to the war, it would be impossible in the short or even medium term for Ukraine to address the impact issues and implement the necessary corrective actions. Additionally, not addressing the issues in the short term will introduce a longer-term risk related to the sustainable safe operation of Ukraine's nuclear sector. To address these issues and maintain sufficient level of education, similarly to Scientific Institutions, several measures are necessary:

- Financial support and assistance, for the restoration of damaged buildings and infrastructure as well as for the replacement of damaged and lost equipment.
- Support from European and International institutions in the preparation of modern educational programs, addressing current and future needs of Ukrainian Nuclear Industry.
- Providing online courses from Western universities free of charge to Ukrainian students, twinning programmes for universities with an emphasis on student exchange experience.
- Facilitating an increased involvement of the Ukrainian Research Institutes and Universities in the implementation of European research projects.

Based on the long-term strategic plans, SNETP together with the Academy and Ministry would be able to establish a road map of post war recovery, ensuring the implementation support in accordance with agreed priorities. Once approved, implementation of the roadmap could be planned on an annual basis and implemented in accordance with available funding. It should be noted that whilst the above planning could be implemented, it is not recommended to implement activities associated with reconstruction of infrastructure in areas of high risk, such as Kharkiv, until the armed conflict is over.