Developer

NEK

SUPPLEMENT FOR ASSESSMENT OF THE ACCEPTABILITY OF THE IMPACTS ON PROTECTED AREAS

for the extension of NEK's operational lifetime from 40 to 60 years – Nuklearna elektrarna Krško d.o.o.

Contractor

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CONTENT OF REPORT

Pursuant to the Decree on Special Protection Areas (Natura 2000 Areas) (Official Gazette of RS, Nos. 49/04, 110/04, 59/07, 43/08, 8/12, 33/13, 35/13 – corrigenda, 39/13 – Constitutional Court Decision, 3/14, 21/16 and 47/18), the Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206 of 22 July 1992, p. 7), as last amended by Council Directive 2013/17/EU of 13 May 2013 adapting certain directives in the field of the environment, by reason of the accession of the Republic of Croatia (OJ L No 158 of 10 June 2013, p. 193), and Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (OJ L 20 of 26 January 2010, p. 7), as last amended by Council Directive 2013/17/EU of 13 May 2013 adapting certain directives in the field of the environment, by reason of the accession of the Republic of Croatia (OJ L 158 of 10 June 2013, p. 193), are transposed into the legislation of the Republic of Slovenia.

The Supplement is drawn up in accordance with the Rules on the assessment of the acceptability of effects caused by the execution of plans and activities affecting nature in protected areas (Official Gazette of RS, Nos. 130/04, 53/06, 38/10 and 3/11). Article 2 of these Rules provides that the assessment of the acceptability for a plan or activity affecting nature, the implementation of which could, in itself or in connection with other plans or activities affecting nature (hereinafter: cumulative impact), have a significant impact on protected areas and Natura sites (hereinafter: protected areas), is to establish the expected impacts and assess the acceptability of their implementation on the objectives of protected areas and their integrity and interconnection, including the interconnection of the European Natura 2000 ecological network. Annex 8 to the above Rules specifies the content of the Supplement by sections and the form of its presentation. This document fully follows the structure prescribed by Annex 8 to the above Rules.

1 NAME AND BRIEF DESCRIPTION OF THE ACTIVITY

The subject of the discussion is the extension of NEK's operational lifetime from 40 to 60 years, i.e. from 2023 to 2043.

Nuklearna elektrarna Krško, d.o.o. (hereinafter: NEK) produces approximately 38% of total Slovenian electricity, making it one of Slovenia's largest producers of electrical energy. NEK is equipped with Westinghouse's pressurised light-water reactor with thermal power of 1994 MW. Its net electrical output is 696 MW. The power plant is connected to the 400 kV network that supplies electricity to consumers in Slovenia and Croatia. The power plant began commercial operations in 1983. At the time of construction, a minimum operational lifetime of forty years was envisaged for the facility. However, a number of safety and other upgrades, including numerous analyses, were carried out which indicate that from the point of view of climate protection, the reduction of greenhouse gas (GHG) emissions, phasing out the use of fossil fuels, safety and economy, the extension of NEK's operational lifetime would be a prudent solution that is also recognised globally. Technical conditions have therefore been put in place for NEK to operate for at least another twenty years, i.e. to the end of 2043.

NEK has in the past already performed all the necessary analyses and safety updates, and acquired all the permits necessary for them and the agreement of the Slovenian Nuclear Safety Administration. NEK has thus replaced all key equipment to ensure further uninterrupted, safe, reliable and environmentally compliant production of electricity. The above actions have already established the technical preconditions necessary for the extension of the operational lifetime. Therefore the extension of NEK's operational lifetime does not change neither the position or location of the power plant, its dimensions and technical design, nor its production capacity and its operation mode. The only change concerns the operational lifetime of the facility, which is extended by 20 years, i.e. from 40 to 60 years. Construction of new structures or facilities that would change the physical properties of NEK is not foreseen.

2 INFORMATION ABOUT THE PLANNED ACTIVITY

2.1 The space or area included in the activity

The site of the activity is in the Municipality of Krško, southeast of the town of Krško, in the cadastral municipality of Leskovec, at the address Vrbina 12, Krško. This is an area of long-term energy use on the left bank of the Sava.

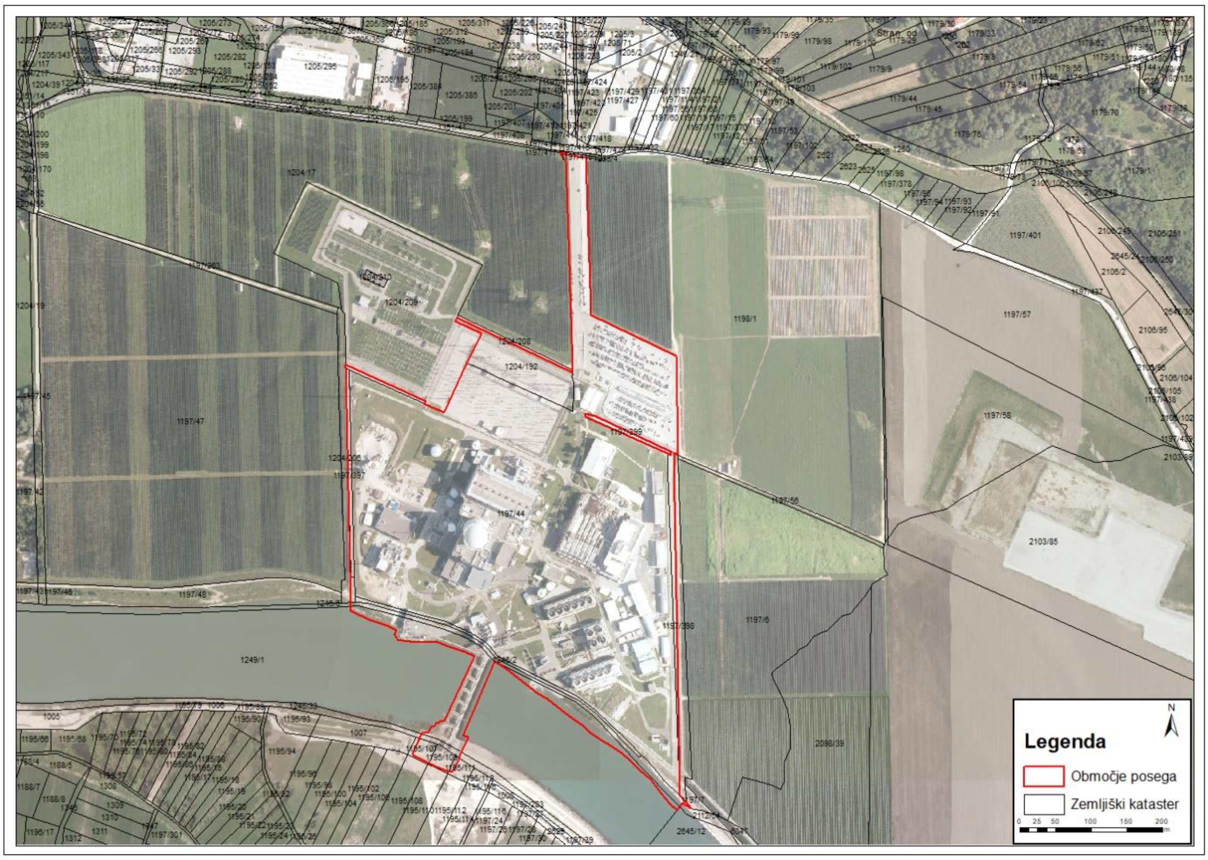

Figure 1: Area of the activity (NEK, 2020)

Legenda	Key
Območje posega	Area of the activity
Zemljiški kataster	Cadastral register

The area of the activity is located on land with the following parcel numbers:

- plots owned by NEK: 1197/44, 1204/192, 1197/397, 1246/2, 1197/398 (partly) and 1204/206 (partly), all in cadastral municipality (1321) Leskovec.
- parts of plots, on which NEK holds building rights: 1204/209, 1246/6, 1249/1, 1246/33, 1195/107, 1195/109, 1195/111, all in cadastral municipality (1321) Leskovec.

2.2 Designations of the intended use of land, its extent and orientation, the spatial distribution of activities or the spatial orientation and extent of the planned activities affecting nature

The basis for the siting of facilities is the Ordinance on NEK's development plan (Official Gazette of the SRS, No. 48/87, Official Gazette of RS, Nos. 59/97 and 21/20).

The intended use of land at the NEK site is defined by the following ordinances:

- Ordinance on the municipal spatial plan (OPN) for the area of the Krško Municipality (Official Gazette of RS, No. 61/15);
- Ordinance on NEK's development plan (Official Gazette of the SRS, No. 48/87);
- Amendments to the Ordinance on NEK's development plan (Official Gazette of RS, No. 59/97).
- Amendments to the Ordinance on NEK's development plan (Official Gazette of RS, No. 21/20).

According to the spatial planning document, the site of the activity is located in an area of building land intended for:

- E – energy infrastructure, in spatial planning unit (EUP) KRŠ 025;
- VI – water infrastructure area, in spatial planning unit (EUP) HJE 01.

The NEK complex is surrounded by agricultural land (K) in the north, east and west, and aquatic land of the Sava (VC) in the south. There are also areas of economic activity (IG) in the northern surroundings.

The nearest residential areas are located northeast (buildings in Spodnji Stari Grad), at a distance of approximately 500 m, north (buildings in Spodnja Libna) at a distance of approximately 550 m and approximately 1.4 km west (Žadovinek) from the site of the planned lifetime extension.

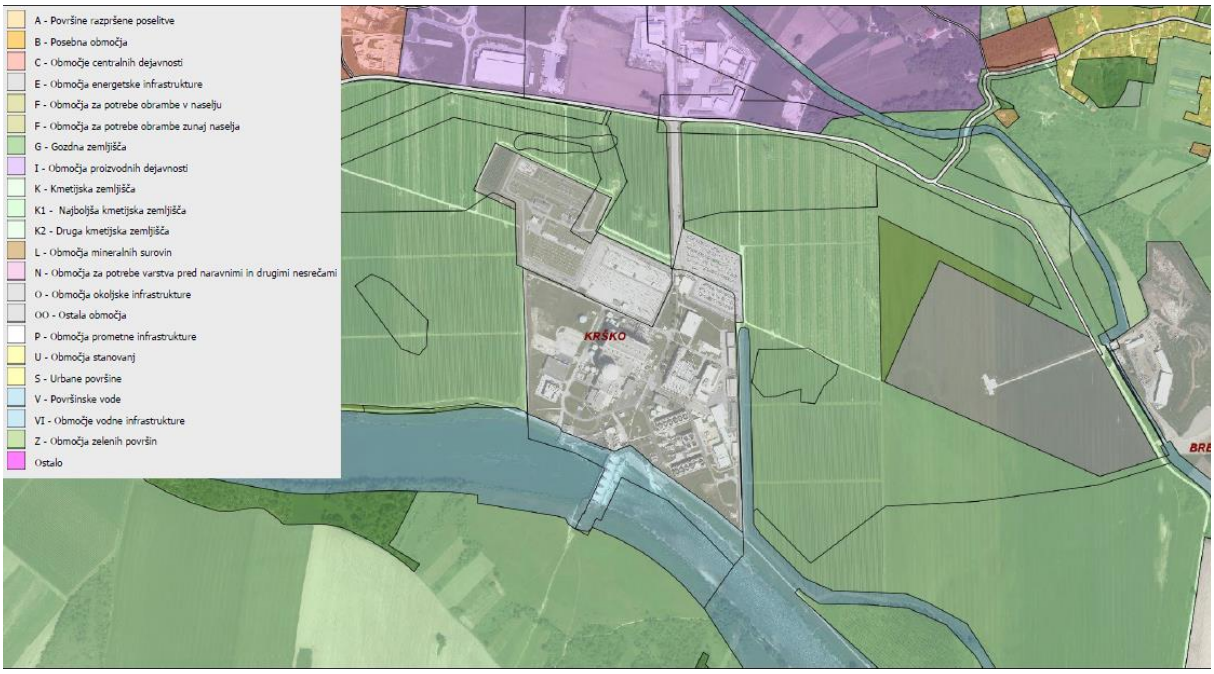

Figure 2: Intended use of land (source: Krško's Municipal Spatial Plan)

A – Površine razpršene poselitve	A – areas of dispersed settlement
B – Posebna območja	B - special areas
C – Območje centralnih dejavnosti	C – area of central activities
E – Območja energetske infrastrukture	E – energy infrastructure areas
F – Območja za potrebe obrambe v naselju	F – urban areas intended for defence
F – Območja za potrebe obrambe izven naselja	F – non-urban areas intended for defence
G – Gozdna zemljišča	G – forest land
I – Območja proizvodnih dejavnosti	I – areas intended for manufacturing
K – Kmetijska zemljišča	K – agricultural land
K1 – Najboljša kmetijska zemljišča	K1 – best agricultural land
K2 – Druga kmetijska zemljišča	K2 – other agricultural land
L – Območja mineralnih surovin	L – mineral raw material areas
N – Območja za potrebe varstva pred naravnimi in drugimi nesrečami	N – areas for protection against natural and other disasters
O – Območja okoljske infrastrukture	O – environmental infrastructure areas
OO – Ostala območja	OO – other areas
P – Območja prometne infrastrukture	P – transport infrastructure areas
U – Območja stanovanj	U – residential areas
S – Urbane površine	S – urban areas
V – Površinske vode	V – surface water
VI – Območje vodne infrastrukture	VI – water infrastructure area
Z – Območja zelenih površin	Z – green areas
Ostalo	Other

North of the location the following manufacturing companies operate:

- SECOM d.o.o.,
  principal activity: 22.230 (Manufacture of products from plastic for construction);
- GEN Energija d.o.o.,
  principal activity: 64.200 (Activities of holding companies);
- GEN-I, d.o.o.,
  principal activity: 35.140 (Electricity trading);
- Saramati Adem, d.o.o.,
  principal activity: 41.200 (Construction of residential and non-residential buildings);

East of the location the following companies operate:

- KOSTAK d.d. Center za ravnanje z odpadki (IED installation),
  principal activity: 36.000 (Water collection, treatment and supply);

At a distance of 800–2,000 m from the location, there are three IED installations: VIPAP VIDEM KRŠKO d.d., KRKA d.d., and KOSTAK d.d. There are currently no installations with upper-tier or lower-tier major accident hazard (Seveso) in the area of Krško.

2.3 Extent and other basic data concerning the planned activities affecting nature

The data concerning the activity are a summary of the document Project: Long Term Operation of Krško Nuclear Power Plant (2023–2043) (NEK d.o.o. NEK No. ESD-RP-205, October 2021). A more detailed description of the activity is provided in the Environmental Impact Assessment Report for the extension of NEK's operational lifetime from 40 to 60 years – Nuklearna elektrarna Krško d.o.o. (E-net okolje d.o.o., Ljubljana, October 2021).

2.3.1 NEK technology

NEK produces heat through the fission of uranium nuclei in the reactor. The reactor consists of the reactor vessel with its fuel elements which constitute the core. In the primary circuit, demineralised water with boric acid circulates through the reactor. Under pressure it carries the released heat into the steam generators. In the steam generators on the secondary side, steam is produced which drives the turbine and this in turn drives the electricity generator. When the steam leaves the turbine it condenses in the condenser which is cooled by water from the Sava. The condensate is then pumped back into the steam generators where it again turns into steam. Water from the Sava flows through the condenser (the so-called tertiary loop), where it makes the steam condense and rejects surplus energy into the river. All the reactor equipment and that of the corresponding primary cooling loop is located in the reactor building which is also called the containment building because of its function.

The reactor vessel containing the fuel elements is tightly closed and under high pressure during operation. The power plant's operation must be shut down and the reactor coolant system cooled down when the planned refuelling is to be carried out. The period between two refuellings is called the fuel cycle, which lasts 18 months at NEK. After the end of each fuel cycle the spent fuel elements are replaced with fresh ones. A fuel element usually stays in the core for at least two fuel cycles.

2.3.1.1 Primary Circuit

The primary circuit consists of: the reactor, steam generators, reactor coolant pumps, pressuriser and piping.
The heat released in the reactor core heats the water which circulates in the primary circuit. The heat of the water is transmitted through the walls of the pipes in the steam generators to the water in the secondary circuit. The circulation of the water in the primary circuit is ensured by the reactor coolant pumps. The pressuriser maintains the pressure in the primary circuit and prevents the water from boiling at the core. All components of the primary circuit are installed in the containment that isolates the primary system from the environment, even in the event of an incident.

2.3.1.2 Secondary Circuit

The secondary circuit consists of: the steam generators, turbine, generator, condenser, feed water pumps and piping. The steam generators are in fact boilers in which water from the secondary circuit evaporates to steam to power the turbine. In the turbine the energy from the steam is converted into mechanical energy. The generator converts this energy into electricity and transfers it to the electricity grid via transformers.
Spent steam from the turbine flows into the condenser where in contact with cold pipes it condenses, i.e. is converted into water. The feed water pumps pump the water from the condenser back into the steam generator where steam is again produced.

2.3.1.3 Tertiary Circuit

The tertiary circuit consists of: the condenser, cooling pumps, cooling towers and piping. The tertiary circuit is intended for cooling the condenser and removing the heat, which cannot be usefully utilised for electricity production. The cooling pumps draw the water from the Sava into the condenser and then discharge it back to the river. When the water flows through the condenser, it heats, as it absorbs the heat from the spent steam. Heating the river water is the power plant's most significant impact on the environment as it can affect the biological properties of the Sava. This impact is limited by administrative decisions specifying the permitted temperature increase and the amount of water intake. In the event of adverse weather conditions, the cooling towers are used. In extremely unfavourable weather conditions, the power of the nuclear power plant has to be reduced to keep the set values within the specified limits.

2.3.1.4 Basic technical data about the facility

Basic technical characteristics are given in the tables below.

Table 1: Basic data about the power plant

Reactor type:	Pressurised light-water reactor
Reactor thermal power:	1994 MW
Gross electric power:	727 MW
Net electric power:	696 MW
Thermal efficiency:	36.6%

Table 2: Basic data about the fuel

Number of fuel elements:	121
Number of fuel rods in a fuel element:	235
Fuel rod array:	16 x 16
Fuel rod length:	3.658 m
Cladding material:	Zircaloy-4, ZIRLO
Chemical composition of fuel:	UO_2
Total quantity of uranium:	48.7 tonnes

Table 3: Basic data about the reactor coolant

Chemical composition:	H_2O
Additives:	H_3BO_3
Number of cooling loops:	2
Pressure:	15.41 MPa (157 ata)
Temperature at reactor inlet:	287°C
Temperature at reactor outlet:	324°C

Table 4: Basic data about the control rods

Number of control rod assemblies:	33
Neutron absorber:	Ag-In-Cd
Composition percentage:	80-15-5%

Table 5: Basic data about the steam generators

Material:	INCONEL 690 TT
Number of steam generators:	2
Pressure of steam leaving generator:	6.5 MPa (63.5 ata)
Steam flow rate from both generators:	1,088 kg/s

Table 6: Basic data about the turbine and generator

Maximum power:	730 MW
Inlet pressure of fresh steam:	6.4 MPa (63 ata)
Temperature of fresh steam:	280.7°C
Turbine rotation speed:	157 rad/s (1500 rot./min)
Steam moisture at inlet:	0.10%
Condensation pressure (vacuum):	5.1 kPa (0.052 ata)
Average condensate temperature:	33°C
Rated power of generator:	850 MVA
Rated voltage:	21 kV
Rated frequency of generator:	50 Hz
Rated cos θ:	0.876

Table 7: Basic data about the transformers

Block transformers	
Rated power:	2 x 500 MVA
Voltage ratio:	21/400 kV
Unit transformers	
Maximum permitted continuous power:	2 x 30 MVA
Voltage ratio:	21/6.3 kV
Auxiliary transformer	
Maximum permitted continuous power:	60 MVA
Voltage ratio:	105/6.3/6.3 kV

2.3.1.5 Safety systems

Safety systems prevent the uncontrolled release of radioactive substances into the environment. A high level of attention was paid to nuclear safety in the phase of planning the reactor and designing the power plant. The design of safety systems provides safety functions in all operational states, even in the event of specific equipment failure.

The nuclear power plant is in a safe state if three basic safety conditions are met at all times:

- effective reactivity control (reactor power control),
- cooling of the fuel in the reactor, the spent fuel pool and in the spent fuel dry storage,
- confinement of radioactive material (prevented release of radioactive material into the environment).

The release of radioactive material into the environment is prevented by 4 successive safety barriers:

- The first barrier is the fuel (fuel pellets), which confines the radioactive material within itself.
- The second barrier is a waterproof cladding that encloses fuel pellets and prevents leakage of radioactive gasses from fuel.
- The third barrier is the primary system boundary (pipe walls, reactor vessels and other primary components) that confines the radioactive water for reactor cooling.
- The fourth barrier is the containment that hermetically separates the primary system from the environment.

The basic objective of the first three barriers is to prevent radioactive material from passing to the next barrier, whereas the fourth barrier prevents radioactive material from being released directly into NEK's surroundings.
Since the operation of safety systems in the event of a defect and failure or a very unlikely accident at a nuclear power plant is paramount, all safety systems are redundant (NEK has two trains of safety systems). To comply with safety conditions and maintain safety barriers, the operation of only one

train of safety systems is always sufficient. Furthermore, all safety systems and their individual devices are systematically tested during the operation of the power plant and during regular outages.

2.3.1.6 Spent fuel

Since it began operating, NEK has stored all spent fuel (referred to as: SF) inside the fence encircling the power plant's technological section in the spent fuel pool (SFP) in the fuel handling building (FHB) as was foreseen in the power plant's original design. The removal of residual heat from the SF takes place via the active cooling system of the spent fuel pool. The set of safety upgrades that were carried out included an improvement for the alternative cooling of the spent fuel pool.

An analysis of possible improvements to the storage of fuel was part of the response to the Fukushima accident by the nuclear industry and administrative bodies. It follows from the conclusions of analyses by NEK and the analyses and decisions of the Slovenian Nuclear Safety Administration that due to new safety requirements, the introduction of dry storage for spent fuel constitutes an important safety upgrade. The proposed technical solution for dry storage of spent fuel is noted in the Resolution on the National Programme for Radioactive Waste and Spent Fuel Management 2016–2025 (ReNPRRO16-25).

The main purpose of the dry storage building for spent nuclear fuel is a technological upgrade of the temporary SF storage. The introduction of SF dry storage technology represents a safer way of storing SF as the cooling system is passive, so no device, system or energy source is needed for cooling and operation. Additionally, both radiation safety and the robustness of the system are improved. The building and containers with spent fuel will be located on the NEK site, inside the fence encircling the power plant's technological section.

Dry storage is a safer way of storing spent fuel under the same environmental and radiation conditions as are prescribed in the existing operating licence. Dry storage is recognised worldwide as the safest and most widespread technological solution for SF storage. In addition to the passive cooling method, better radiation safety and robustness, dry SF storage also has other benefits, above all due to better protection against intentional and unintentional negative influences or human acts.

After several years of cooling in the spent fuel pool (SFP), the SF is transferred to special canisters (shown in the figure below), that are hermetically sealed and placed in a suitable overpack (for transfer, storage or transport).

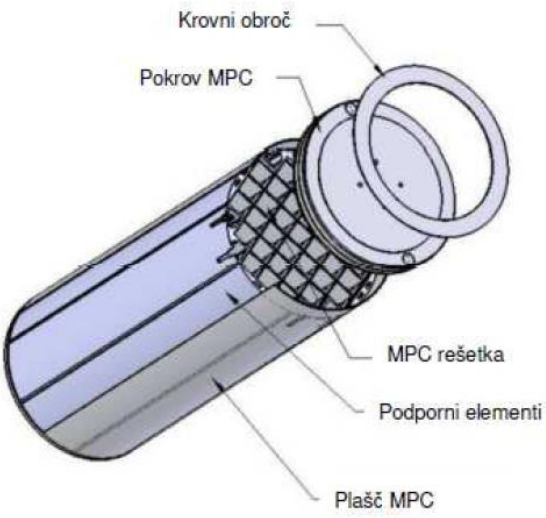

Figure 3: Spent fuel multi-purpose canister (MPC)

Krovni obroč	Shield ring
Pokrov MPC	MPC lid
MPC rešetka	MPC fuel basket
Podporni elementi	Supporting elements
Plašč MPC	MPC overpack

These canisters in special storage overpacks are then placed in the SF dry storage building (shown in the figure below). The building is divided into several areas: manipulation, technical and storage area.

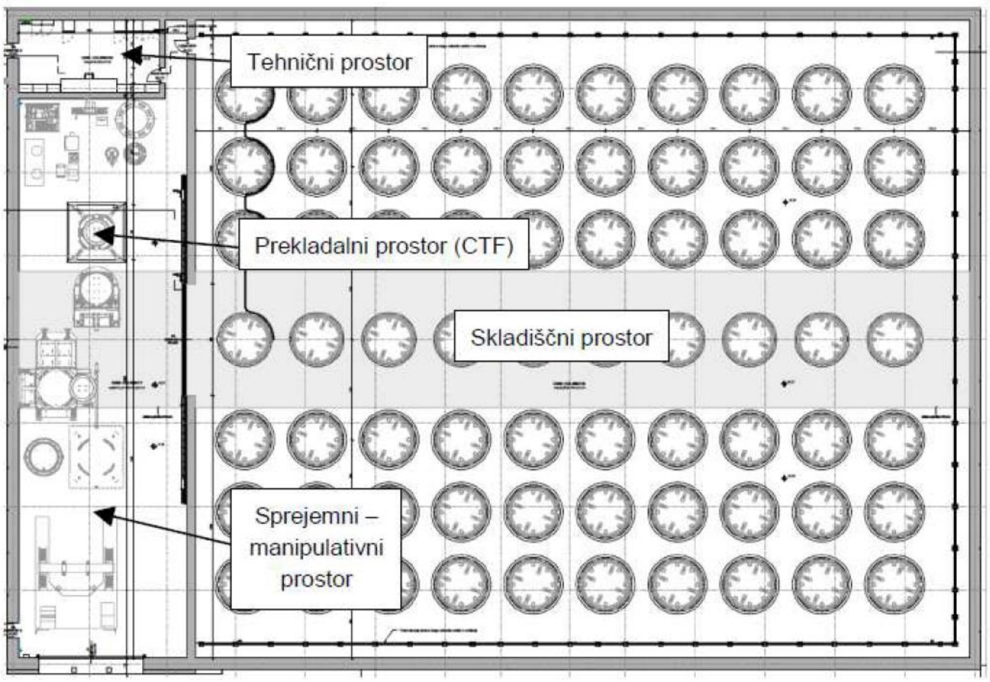

Figure 4: Floor plan of SF dry storage building

Tehnični prostor	Technical area
Prekladalni prostor (CTF)	Canister transfer facility (CTF)
Skladiščni prostor	Storage area
Sprejemni – manipulativni prostor	Acceptance, manipulation area

Spent fuel will remain stored in the building until a decision is made on the national strategy for SF disposal or re-processing. After the 2021 outage, the spent fuel pool contains 1,376 spent fuel elements. The first phase of dry storage loading will be carried out in 2023, when the initial 592 spent fuel elements are to be transferred. In the second phase in 2028, the next 592 spent fuel elements will be transferred.

2.3.2 Safety Upgrade Programme

In compliance with Slovenian legislation in the field of nuclear safety (Rules on Radiation and Nuclear Safety Factors) NEK has analysed the systems, structures and components from the point of view of severe accidents. Deriving from the analysis, NEK should take all reasonable measures to prevent and mitigate the consequences of severe accidents within the set deadlines. Following the accident at Japan's Fukushima Daiichi power plant in March 2011, this process was given high priority. Based on the URSJV Decision No. 3570-11/2011/7 of 1 September 2011, a severe accident analysis and preparation of a programme of safety upgrades was demanded.

Even prior to the accident in Japan, NEK was already implementing certain upgrades, such as the installation of a third diesel generator to power the safety systems. In October 2012, the European Commission published a final report containing the results of the extraordinary safety reviews of all power plants, which confirms that NEK achieves extremely good results and is adequately prepared for extreme events.

NEK's spent fuel pool and the reactor core are the major potential sources of radiological hazards to the surrounding environment in the event of a nuclear accident. The spent fuel storage strategy changed due to the latest events and findings from the Fukushima accident, and because of the revised Resolution on the National Programme for Radioactive Waste and Spent Fuel Management for the Period of 2016 –2025. In 2023, the project to construct dry spent fuel storage will be completed. It will further enhance nuclear safety and minimise the risk of potential accidents in the spent fuel pool.

On the basis of its own analyses and the recommendations of international organisations and administrative bodies, NEK adopted certain short-term and long-term projects. One of the short-term projects involved purchasing specific mobile equipment (e.g.: diesel generators of different powers, air compressors, water pumps, a vehicle for towing). Different systems in the plant have been fitted with appropriate connections for mobile equipment. As part of the long-term actions and based on the URSJV Decision, a thorough analysis was carried out and a comprehensive upgrade programme for the prevention of severe accidents and mitigation of their consequences was elaborated which has been completed in 2021, with the exception of the completion of construction of the dry storage and the transfer of spent fuel (first campaign), which will be carried out in the first half of 2023.

2.3.3 Periodic Safety Review (PSR)

The Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1, Official Gazette of RS, Nos. 76/17 and 26/19) requires, in Article 112, the operator of a radiation or nuclear facility to "ensure regular, comprehensive and systematic assessment and monitoring of the radiation or nuclear safety of a facility in periodic safety reviews".

The frequency, content, scope, duration and method of performing periodic safety reviews, and the method of reporting on such reviews are defined in the Rules on the safety assurance of radiation and nuclear facilities (Official Gazette of RS, Nos. 87/11, 76/17). A successfully carried out PSR is a precondition for extending the operational lifetime for a maximum of ten years.

The aim of the periodic safety review is for the operator of a radiation or nuclear facility to:

- review the overall impacts of plant aging, the impacts of modifications to the facility, operational experience, technical development, impacts of changes on the site and any other potential impacts on radiation or nuclear safety, and to determine the compliance with the design bases, based on which the operating licence was issued, with international safety standards and international practice, thereby confirming the facility is at least as safe as projected during the design phase and that it continues to be fit for safe operation;
- use the latest relevant, systematic and documented methodology based on deterministic as well as probabilistic approaches to analyses and assessments of radiation and nuclear safety;
- eliminate, at the earliest opportunity, any deviations from the design of the facility established during a periodic safety review, taking into account their significance for nuclear safety.
- examine and organise knowledge of the facility and processes, as well as the complete set of technical documentation;
- identify and evaluate the significance for safety of deviations from applicable standards and best international practice;
- carry out all appropriate and reasonable modifications resulting from the periodic safety review;
- carry out modifications in such a way that a written assessment of the state of each item of content is compiled, documented and supported by relevant analyses.

In keeping with requirements NEK successfully carried out two periodic safety reviews, the first one in 2003 and the second one in 2013. The comprehensive safety assessments, which are part of the PSR, confirmed that the power plant is safe and that it is capable of operating safely in the period until the next PSR. The third periodic safety review is currently in progress and will be completed in 2023.

2.3.4 Independent International Expert Reviews

NEK participates in a number of independent international expert reviews (missions), which examine in detail all aspects of safe and reliable operation of the power plant. These reviews are carried out by various organisations: IAEA – International Atomic Energy Agency, WANO – World Association of Nuclear Operators and others.

The aim of the missions is to promote improvements concerning nuclear safety and reliability of nuclear power plants through the exchange of information between foreign experts and NEK, and to promote communication and comparisons between WANO members. A comparison of one's own practices with the global experience and an objective assessment of the operation status are directed towards achieving the highest standards of nuclear safety, availability and excellence in the operation of nuclear power plants.

The auditors compared NEK with high operational standards as defined by the nuclear industry in the field of safety culture and human behaviour, organisation and administration, improvements in efficiency and operational experience, operation, maintenance, chemistry, work process management, engineering, configuration control, nuclear fuel efficiency, equipment reliability, radiological protection, training and qualifications, fire protection, occupational health and safety, organisation and measures in the event of an emergency, and implementation of international recommendations. The observers also observe the operational shift scenarios to assess the response of operating personnel to potential unplanned events.

In the mid-1990s, analyses of selected accident scenarios that go beyond design basis accidents were also performed as part of the Level 2 probabilistic safety analyses for the power plant. These analyses included situations with reactor core damage and containment failure, known as severe accident analyses. These analyses provided a platform for the preparation of Severe Accident Management Guidelines (SAMG). Furthermore, equipment was inspected and some modifications were made to allow a more appropriate response both from the equipment and personnel in the event of such accidents. Some examples include: the strategy of flooding the space under the reactor vessel (wet cavity) in the event of the reactor vessel meltdown, replacement of the recirculation sump strainer in the containment and thermal insulation of the containment piping. After purchasing a simulator for operator training and preparing the SAMG, NEK is able to perform emergency preparedness drills for accidents that go beyond design basis accidents too. During the trainings, the functionality of the SAMG procedures was also tested.

Upon the invitation of the URSJV, the RAMP mission organised by the IAEA was held at NEK in 2001. The mission reviewed the scope and adequacy of the aforementioned analyses and guidelines for severe accident management. The RAMP recommendations were partially implemented in the post-review period, while the remaining recommendations required additional and in-depth analyses, which were carried out by NEK in the framework of the action plan for the first periodic safety review (e.g. generation, distribution of hydrogen and risk management for the case of hydrogen explosion in the containment in the event of a severe accident). As part of the action plan for the periodic safety review, NEK also prepared specific grounds for emergency operating procedure (EOP) instructions, and revised the set-points on the basis of analyses for these instructions. All of the actions from this action plan were completed (reviewed and approved also by the URSJV as part of different administrative procedures).

As part of the stress tests a review of severe accident management (equipment, procedures, organisation etc.) was also carried out. Alongside the IAEA and WANO reviews in 2017 and 2019, a review of the suitability of organisation for managing accidents was also carried out. In 2018 the validation of the new SAMG on the NEK simulator was successfully carried out.

2.3.5 Aging Management Programme

The Aging management programme (AMP) was drawn up as part of the Periodic Safety Review (PSR2).

NEK has completed all actions that were part of its periodic safety review that referred to the plant's extended operational lifetime. In the administrative procedure, the URSJV approved the amendments to the NEK safety report (USAR), and NEK technical specifications (NEK TS) referring to the extension of NEK's operational lifetime (URSJV Decision No. 3570-6/2009/28 of 20 April 2012 and URSJV Decision No. 3570-6/2009/32 of 20 June 2012) and approved the entire Aging Management Programme (AMP).

The NEK Aging Management Programme is based on US legislation NUREG-1801, Generic Aging Lessons Learned, Revision 2. The AMP program thus covers all passive and long-life systems, structures and components. The European AMP, prepared by the IAEA (International Generic Aging Lessons Learned (IGALL) for Nuclear Power Plants) foresees that the aging programme also addresses active components. NEK monitors active components in accordance with the so-called Maintenance Rule (10 CFR 50.65) and the Environmental Qualification Program (10 CFR 50.49).

The review of the aging of active components and the maintenance itself were prepared on the basis of:

- 10 CFR 50.65 – Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants, Regulatory Guide 1.160,
- "Monitoring the Effectiveness of Maintenance Rule at Nuclear Power Plants", Rev. 3 and NUMARC 93-01,
- "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants", Rev. 4A.

An important part of the AMP consisted of the time-limited safety analyses (TLAA analyses), among which the AMP-TA-10 analysis "Update of USAR Chapters 11 and 15" should be highlighted, as it has shown that extending NEK's operational lifetime does not change the existing status and lead to new environmental hazards and burdens.

The compliance and integrity of the aging programme was reviewed in a number of missions:

- 2014, WANO Peer Review mission at NEK (AMP),
- 2017, IAEA OSART + LTO + PSA mission,
- 2017, NEK actively participated in the preparation of the national ENSREG Topical Peer Review (TPR) on Aging Management,
- 2019, WANO Peer Review of the NEK AMP.

A special programme for aging management was drawn up for the dry storage project.

All missions and the URSJV review along with the subsequent decision demonstrated the compliance of the aging programme with international recommendations and the Rules on the operational safety of radiation and nuclear installations.

2.3.6 The key safety characteristics of the power plant in 2021

Safety modifications and upgrades of NEK are not the subject of this assessment. They are only listed with the aim of showing what has been done in the past to improve NEK's safe and efficient operation. All the safety modifications and upgrades listed below represent the latest state of technology at NEK in its present state.

Thanks to NEK's prudent and focused safety upgrades in the past ten years, especially the implementation of the safety upgrade programme, the safety level is improving on an on-going basis, as shown in the figure below, which shows the core damage frequency due to all potential internal (equipment failure, pipe breaks, fires, etc.) and external (earthquakes, floods etc.) events. The figure below shows core damage frequency for all events at NEK in the operating year by comparing operating history with the target values of US NRC and the IAEA for 2nd generation nuclear power plants, indicated with the orange line, and target values of the IAEA and EU for new 3rd generation power plants, indicated with the grey line, as defined in the NEA/CSNI/R (2009)16. Core damage at NEK complies with the definition of the US NRC 10 CFR 50.46, Section 1b. It is clear from the graph that during the past 20 years core damage frequency has significantly reduced, which is the result of large investments in safety upgrades in the power plant. Essential upgrades were made in the areas of earthquake hazard, flood protection, measures to mitigate the consequences of fires, provision of additional power supply sources in the event of an emergency or loss of off-site power supply, and others. As an example we can list the Alternative Ultimate Heat Sink (AUHS) with the new DEC systems (ASI tank, AAF tank and well), which ensure the power plant's long term cooling. A decrease of risk in the past years and the planned decrease in 2021 are the result of the NEK Safety Upgrade Programme.

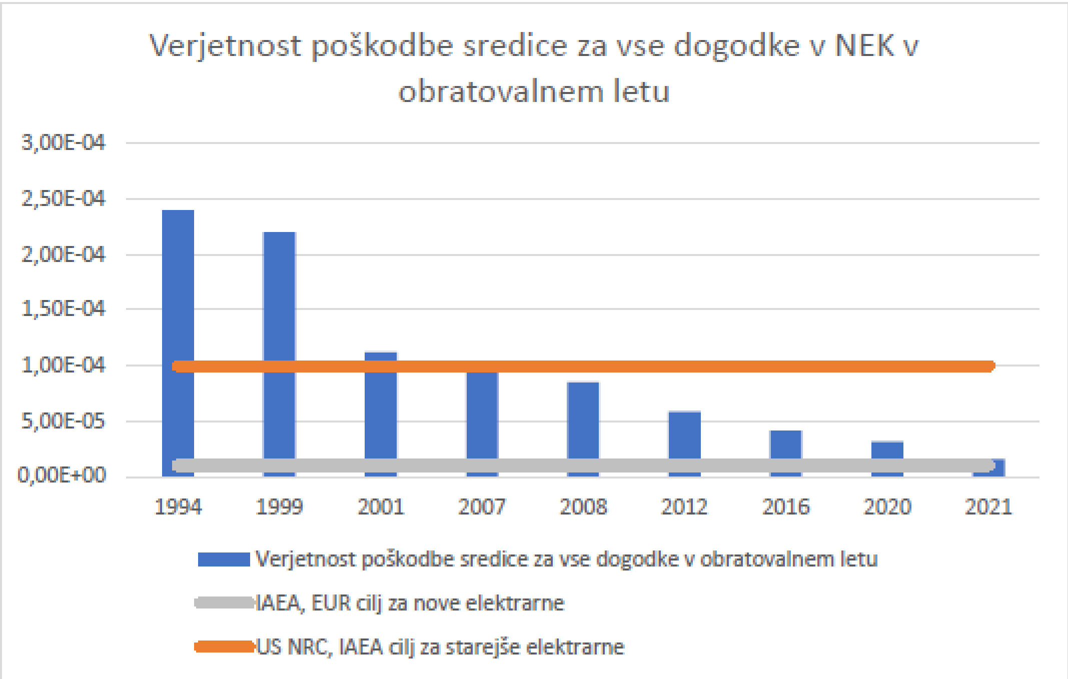

Figure 5: Safety level measured with core damage frequency per operating year (CDF/yr)

Verjetnost poškodbe sredice za vse dogodke NEK v obratovalnem letu	Core damage frequency for all events at NEK in the operating year
Verjetnost poškodbe sredice za vse dogodke v obratovalnem letu	Core damage frequency for all events in the operating year
IAEA, EUR cilj za nove elektrarne	IAEA, EUR target value for new power plants
US NRC, IAEA cilj za starejše elektrarne	US NRC, IAEA target value for old power plants

2.3.6.1 Major Modifications in the Primary Circuit

Replacement of steam generators
The replacement of the steam generators was carried out as part of the power plant modernisation, which also allowed a 40 MW-increase in the power plant output capacity. The modernisation comprised a number of subprojects. The first one involved the design, manufacture, finishing, assembling, testing and transporting of the new steam generators. The second one dealt with safety analyses and obtaining permits for the replacement. The third one, which was completed when the outage began, involved building a comprehensive personnel training simulator and analysing the power plant response in different situations. The replacement of the steam generators and the installation of the simulator took place in 2000.

Introduction of a new system for measuring the temperature of the primary circuit
The temperature measurement system for the primary coolant had a bypass installed on the A and B coolant loops that was connected to the hot, cold and intermediate legs and had a total of 30 valves. Due to the difficultly of maintenance and the possibility of leaks, all valves and bypass lines were removed during the 2013 outage, whereas the temperature measuring sensors were installed directly in the primary coolant pipe. This solution reduces the number of operational and maintenance interventions and the risk of primary coolant leaks.

Upgrade of reactor coolant pump motors
Both electric motors of the reactor coolant pump were renewed and upgraded. The control panel and visual indicators for monitoring bearing temperature, oil levels in bearings and motor vibrations have also been modernised. The upgrade took place in 2007 and 2010.

Replacement of the reactor vessel closure head
On the basis of operational experience in the industry, the reactor vessel closure head was replaced. Materials with better corrosion-resistant properties and improved manufacturing processes ensure safer and more reliable operation of the power plant. The reactor vessel closure head was replaced in 2012.

2.3.6.2 Major Modifications in the Secondary Circuit and electric systems

Replacement of the low-pressure turbines
NEK replaced both low-pressure turbines, as they were worn-out and the production of electricity needed optimisation. The new low-pressure turbines have a higher internal efficiency compared to the old turbines, which means output power is approximately 3% higher and over 20 MW more electricity is produced. The replacement took place in 2006.

Replacement of the stator and rotor of the main generator
The modification involved the replacement of the stator part of the generator (outer and inner housing, core, winding, main connections with bushings, hydrogen coolers), stator cooling water system, hydrogen temperature control valve, local alarm panel, installation of a new hydrogen dryer and the modernisation of control instrumentation with data transfer to the main control room.
NEK decided to replace the rotor of the main generator, taking into account the estimate that all generator subcomponents are designed and manufactured for a 30-year operational life span under normal operation conditions and reliability. The generator rotor was replaced with a new one that has better characteristics in terms of efficiency and reliability. The stator and rotor of the main generator were replaced in 2010 and 2012.

Replacement of the turbine regulation and protection system (turbine operating and monitoring system)

The old digital electrohydraulic system (DEH) of the turbine control system was replaced with a new programmable digital electrohydraulic system (PDEH), manufactured by the original supplier.
The installation of the new PDEH turbine operating and monitoring system also involved replacing the turbine emergency trip system (ETS), control systems for steam superheating and moisture separation, and the relocation of the operating and testing controls for twelve valves of the steam separation system from the autonomous panel to the new PDEH-system. The replacement took place in 2012.

Replacement of the exciter, voltage regulator and main generator switch

The third generator system upgrade project involved replacing the exciter and the voltage regulator of the main generator.
The replacement of the main generator switch was one of the performed upgrades of the generator system to enhance the reliability of the nuclear power plant operation. The project involved replacing the main generator switch with all its associated equipment and the replacement of overvoltage protection. As the new generator switch requires neither water cooling nor compressed air for its functioning, both the existing compressor plant and the cooling system of the old generator switch were removed. The system was replaced in 2016.

Refurbishment of the switchyard and the replacement of the 400-kilovolt system buses

In accordance with the Agreement on Technical Aspects of Investments, the switchyard was thoroughly refurbished in cooperation with the system operator ELES. The refurbishment has already begun in the 2010 outage and continued in the 2012 and 2013 outages when all the primary equipment including circuit breakers, isolators and buses, and measuring and control systems was replaced.
Some of the 400-kilovolt buses with insulating supports and portals were replaced in the section stretching from the double fence between NEK and the Krško RTP (distribution substation) to the NEK transformer field. The replacement of buses is the first phase of the joint project of NEK and ELES in reconstructing the 400-kilovolt switchyard.

Installation and connection of the energy transformer

NEK replaced the main transformer (400 MVA rated power) with a new 500 MVA one. The bottleneck in electricity distribution to the grid is eliminated and the basic configuration of the power plant with two transformers of equal power is restored. The replacement took place in 2013.

2.3.6.3 Major Modifications in the Tertiary Circuit and Subsystems

Extension of the cooling tower system

The design modification is the result of changes in the power plant and the environment. The cooling system of the NEK tertiary circuit was improved with carefully chosen technical solutions. Four new cooling cells (a new cooling tower – CT3) were installed, and all the electrical equipment of the cooling tower system was replaced. The replacement took place in 2008.

Reconstructions due to the construction of the Brežice HPP

Due to Brežice HPP, the level of the Sava at the NEK site has risen by 3 m, to the level of 153.20 m a.s.l. As a result of these changed hydraulic circumstances, it was necessary to reconstruct certain systems on the NEK site so that they could still operate inside the existing design bases following the Sava's rise in level, and at the same time it has been made possible to maintain the affected systems and structures the normal way.

<u>Modification to the dam's hydraulic system</u>

The modification required all the necessary mechanical, construction, electric and I&C activities that are needed on the NEK dam due to the construction of Brežice HPP. Due to hydraulic alterations on the Sava, upstream and downstream of the NEK dam, it was necessary to carry out the following interventions:

Construction part:

- providing access to and arranging the dam surroundings,
- expansion of the repository for the outage floodgates,
- raising the pillars of the spillways and construction of a new bridge,
- reconstruction of the downstream foundation with an additional steel threshold,
- installation of additional guides on the dam's side walls,
- extension of the foundations of the crane tracks and
- an additional embankment to complete the plateau of the expanded repository.

Mechanical part:

- supply and installation of downstream outage segmental floodgates (six new elements);
- supply and installation of upstream outage floodgates (two new rolling segments);
- supply and installation of new mobile lifting frames, 2 x 100 kN for manipulating the downstream outage floodgates on the water channels using the crane track;
- supply and installation of lifting tongs for grabbing and releasing elements of the downstream outage floodgates; they hang from the mobile lifting frame;
- supply and installation of a load transfer mobile hydraulic device for transporting the downstream outage floodgates from the mobile lifting frame to the repository for the floodgates with crane track;
- supply and installation of equipment for the downstream outage floodgates repository, which encompasses a set of bases for installing the floodgates; and
- reconstruction of the hydraulic lifting equipment of the radial floodgates, which includes electric, motor and hand-powered hydraulic units, hydraulic cylinders and piping with flexible pipes for flexible connections.

Electrics and control:
The current system for control and monitoring of the equipment on the NEK dam, which includes the regulation of the height of the Sava by taking measurements of flows and levels, was replaced by a new system. Two-way data connections with the control equipment of the Brežice HPP and Krško HPP were also set up, which enable the joint control of these dams together with the NEK dam.

<u>Reconstruction of the Circulating Water (CW) system</u>
To ensure the power plant's normal and safe operation after the Sava's level increased with the construction of Brežice HPP, the tertiary Circulating Water System also required certain reconstructions including:

- installation of extra stop logs for isolating the CW inflow facilities, enabling maintenance of the coarse screens and travelling screens and CW pumps;
- reconstruction and modernisation of CW cleaning systems – a new device for cleaning the screen racks (two new and more powerful machines);
- CW 105TSC-001 travelling screens; -006 modernisation (increased speed of movement of the screens, modification of the safety valves);
- installation of an extra pump for flushing the screens and extra nozzles for each screen;
- replacement of the electrical cabinets and modification of the control system, upgrading of measurements of water level differences on the coarse screens and travelling screens;
- reconstruction of the CW deicing piping to prevent the accumulation of ice in the CW;
- installation of a new pump to meet the requirements of the functioning of the deicing system;
- modification of the nozzles on the deicing piping (extra nozzles on the CW deicing piping);
- renewal of the manipulation surfaces.

Reconstruction of the Essential Supply Water (SW) system

Due to the construction of Brežice HPP it also became necessary to carry out the reconstruction of the tertiary cooling system (the SW system), which ensures cooling of the safety components. The reconstruction included:

- the installation of extra barriers and the requalification of the existing ones,
- redesign of the SW pumps control system,
- installation of new working platforms,
- upgrading or replacement of the existing sediment removal system,
- modernisation of the system for measuring the level of silt in the intake basin,
- adaptation of the system of cathode protection for underwater structures and pipelines.

Reconstruction of the Pretreatment Water (PW) and Sanitary Drain Systems

Due to the construction of Brežice HPP it was also necessary to carry out the reconstruction of the system of underwater wells, rainwater drainage and sewerage pipes:

- Underground wells: in order to keep the water table at the same level as before construction, three underground wells were built inside the diaphragm seal, with accompanying connecting piping to the existing pretreatment building.
- Rainwater drainage system: demolition of the existing pumping station for rainwater drainage and the construction of a new one at the same location.
- Faecal sewage system:
  - construction of a new gravitational discharge above the future elevation of the Brežice HPP dam at 153.50 m a.s.l.
  - Replacement of the two existing submersible pumps.

2.3.6.4 Other design-related modifications to improve safety

Improvement of the AC safety power supply (DG3)

The power plant's AC safety power supply was improved by providing an alternative source in the event of loss of the complete AC power supply (Station Blackout – SBO). The upgrade of the safety power supply included the installation of an additional diesel generator (DG3) with a power of 4 megawatts (6.3 kV, 50 Hz, start-up time less than 10 seconds), which is connected to the MD1 or MD2 safety buses via a new 6.3-kilovolt bus (MD3). The upgrade took place in 2006 and 2013.

2.3.6.5 NEK Safety Upgrade Programme

Following the completion of the Safety Upgrade Programme, NEK is ready for severe accidents as demanded by ZVISJV-1 (Official Gazette of RS, Nos. 76/17, 26/19) and the Rules on radiation and nuclear safety factors (Official Gazette of RS, Nos. 74/16 and 76/17 – ZVISJV-1). The Safety Upgrade Programme was reviewed and approved by the URSJV in February 2012 with Decision No. 3570-11/2011/09. Already in 2012, NEK began to prepare project documentation for the Safety Upgrade Programme and in 2013 it also filed applications for the implementation of the first two safety upgrade modifications (installation of a passive autocatalytic system for hydrogen recombination and the installation of a passive containment filtered venting system). These two modifications represent key solutions for severe accidents and were approved by the URSJV in October 2013.

Phase 1 – Installation of passive autocatalytic hydrogen recombiners in the containment

The installation of passive autocatalytic hydrogen recombiners limits the concentration of explosive gases (hydrogen and carbon monoxide) in the containment in the event of a severe accident. The installed equipment does not require a power supply for its operation and therefore works even if the AC power supply to the power plant completely fails. The safety upgrade ensures the integrity of the containment in the event of a severe accident. The installation of autocatalytic recombiners took place in 2013.

Phase 1 – Construction of the system for filtered venting of the containment
The installation of passive venting (relief) of the containment ensures a minimum release (less than 0.1%) of radioactive fission products of the core (with the exception of noble gases), which are released into the containment in the event of a severe accident, when the pressure in the containment rises above the design-basis level. In this way the integrity of the containment as a barrier preventing the uncontrolled release of radioactive material into the environment is preserved. A dry filter system was installed, consisting of five aerosol filters in the containment, an iodine filter in the auxiliary building, piping with a rupture disc, valves, an orifice, a nitrogen plant, a radiation monitor and the necessary instrumentation. The primary objective of the modification is to maintain the integrity of the containment by preventing it from collapsing in the event of severe accident that could result in uncontrolled pressure increase. The system was installed in 2013.

Phase 2 – Flood safety of NEK facilities
In 2012, design solutions were prepared to ensure flood safety of NEK facilities up to an elevation of 157.530 m above sea level, including in the event that the downstream and upstream embankments of the Sava collapsed. Design solutions included passive and active flood protection elements. Passive elements include the watertight external walls of buildings, the replacement of external doors with watertight ones and the replacement of seals on penetrations through the external walls with watertight ones. Active flood protection is ensured with the installation of water barriers and check valves on the drainage systems. The new NEK flood protection is designed and dimensioned so as to provide functional protection even in case of earthquake of 0.6 g ground acceleration. The project was completed in 2017.

Phase 2 – Construction of the emergency control room
The main reason for the construction of the emergency control room is to provide an alternative control location, which allows safe shutdown and cooling of the power plant if the main control room is evacuated and control of the status in the containment in the event of a severe accident with core damage. The construction of the control room was completed in 2019.
The new emergency control room provides an alternative location for shutdown and cooling of the power plant (if the main control room is lost); NEK is thus equal to comparable nuclear power plants in northern Europe, which built similar bunkered emergency control rooms in the 1990s. More recent nuclear power plants already have this solution integrated in the basic design.
The emergency control room has additional instrumentation installed that operates independently of the main control room and is used for control of the power plant in the event of a severe accident.

Phase 2 – Upgrade of the technical and operating support centres
Along with the construction of the emergency control room, an upgrade in the new technical support centre (referred to as: OPC) was also carried out. The capacity of the existing underground shelter has been increased while the new operating support centre (OPC) building provides the conditions necessary for the long-term work and stay of a team of up to 200 people, even in the event of extreme earthquakes, floods and other unlikely emergencies. In addition to extra air filters, the building has a new diesel generator which provides the centre with an independent power supply source. The upgrade was completed in 2021.

Phase 2 – Alternative cooling of the spent fuel pool
The project included the installation of a new spray system (fixed distribution of nozzles for spraying the spent fuel pool), a pool cooling system with a mobile heat exchanger (a new mobile heat exchanger for alternative cooling of the spent fuel pool) and a pressure relief damper in the fuel handling building (FHB). The upgrade of the system was completed in 2020.

Phase 2 – Installation of bypass motor-operated relief valves of the primary system
This modification provides a flow path for the controlled relief of the primary system in design extension conditions if the existing relief valves are not available. Implementing the strategy for the coordinated relief and feed of the primary system ensures cooling of the core, thereby preventing damage to the core. The design modification was completed in 2018.

Phase 2 – Alternative cooling of the reactor cooling system and the containment
The main aim of the design modification was to install an alternative system for long-term residual heat removal. The primary function of the new system is to remove residual heat from the reactor cooling system in design extension conditions by removing the coolant from the hot leg of the reactor cooling system, cooling via the heat exchanger and returning the coolant to the cold leg of the reactor cooling system, and removing the residual heat from the reactor cooling system by recirculating water from the containment sump back to the reactor cooling system. It is also possible to cool the containment by spraying. The modification was completed in 2021

Phase 3 – Construction of the reinforced bunkered building (BB2) with additional water tanks for removal of residual heat from reactor
The upgrade includes the construction of a new bunkered building 2 (BB2) with auxiliary systems and the connection of various new systems within the new building to the existing NEK systems, buildings and components. The BB2 building is designed to accommodate alternative safety injection system (ASI), an alternative auxiliary feedwater system (AAF) and safety power supply to the BB2 building. For the construction of this building including all the installed systems (AAF, ASI etc.) a special building permit (No. 35105-68/2018/8 1093 and 35105-29/2018/6 1093-04 dated 24 July 2018) was obtained. Construction was completed in 2021.

Phase 3 – Alternative auxiliary feedwater system (AAF)
This upgrade is part of the third phase of the Safety Upgrade Programme and includes the installation of an additional pump for filling the steam generators including all piping and valves which allow the new system to be connected to the existing auxiliary feedwater system. The new alternative system for filling the steam generators will in design extension conditions or in the event of the loss of existing auxiliary feedwater system, provide an alternative source of cooling water for one or both steam generators, allowing heat to be removed from the primary circuit and cooling of the reactor. The design modification was completed in 2021.

Phase 3 – Alternative safety injection (ASI)
This upgrade, also part of the third phase of the Safety Upgrade Programme, includes the installation of an alternative safety injection system for injection of borated water into the reactor coolant primary circuit. The system installed in the new bunkered building BB2 consists of a tank containing 1,600 m^3 borated water, a high-pressure pump and the main motor-operated valve, the accompanying piping connected to the existing NEK system and the equipment to support the system operation and control. The project was completed in 2021.

Phase 3 – Spent fuel dry storage (SFDS)
The spent fuel (SF) dry storage brings a technological and safety upgrade within the existing NEK energy complex. In addition to the passive cooling method, better radiation safety and robustness, SF dry storage also has other benefits, above all better protection against intentional and unintentional negative human influences or acts. Spent fuel dry storage is a temporary and safer form of storing SF during NEK's operation and also after its shutdown, however, it is not intended for permanent final spent fuel storage. The dry storage is under construction and is expected to be completed in the first half of 2023. The spent fuel dry storage is located in the technological part of NEK, west of the present spent fuel pool location.

Phase 3 – Installation of high-temperature seals in the reactor coolant pump
The upgrade includes the installation of a new sealing insert in the reactor coolant pumps with high-temperature seals (HTS). The HTS enable the power plant to better respond to a potential loss of

complete AC power supply in case of disruptions in the supply of sealing and cooling water for the reactor coolant pump seals, leading to leaking of the primary coolant. Installation of HTS thus prevents the loss of primary coolant. The project was completed in 2021.

2.3.7 Removal of waste water

All waste water (communal, industrial, rainwater) from the NEK plant flows into the Sava via 9 discharges and 12 outlets. The developer has acquired an environmental permit concerning emissions to water no. 35441-103/2006-24 of 30 June 2010, changed by decision no. 35441-103/2006-33 of 4 June 2012, which summarises all the information about the discharges and the largest quantities allowed and flow rates in the following table.

Table 8: Existing release points and discharges of NEK (source: Environmental permit)

Designation of the discharge (MM)	Type of waste water	Location (coordinates)	Largest annual quantity, daily and 6-hour average flow rate
V1	Industrial waste water	GKX = 88198 GKY = 540250	26,002,500 m³/year 1,606 l/s 1,606 l/s
	of which:		of which:
V1-1 MM1	- Industrial waste water from outlet V1-1, Discharge of essential service water	GKX = 88332 GKY = 540280	26,000,000 m³/year 1,600 l/s 1,600 l/s
V1-12 MM2	- industrial waste water from outlet V1-12, NEK liquid waste reservoir	GKX = 88320 GKY = 540893	2,500 m³/year 1,600 l/s 6 l/s
V2	- industrial waste water (flushing of rotating rakes)	GKX = 88199 GKY = 540231	
V3	- industrial waste water (discharge of fire protection pumps)	GKX = 88197 GKY = 540219	
V4	- industrial waste water (essential service water supply)	GKX = 88196 GKY = 540243	
V5	- industrial waste water (flushing of travelling screen)	GKX = 88178 GKY = 540364	
V6	- industrial waste water (pumping during an outage)	GKX = 88177 GKY = 540362	
V7	- cooling waste water and waste water from water treatment	GKX = 88103 GKY = 540438	791,000,000 m³/year 25,000 l/s 25,000 l/s
	Of which:		
V7-7 MM3	- cooling waste water (discharge of cooling water through measuring point MM3) - in the period between October and April of the following calendar part	GKX = 88162 GKY = 540400	331,000,000 m³/year 25,000 l/s 25,000 l/s 460,000,000 m³/year 25,000 l/s 25,000 l/s

Designation of the discharge (MM)	Type of waste water	Location (coordinates)	Largest annual quantity, daily and 6-hour average flow rate
V7-10 MM4	- cooling waste water (NEK cooling towers through measuring point MM4) - in the period between October and April of the following calendar part	GKX = 88154 GKY = 540435	52,000,000 m³/year 15,000 l/s 15,000 l/s 104,000,000 m³/year 15,000 l/s 15,000 l/s
V7-11 MM5	- waste water from water treatment (Discharge from the water treatment tank through the neutralisation tank through measuring point MM5) - in the period between October and April of the following calendar part	GKX = 88370 GKY = 540418	6,000 m³/year 6 l/s 6 l/s 9,000 m³/year 6 l/s 6 l/s
V8	- precipitation waste water (during outages also cooling waste water from the boiler room) pressure pipe 1 pressure pipe 2 pressure pipe 3 pressure pipe 4	GKX = 88010 GKY = 540582 GKX = 88012 GKY = 540580 GKX = 88014 GKY = 540578 GKX = 88016 GKY = 540576	
V9 MM6	- municipal waste water from the small communal treatment plant	GKX = 87993 GKY = 540587	10,000 m³/year 2.9 l/s 2.9 l/s

In the table, discharges are marked with letter V and a number (e.g. V1) and represent a release into the Sava. Outlets are marked with the number of the discharge to which they are connected, and the number of the outlet (e.g. V1-1), and denote a release from NEK. Measuring points are marked with the letters MM and a number (e.g. MM1).

Large cooling system – CW (Circulating Water System) (outlets 7 and 10; discharges 7 – V7-7 and V7-10)

The large cooling system is intended for cooling the main condenser and the TC system (Turbine Closed Cycle Cooling System), which is the actual system that cools the secondary components. The flow rate of CW water through the TC system is 1 m^3/s. When the Sava's flow rate exceeds 100 m^3/s, the condenser is cooled with flowing water (outlet 7, discharge 7 – V7-7). When the flow rate is lower (less than 100 m^3/s, possibility of heating the Sava by more than 3 K) the flow cooling is combined with the cooling towers which make use of the forced cooling of the tertiary system with ventilating cooling cells (release point 7, discharge 10 – V7-10). In both cases the water flow through the condenser is ca. 25 m^3/s.

Before and after being pumped the water is only mechanically cleaned. Chemicals are added only to the TC system - a mixture of sodium nitrite and sodium tetraborate, in a ratio of 30/70. This system is closed and has no direct connections with outlets or discharges into the Sava.

Small cooling system – SW (essential service water supply system) (outlet 1; discharge 1 – V1-1)

The cooling water cools the CC system (Component Cooling System) via heat exchangers. The CC system is intended for cooling components in the power plant's installations (pumps, exchangers). On the CC side of the heat exchangers of the CC system, molybdate (MoO_4^{-2}) is added to the water – in a concentration of 200–1,000 mg/l. As the system is completely closed, there can be no release into the Sava. No dangerous substances are added to the small cooling system.

Buildings and equipment for water treatment (outlet 11; discharge 7 – V7-11)
As its primary source of raw water NEK uses its own wells. NEK uses water for process purposes from the following wells: the well on the right bank of the Sava (Partial Water Permit, No. 35536-31/2006 of 15 October 2009, Decision No. 35536-26/2011-9 of 23 May 2013, and Decision on the Modification of the Water Permit, No. 35530-7/2018-2 of 22 June 2018); three wells on the nuclear island, i.e. the left bank of the Sava (Water Permit No. 35530-100/2020-4 of 14 November 2020), and the well next to BB2 (Water Permit No. 35530-48/2020-3 of 9 September 2021). Water from the public water supply is used as a reserve source of raw water. Before the raw water enters the water treatment system it is mechanically cleaned with the Dual Media Filter (sand filter with sand grains of different sizes and added anthracite). Water purified in this way is kept in two tanks for pre-treated water (PW) and is later used for two purposes: as seal water for different pumps and as a source of water for the system for production of deionised water which begins with wet filtration on filters with filter inserts. From there the water is further purified through two-level reverse osmosis modules and continues through a softening unit (mixed ion exchanger). The final fine purification is achieved with the help of electrodeionisation (EDI).

During the periodic cleaning of the system (reverse osmosis, degassing, EDI), which NEK can perform if the system's parameters worsen (it has not been carried out in recent years), chemicals such as citric acid and hydrochloric acid are used. In this case the system is transformed in such a way that waste water is collected first in the neutralising pool where the pH is constantly monitored and also adjusted to the neutral value before it is finally discharged (i.e. outlet 11 and discharge 7 – V7-11).

WP (L) system (12; discharge 1 – V1-12)
The WP (waste processing) system is a system intended for the treatment of liquid radioactive waste where boron in the form of boric acid acts as a neutron absorber. The absorption of neutrons controls criticality of the chain reaction. Liquid radioactive waste coming from the primary circuit is concentrated in the evaporator. The concentrate then dries and the liquid waste turns solid while the evaporated water, which still contains small quantities of boron, is discharged into the first tank for control of liquid radioactive waste. In the event that this waste water is safe in terms of radioactivity, it is discharged into the Sava via outlet no. 12, which later joins with outlet no.1 - the small cooling system) and flows out through discharge no. 1.

The second source of boron is in detergents that are used in the laundry for overalls. Due to the possibility of radioactive contamination, the waste from the laundry is also collected in the second control tank for liquid radioactive waste.

The main chemical that is added is therefore boric acid. The annual quantity of boron released in 2020 was 17 kg. This data is evident from NEK's internal measurements, which are kept in the NEK archive and can also be consulted via the environment engineer. The concentration of boron is determined prior to each release. This fulfils the requirement from point 1.3 of the environmental permit regarding discharges into water.

OTHER WASTE WATER

Waste water that is not measured is also created at this site (flushing of the rotating rakes, discharge from the fire protection pumps, filter cleaning, flushing of the travelling screen and emptying of the maintenance channels), sanitary waste water produced by employees and waste water from the water treatment.

Municipal waste water
The small waste water treatment plant is a biological treatment plant with an EKOROL - 22 rotating contactor. Municipal waste water from NEK flows into the treatment plant. The plant's capacity is 700

PE, the average daily amount of waste water measured at the intake is ca. 140 m^3. It began operating in 2001 and the discharged water goes into the Sava.

Basic technical information about the treatment plant:
WATER LINE:
primary settling in the Emscher settler, rotating contactor - 2x, supplementary settler
SLUDGE LINE:
anaerobic stabilisation of sludge in the "Emscher" digester (primary sludge and superfluous sludge from the supplementary settler).

Waste water from NEK is discharged through a number of discharges, while monitoring takes place at different measuring points. The discharges and measuring points are listed below and their locations are shown on the figure below.

- Discharge V1: essential service water (Y=540250, X=88198)
  - Outlet V1-1: waste cooling water (essential service water) via measuring point MM1 (Y=540280, X=88332)
  - Outlet V1-12: liquid waste tank via measuring point MM2 (Y=540893, X=88320)
- Discharge V2: waste water from flushing the rotating rakes (Y=540231, X=88199)
- Discharge V3: discharge of the fire protection pumps (Y=540219, X=88197)
- Discharge V4: essential service water (Y=540243, X=88196)
- Discharge V5: waste water from flushing the travelling screen (Y=540364, X=88178)
- Discharge V6: pumping during an outage (Y=540362, X=88177)
- Discharge V7: discharge of cooling water (Y=540438, X=88103)
  - Outlet V7-7: discharge of cooling water via measuring point MM3 (Y=540400, X=88162)
  - Outlet V7-10: discharge of cooling water via cooling towers via measuring point MM4
  - Outlet V7-11: discharge from the water treatment tank via the neutralisation tank via measuring point MM5
- Rainwater is discharged via oil separators into the rainwater sewer system which ends up (via discharge V8) in the Sava. All the oil separators have operating procedure and diary and are checked on a regular basis.
- Discharge V9: discharge from the waste water treatment plant (small municipal treatment plant with a capacity of 700 PE) via measuring point MM6 (Y=540587, X=87993). Municipal waste water flows into the small communal treatment plant whose discharge (V9) goes into the Sava.

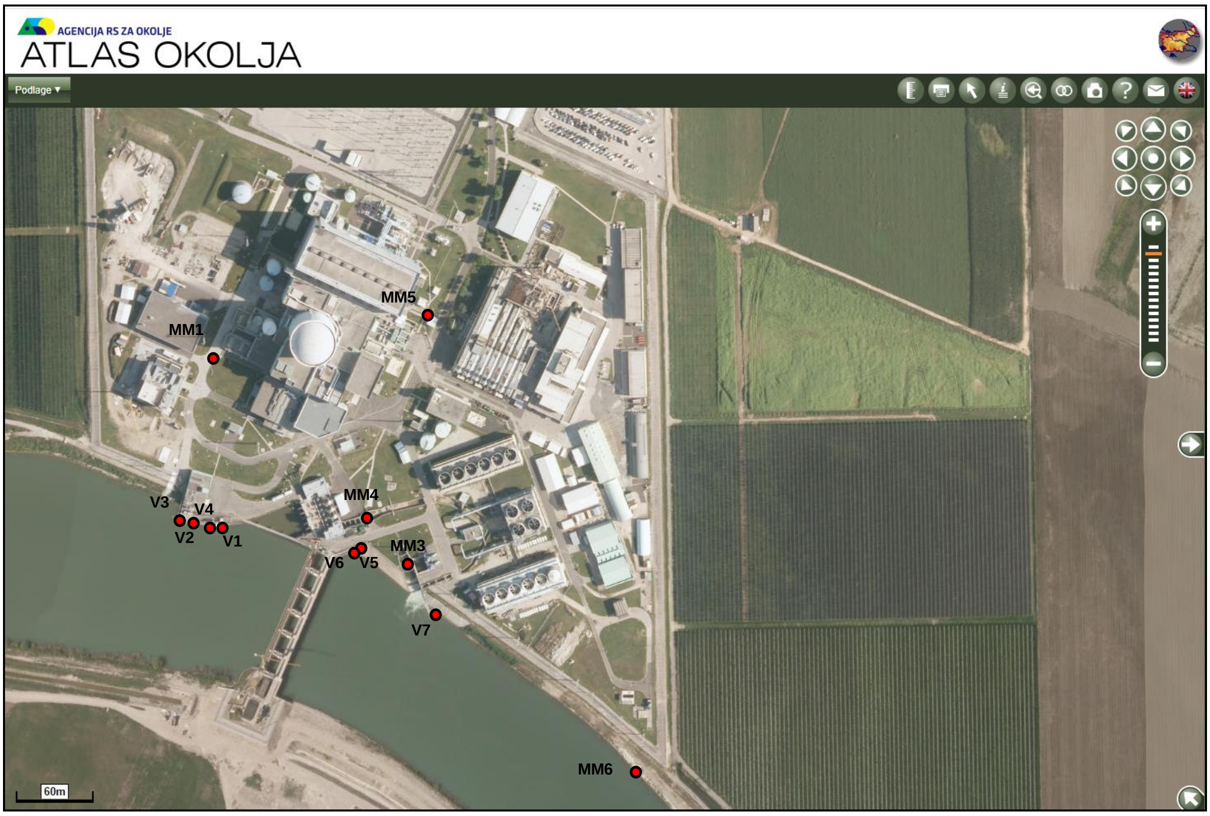

Figure 6: Locations of discharges and measuring points of NEK waste water

AGENCIJA RS ZA OKOLJE	SLOVENIAN ENVIRONMENT AGENCY
ATLAS OKOLJA	ENVIRONMENT ATLAS

The permitted quantities of waste water from an individual discharge, the monitoring programme of different pollution indicators and their limit values are defined in the Environmental operating permit for Krško Nuclear Power Plant regarding discharges into water (No: 35441-103/2006-24 of 30 June 2010), (No.: 35441-103/2006-33 of 4 June 2012), (No.: 35441-11/2013-3 of 10 October 2013) and (No.: 35440-2/2015-5 of 15 May 2015).

Permitted quantities for discharge V1:

- 26,002,500 m^3/year
- 1,606 l/s (maximum daily flow)
- 1,606 l/s (maximum six-hour average flow)

Outlet V1-1: waste cooling water (safety supply) via measuring point MM1 (Y=540280, X=88332):

- 26,000,000 m^3/year
- 1,600 l/s (maximum daily flow)
- 1,600 l/s (maximum six-hour average flow)

Outlet V1-12: liquid waste tank via measuring point MM2 (Y=540893, X=88320):

- 2,500 m^3/year
- 1,600 l/s (maximum daily flow)
- 6 l/s (maximum six-hour average flow)

2.4 Classification of activities according to the Rules on the assessment of the acceptability of effects caused by the execution of plans and activities affecting nature in protected areas

Article 5 of the Rules on the assessment of the acceptability of effects caused by the execution of plans and activities affecting nature in protected areas (Official Gazette of RS, Nos. 130/04, 53/06, 38/10 and 3/11, hereinafter: the Rules) states:

- The assessment of the acceptability is carried out for plans that may have a significant impact on protected areas, either on their own or as cumulative impacts.
- Plans that may have a significant impact on protected areas are those which due to the implementation of activities affecting nature, as set out in Annex 2 to these Rules, designate the intended use of land or the modifications thereof (hereinafter: designation of the intended use of land), set out in Annex 1, which is an integral part of these Rules, and those plans which designate or plan said activities affecting nature in protected areas, or in areas whose distance from protected areas is smaller than the maximum area of remote impact specified for activities affecting nature in Annex 2 to these Rules.

According to the Decree on the Classification of Buildings (Official Gazette of RS, No. 37/18), the NEK complex is a built industrial complex. According to the Rules, complex industrial buildings are defined in Chapter II of Annex 2 as areas intended for manufacturing.

Table 9: Classification of the activity according to the Rules on the assessment of the acceptability of effects caused by the execution of plans and activities affecting nature in protected areas (Official Gazette of RS, Nos. 130/04, 53/06, 38/10, 3/11)

Activity affecting nature	Direct impact	Area of direct impact (in m)	Remote impact	Area of remote impact (in m)
Complex industrial buildings	ALL GROUPS	100	birds, bats, aquatic and riparian habitat types, beetles	1000

Article 20 of the Rules further states:

- Remote impact is established if the plan envisages an activity affecting nature, as defined in Chapters I to XVIII of Annex 2 to these Rules, in the area of remote impact, except for those types of activities for which the environmental impact assessment is mandatory in accordance with the regulation governing the types of activities affecting the environment that require an environmental impact assessment. For activities that require an environmental impact assessment, the remote impact is established in an area twice as large as the remote impact area referred to in Annex 2 of those Rules, unless findings from the field, detailed data on the implementation of the activity or other factual circumstances indicate that the area of remote impact is different.
- The area of remote impact established for the specific activity affecting the environment may differ at any time from the area of remote impact of an activity affecting the environment referred to in Annex 2 of these Rules if this is based on findings from the field, detailed data on implementation of the activity and other actual circumstances.

It follows from the above that the area of remote impact for the lifetime extension is 2,000 m according to the Rules.

There are no protected areas within the area of direct impact. There is one Natura 2000 site within the 2,000-metre area of remote impact: Vrbina SAC (SI3000234); the distance from the site of the planned activity is about 350 m.

Under Article 20 of the Rules, the area of remote impact established for the specific activity affecting the environment may differ at any time from the area of remote impact of an activity affecting the environment referred to in Annex 2 of these Rules if this is based on findings from the field, detailed data on implementation of the activity and other actual circumstances. NEK's cooling systems use water from the Sava. The plant has 9 discharges through which waste water flows into the Sava. In addition to the remote impact within a radius of 2,000 m as defined by the Rules, remote impact is therefore also possible downstream along the Sava. It is assumed that the area of remote impact downstream along the Sava stretches 8 km downstream of the discharges from NEK, where the Sava has been declared a Natura 2000 area (Lower Sava SAC, SI3000304).

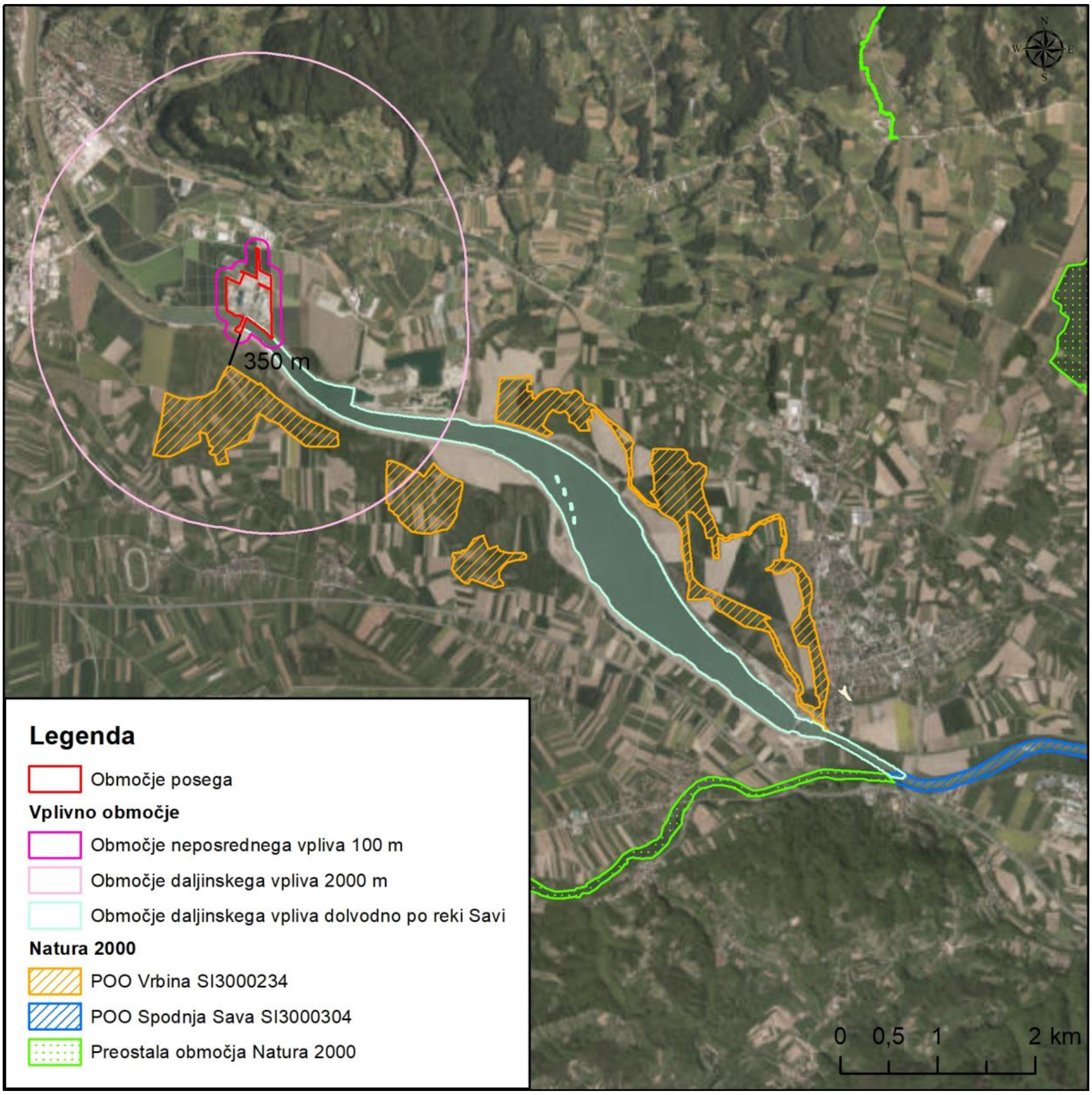

Figure 7: Protected areas and areas of direct and remote impact on protected areas

Legenda	Key
Območje posega	Area of the activity
Vplivno območje	**Impact area**
Območje neposrednega vpliva 100 m	Area of direct impact 100 m

Območje daljinskega vpliva 2000 m	Area of remote impact 2,000 m
Območje daljinskega vpliva dolvodno po reki Savi	Area of remote impact downstream along the Sava
Natura 2000	**Natura 2000**
POO Vrbina SI3000234	Vrbina SAC SI3000234
POO Vrbina SI3000304	Vrbina SAC SI3000304
Preostala območja Natura 2000	Other Natura 2000 areas

2.5 Envisaged period of implementation

It is envisaged that the operational lifetime of NEK will be extended by 20 years, i.e. until 2043.

2.6 Needs for natural resources

According to the Environmental Protection Act (ZVO-1), a natural resource is part of the environment when it is the subject of commercial
exploitation, while elements of the environment include soil, mineral raw materials, water, air and animal and plant species, including their genetic material.

The use of natural resources by NEK includes the use of water (potable water from the public water network and river water from the Sava for process purposes). Potable water is used for sanitary and fire protection purposes while the river water is for process purposes. The current annual water use is shown in the table below. The annual water use will not increase with the planned lifetime extension.

Table 10: Water used in 2020 (NLZOH, 2021)

Water source	2020 (1,000 m^3/year)
From the public water supply	31
From a private source	204
Other	768,622
Water supply – total	**768,857**
Water consumption	
Cooling waste water	190
Municipal waste water	10
Industrial waste water	768,626
Evaporated water	30
Water losses due to system failures	1
Water consumption – total	**768,857**

2.7 Estimated emissions, waste and waste management

Emissions of ionising radiation

Operation

By extending the operational lifetime the emission of radioactive material into the environment will be equal to or smaller than the existing rate. NEK is continuously upgrading and improving its safety and

process systems which means that the burden on the environment is constantly decreasing. The estimated annual effective dose from NEK to the critical member of the public will be 0.1 µSv at most, which is approximately 0.005 % of the natural background.
When the dry storage facility for spent fuel comes into use, the dose on the NEK fence near the storage facility will increase. The annual effective dose of external radiation on the NEK fence following the storage of spent fuel will not exceed the 200 µSv limit (RETS 3.11.7).
The dose rate on the outside wall of the dry storage building will not exceed the limit of 3 µSv/h, as defined in point 3.2.b.2.1 of specification SP-ES5104 or the fourth point of the first paragraph of Article 4 of the Rules on radiation protection measures in controlled and monitored areas - SV8A (Official Gazette of RS, No. 47/18), which defines the limiting average dose rate within eight hours for controlled areas. The surroundings of the dry storage building therefore do not need to be declared as a controlled area.

Cessation of operations
After NEK ceases operating, the fuel will no longer be in the reactor, but stored safely in the spent fuel pool and/or in the dry storage for spent fuel. Ionising radiation due to the dry storage will be present on the NEK fence, as shown in the table below, while the gaseous and liquid effluents will be considerably smaller or completely non-existent.

Table 11: Results of calculations of dose rates and doses on the NEK fence

Campaign	Highest dose rates (µSv/h)	Annual effective dose (mSv)	Annual limits from the technical specification (mSv)
After Campaign IV (full dry storage)	5.622 E-03	0.0492	0.05
After Campaign IV (full dry storage), realistic estimate	4.525 E-03	0.0396	0.05
After Campaign II	5.369 E-03	0.0470	0.05
After Campaign I	4.315 E-03	0.0378	0.05

Emissions of soil pollutants
Operation
There will be no emissions of soil pollutants during operation. All waste water from the existing NEK plant flows into the Sava following suitable treatment. All waste is appropriately stored and does not present a danger for soil contamination.

Cessation of operations
There will be no emissions of soil pollutants during the cessation of operations of NEK.

Emissions of water pollutants
Operation
NEK discharges waste water into the Sava in compliance with environmental permit no. 35441-103/2006-24 of 30 June 2010, which was amended in three points of the operational part (points 1.1, 1.4 and 1.8). Decision no. 35441-103/2006-33 of 4 June 2012 reaffirmed the environmental permit, which was amended (point 1.5, Table 3) under decision no. 35444-11/2013-3 of 10 October 2013.
The extended operational lifetime will not cause any new waste water discharges. The quantities of discharged pollutants will remain unchanged.
There are other facilities operating at the NEK site alongside the primary activity (the production of electricity) which we consider to be sources of waste water:
- large cooling system,
- small cooling system,
- buildings and components for water treatment and
- the WP system (treatment of liquid radioactive waste).

The water permit allows water abstraction for process purposes, the annual total being as much as 915,000,000 m^3 (29,000 l/s).

Cessation of operations
The cessation of operations means there will be no more need for cooling water for the technological process of electricity production. After NEK ceases to operate, there will be no more thermal load on the Sava from this address.
The spent fuel pool and some other safety components will still have to be cooled. It is estimated that water will be withdrawn and returned to the Sava at the rate of approximately 1.6 m^3/s.
When NEK ceases to operate there may be temporary small quantities of waste water as a result of the cleaning of facilities and they will be taken to the small municipal water treatment plant.
The sampling and analysis of gathered liquid discharges and further handling thereof will consider (alongside the radiological parameters), the Rules on the first measurements and operational monitoring of waste water (Official Gazette of RS, Nos. 94/14, 98/15), the Decree on emissions of substances and heat when discharging waste water into water and public sewage system (Official Gazette of RS, Nos. 64/12, 64/14, 98/15) and the Decree governing the discharge and cleaning of communal and rain waste water in the Municipality of Krško (Official Gazette of RS, Nos. 73/12, 84/13), or the appropriate regulations according to the valid legislation.
In the event of radiological pollution, the waste water will be suitably treated in the existing NEK systems.
If the water is not contaminated with radiation but the parameter values surpass the limit values for discharging into the watercourse according to the valid legislation, then these waters will not be discharged into the sewer system which flows into the Sava, but will be handed over to an authorised collector or processor of such waste.

Emissions of air pollutants
Operation
The emission of substances into the air will be the same as in the present state. Emissions of substances that affect air quality are very small and are the consequence of combustion of fossil fuels on the site. They come from: emergency diesel electricity generators (DG1, DG2 and DG3), an auxiliary boiler room, on-site goods transport, cars in the carpark.
Another source of air pollutants is the traffic on public roads – the cars of employees and goods vehicles.

Cessation of operations
Following the cessation of NEK's operations, pollutants will temporarily be released into the air from the auxiliary boiler room, which will be used for heating premises and for safety purposes (to prevent freezing). The total quantity of fuel used will be reduced as heat will no longer be needed to generate supplementary steam. Temporary emissions will occur as a result of the testing of the diesel generators, which will remain on site as an emergency source of electricity.

Greenhouse gas emissions
Operation
A nuclear power plant does not emit greenhouse gases in the process of producing electricity. This will remain the case during the extended operational lifetime.
The LTE will generate very small emissions of greenhouse gases which are the result of the use of fuel oil in the emergency power supply diesel generators (three diesel engines, emissions from the auxiliary boiler room). The diesel engines are in operation only when the facility is being tested, and the boiler room is an emergency heat source for when the power plant is not operating and/or when steam is needed for heating the system when the power plant is started up. Emissions are calculated using IPCC methodology and emissions factors from the Slovenian National Inventory Report 2021, for fuel oil CO_2 EF = 74.1 t/TJ, CH_4 EF = 0.003 t/TJ and N_2O EF = 0.0006 t/TJ. Greenhouse gas emissions from NEK amount to 0.609 ktCO_2-eq/year, as the average of the last seven years (table below). Annual emissions will not change due to the LTE and will remain the same until 2043. Small variations are, however, possible.

Table 12: Emissions of greenhouse gases by NEK (average in the period from 2014 to 2020)

	$ktCO_2$-eq
Diesel generator emissions	0.223
Auxiliary boiler room emissions	0.386
Total	**0.609**

In 2019 Slovenia's greenhouse gas emissions amounted to 17,065 $ktCO_2$-eq, of which 4,576 $ktCO_2$-eq were from the sector of public electricity and heat production. The greenhouse gases emitted by NEK account for 0.003% of Slovenia's emissions and 0.013% of the emissions from the public electricity and heat sector.

The Decree on the use of fluorinated greenhouse gases and ozone-depleting substances (Official Gazette of RS, No 60/16) also defines the operator's obligation to report stationary equipment, and the obligation of the operator, maintenance provider and authorised company to report the use, capture, and delivery of waste fluorinated greenhouse gases and waste ozone-depleting substances to the waste collector. NEK has informed ARSO of the presence of stationary equipment containing fluorinated greenhouse gases (F-gases) and SF6 gas. F-gases are present in the equipment for cooling, air-conditioning and the heat pumps, and the fire-extinguishing equipment, while SF6 gas is present in the circuit breakers and switchgear. The F-gases used include gases with the industrial names for mixtures R134a, R407c and R410a, and the gas with high global warming potential SF6 (22,800). SF6 gas has extremely high insulation strength, and its use means reductions in the size of equipment, so it is nowadays used as standard in new plants. These gases are potential sources of emissions. Emissions would occur if gases leaked from equipment. The total potential emission of F-gases from the process is 0.323 $ktCO_2$-eq, SF6 0.135 $ktCO_2$-eq, and from non-process sources 0.043 $ktCO_2$-eq, altogether 0.501 $ktCO_2$-eq.

Cessation of operations
Following the cessation of NEK's operations, greenhouse gases will temporarily be released into the air from the auxiliary boiler room, which will be used for heating premises and for safety purposes (to prevent freezing). Temporary emissions will occur as a result of the testing of the diesel generators, which will remain on site as an emergency source of electricity.

F-gases remain in the cooling and air-conditioning equipment, heat pumps and fire-extinguishing equipment. SF6 gas remains also in the circuit breakers and switchgear. The above are possible sources of greenhouse gas emissions so this equipment must be regularly maintained and monitored in compliance with the Decree (Official Gazette of RS, No. 60/16).

Noise emissions
Operation
No new sources of noise emissions, such as ventilating or cooling devices, are foreseen due to the extended operational lifetime. Noise emissions during the operating period will be the same as the existing ones. Due to climate change, there could be an increase in the operation of cooling towers.

Cessation of operations
There will be no noise emissions after NEK ceases to operate, or there will be only some temporary noise due to activities connected with the termination of the activity.

Electromagnetic radiation
Operation
No new sources of electromagnetic radiation are foreseen (e.g. transformer stations) due to NEK's extended operational lifetime. Emissions of electromagnetic radiation will be the same as the present ones.

Cessation of operations
There will be no more sources of electromagnetic radiation once NEK ceases to operate.

Light emissions
Operation
The extension of the operational lifetime does not change the effect of light shining out into NEK's surroundings. Light emissions into the environment will be identical to the present ones.
As NEK's external lighting is an integral part of the technical systems for ensuring its physical protection, NEK is not bound by the Decree on limit values for light pollution (Official Gazette of RS, Nos. 81/07, 109/07, 62/10, 46/13), but by the Rules on the physical protection of nuclear facilities and nuclear and radioactive materials, and the transport of nuclear materials (Official Gazette of RS, Nos. 17/13, 76/17 [ZVISJV-1]).

Cessation of operations
After NEK ceases operating, light emissions into the environment will be identical to the present ones as the facility will still be subject to security control.

Waste types and quantities and waste management

Operation
<u>Radioactive waste</u>
The dynamics of waste generation remain unchanged and compliant with the provisions of the USAR. Due to the extension of the operational lifetime from 2023 to 2043, there will be an extra 547 m^3 or 884 t of low- and intermediate-level radioactive waste. The quantity of waste on 31 December 2020 is given in the table below.

Table 13: Inventory of processed LILW, located in the Storage Building on 31 December 2020 (source: NEK data)

Waste type	Designation	No of packages	Gamma activity [Bq]	Alpha activity [Bq]*	Volume [m^3]
incineration products	A	[1]70	$5.14 \cdot 10^{9}$	$1.14 \cdot 10^{8}$	14.6
dried spent ion-exchange resins from the secondary cycle	BR	[2]1	$8.80 \cdot 10^{8}$	$1.33 \cdot 10^{6}$	0.2
compressible waste	CW	[3]7	$1.95 \cdot 10^{8}$	$3.34 \cdot 10^{5}$	1.5
dried evaporator concentrate	DC	9	$1.75 \cdot 10^{9}$	$1.70 \cdot 10^{5}$	1.8
dried sediment	DS	1	$3.39 \cdot 10^{7}$	$6.30 \cdot 10^{3}$	0.2
evaporator concentrate	EB	2	$2.28 \cdot 10^{8}$	$1.19 \cdot 10^{5}$	0.4
spent filters	F	117	$1.10 \cdot 10^{11}$	$4.74 \cdot 10^{7}$	24.3
other waste	O	[4]7	$3.56 \cdot 10^{8}$	$1.28 \cdot 10^{6}$	1.5
dried spent ion-exchange resins from the primary cycle	PR	1	$1.43 \cdot 10^{10}$	$9.69 \cdot 10^{6}$	0.15
supercompacted waste from 1988 and 1989	SC	617	$1.29 \cdot 10^{10}$	$2.09 \cdot 10^{8}$	197.4

Waste type	Designation	No of packages	Gamma activity [Bq]	Alpha activity [Bq]*	Volume [m³]
spent ion-exchange resins	SR	689	$1.87 \cdot 10^{12}$	$3.75 \cdot 10^{9}$	143.3
TTCs containing compressed waste from 1994 and 1995, and pressings from ongoing supercompaction (2006, 2007, 2008, 2010, 2011, 2012, 2013 and 2014).	ST	1853	$5.32 \cdot 10^{11}$	$6.73 \cdot 10^{8}$	1601.0
TTC, into which standard noncompacted drums are inserted	TI	364	$1.23 \cdot 10^{13}$	$1.93 \cdot 10^{10}$	316.2
Total		**3,738**	**$1.49 \cdot 10^{13}$**	**$2.41 \cdot 10^{10}$**	**2,302.6**

* Alpha activity is determined on the basis of activity ratios of alpha emitters and radionuclide 137Cs, as was found in the reference samples.
[1] Additional 19 packages located in the Decontamination building will be relocated to the NEK LILW storage facility (4.0 m³)
[2] Additional 53 packages located in the Decontamination building ready for incineration (10.6 m³)
[3] Additional 393 packages located in the WMB and DB, ready to be sent for incineration (81.7 m³)
[4] Additional 28 packages located in WMB prior to measurements and storage in RWSB (5.8 m³)
[5] Additional 80 ingots located in the Decontamination building (8.8 m³)

In the 13th meeting of the Intergovernmental Commission for Monitoring the Execution of the Treaty between the Governments of Slovenia and Croatia on the regulation of status and other legal relations connected with investments, exploitation and decommissioning of NEK (MDP) held on 30 September 2019, a decision was made, based on the report from the Coordination Committee, that a joint solution for the LILW waste repository is not possible.

The total quantities of LILW to be shared between the Slovenian and Croatian parties, determined on the basis of the waste inventory in the NEK storage facility and the estimates of future LILW generation during NEK operation and decommissioning, are shown in the table below.

Table 14: Total amount of LILW to be shared between the Slovenian and Croatian parties.

Period of LILW generation	Data source	Mass (t)	Volume (m³)	Activity (Bq)
1983 – 2018	inventory	4877.4	2,294.9	5.98 E13
2018 – 2023	estimate	264	163.4	1.44 E13
total by 2023	estimate	5141.4	2,458.3	7.42 E13
2024 – 2043	estimate	883.7	546.6	4.33 E13
decommissioning of NEK	PO3[1]	2,860	2,842	/
dismantling of the SF dry storage facility	PO3	392	407	/

Each party will manage its half of LILW in accordance with national strategies and programmes addressing radioactive waste management.

Under the basic scenario, the Slovenian half of the waste should be disposed in Vrbina in two phases: in the first phase, from 2023 to 2025, disposal of the currently stored LILW from operation and other sources; in the second phase, from 2050 to 2058, disposal of the remaining LILW from NEK's operation together with the LILW from decommissioning, at which time the procedures for the final closure of the repository will also be initiated. The LILW from other sources refer to the LILW that meets the acceptance criteria for waste disposal and originate from the central storage facility for radioactive waste.

[1] *Third Revision of the NEK Radioactive Waste and Spent Fuel Disposal Programme, version 1.3, September 2019, ARAO – Agency for Radwaste Management, Ljubljana, Fund for financing the decommissioning of the NEK, Zagreb (PO3), Table 4–17*

The Croatian scenario envisages that the Croatian part of the operational LILW will be transported to Croatia to the centre for radioactive waste management (CRAO), which will be built in compliance with the Strategy. The priority location of the CRAO centre is Čerkezovac, the location of the military logistics complex, which the army does not intend to use in the future. Čerkezovac is located in the municipality of Dvor on the southern slopes of the Trgovska Gora massif.

Spent fuel

All spent fuel at NEK is currently stored in the spent fuel pool, where 1,694 cells are available in storage racks. After the 2021 outage, a total of 1,376 fuel elements are stored in the spent fuel pool.

The spent fuel elements will be relocated from the spent fuel pool to the storage in four campaigns, as listed in the table below.

Table 15: Campaigns for the transfer of SF from the pool to dry storage

Relocation campaigns:	Execution	Approximate number of fuel elements
Campaign I	2023	592 fuel elements
Campaign II	2028	592 fuel elements
Campaign III	2038	444 fuel elements
Campaign IV	2048	remaining fuel elements

If NEK operated until the end of 2023, a total of 1,553 elements of spent fuel would be generated. If NEK operates until the end of 2043, a total of 2,281 spent fuel elements will be generated. Due to the extension of the operational lifetime from 2023 to 2043, an extra 728 spent fuel elements will be generated.

Management of other waste

The table below shows data from the official records of the Slovenian Environment Agency about the types and quantities of waste generated in 2020. Above all construction waste and some other forms of waste were generated because of construction works and are not part of NEK's operation.

Table 16: Types and quantities of waste generated in 2020 (source: Report on generated waste and the management thereof in 2019)

Serial No.	Waste No.	Waste	2020 Quantity (kg)
	08	WASTES FROM THE MANUFACTURE, FORMULATION, SUPPLY AND USE (MFSU) OF COATINGS (PAINTS, VARNISHES AND VITREOUS ENAMELS), ADHESIVES, SEALANTS AND PRINTING INKS	
	08 01	Wastes from MFSU and removal of paint and varnish	
1	08 01 11*	Waste paint and varnish containing organic solvents or other hazardous substances	100
	12	WASTES FROM SHAPING AND PHYSICAL AND MECHANICAL SURFACE TREATMENT OF METALS AND PLASTICS	
	12 01	Waste from shaping and physical and mechanical surface treatment of metals and plastics	
2	12 01 09*	Machining emulsions and solutions free of halogens	564
3	12 01 12*	Spent waxes and fats	91
	12 03	Waste from water and steam degreasing processes (except for 11)	
4	12 03 02*	Steam degreasing wastes	202

Serial No.	Waste No.	Waste	2020 Quantity (kg)
	13	OIL WASTES AND WASTES OF LIQUID FUELS (except edible oils, and those in sections 05, 12 and 19)	
	13 01	waste hydraulic oils	
5	13 01 10*	Mineral based non-chlorinated hydraulic oils	89
	13 02	waste engine, gear and lubricating oils	
6	13 02 05*	Mineral-based non-chlorinated engine, gear and lubricating oils	3.143
	13 03	waste insulating and heat transmission oils	
7	13 03 10*	Other insulating and heat transmission oils	148
	13 07	Liquid fuel waste	
8	13 07 01*	Fuel oil and diesel	431
	15	WASTE PACKAGING; ABSORBENTS, WIPING CLOTHS, FILTER MATERIALS AND PROTECTIVE CLOTHING NOT OTHERWISE SPECIFIED	
	15 01	packaging (including separately collected municipal packaging waste)	
9	15 01 10*	Packaging containing residues of or contaminated by hazardous substances	3.175
	15 02	absorbents, filter materials, wiping cloths and protective clothing	
10	15 02 02*	Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by hazardous substances	657
	16	WASTES NOT OTHERWISE SPECIFIED IN THE LIST	
	16 01	end-of-life vehicles from different means of transport (including off-road machinery) and wastes from dismantling of end-of-life vehicles and vehicle maintenance (except 13, 14, 16 06 and 16 08)	
11	16 01 07*	Oil filters	249
12	16 01 14*	Antifreeze fluids containing hazardous substances	30
	16 05	Gases in pressure containers and discarded chemicals	
13	16 05 04*	Gases in pressure containers (including halons) containing hazardous substances	5
14	16 05 06*	Separately collected electrolyte from batteries and accumulators	155
15	16 05 07*	discarded inorganic chemicals consisting of or containing hazardous substances	127
	16 06	Batteries and accumulators	
16	16 06 01*	Lead batteries	2.450
	16 09	Oxidising substances	
17	16 09 02*	Chromates, e.g. potassium chromate, potassium or sodium dichromate	481
	17	CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)	
	17 01	Concrete, bricks, tiles and ceramics	
18	17 01 01	Concrete	1,546,880
	17 02	Wood, glass and plastic	
19	17 02 03	Plastic	27.120
	17 03	Bituminous mixtures, coal tar and tarred products	
20	17 03 02	Bituminous mixtures other than those mentioned in 17 03 01	321.300
	17 04	Metals (including their alloys)	
21	17 04 05	Iron and steel	18.100
22	17 04 11	Cables other than those mentioned in 17 04 10	230

Serial No.	Waste No.	Waste	2020 Quantity (kg)
	17 05	Soil (including excavated soil from contaminated sites), stones and dredging spoil	
23	17 05 04	Soil and stone other than that mentioned in 17 05 03	234.200
	17 08	Gypsum-based construction materials	
24	17 08 02	Gypsum-based construction materials other than those mentioned in 17 08 01	15.960
	17 09	Other construction and demolition wastes	
25	17 09 04	Mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	28.040
	19	WASTES FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTE WATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE	
	19 08	Wastes from waste water treatment plants not otherwise specified	
26	19 08 09	Grease and oil mixture from oil/water separation containing only edible oil and fats	2,000
	19 09	Wastes from the preparation of water intended for human consumption or water for industrial use	
27	19 09 05	Saturated or spent ion-exchange resins	9.240
	20	MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS	
	20 01	Separately collected fractions (except 15 01)	
28	20 01 08	Biodegradable kitchen and canteen waste	43.425
29	20 01 21*	Fluorescent tubes and other mercury-containing waste	120
30	20 01 25	Edible oil and fat	2.185
31	20 01 33*	Batteries and accumulators mentioned in 16 06 01, 16 06 02 or 16 06 03, and unsorted batteries and accumulators containing these batteries and accumulators	180
32	20 01 36	Discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	880
33	20 01 38	Wood other than that mentioned in 20 01 37	36.280
34	20 01 40	Metals	2.720
	20 02	Garden and park wastes (including cemetery waste)	
35	20 02 01	Biodegradable waste	1.040
	20 03	Other municipal wastes	
36	20 03 07	Bulky waste	280

Key:
* hazardous waste

All the waste in the above table was handed over to another entity (authorised contractor) in Slovenia.

Cessation of operations
After the cessation of operations, the maintenance and emptying of fluid systems, and the decontamination of appliances and facilities will produce the same form and quantity of radioactive waste as during operation. Due to the extension of the operational lifetime from 2023 to 2043, there will be an extra 547 m^3 or 884 t of low- and intermediate-level radioactive waste. Due to the extension of the operational lifetime from 2023 to 2043, an extra 728 spent fuel elements will be generated.

3 INFORMATION ABOUT THE PROTECTED AREA

3.1 Conservation objectives of the protected area and factors contributing to the conservation value of the area

Natura 2000 areas

The general conservation objectives for Natura 2000 areas are defined by the Decree on Special Protection Areas (Natura 2000 areas) (Official Gazette of RS, Nos. 49/04, 110/04, 59/07, 43/08, 8/12, 33/13, 35/13, 39/13, 3/14, 21/16, 47/18).

Annex 6.1 "Objectives and Measures" of the Management Programme for Natura 2000 Areas (2015–2020) sets out detailed conservation objectives, as well as the competent departments and bodies responsible for the implementation of conservation measures for all Natura 2000 areas. Detailed conservation objectives generally refer to each species or habitat type (or zone) in each Natura 2000 area, and derive from the conservation objectives defined by the Decree on Special Protection Areas (Natura 2000 areas), as well as the conservation objectives for the habitats of endangered plant and animal species, and habitat types given favourable conservation status as a matter of priority under nature conservation regulations and strategies and programmes adopted in this field.

The Supplement for Protected Areas includes specific conservation objectives that contribute to the conservation value of the Natura 2000 area. These objectives have been taken from the aforementioned Programme (table below).

Table 17: Detailed conservation objectives of protected areas (MPN, 2015; Official Gazette of RS 78/15)

Protected area	Conservation objectives
Natura 2000 areas Decree on Special Protection Areas (Natura 2000 areas) (Official Gazette of RS, Nos. 49/04, 110/04, 59/07, 43/08, 8/12, 33/13, 35/13 – corrigenda, 39/13 – Constitutional Court Decision, and 3/14, 21/16, 47/18).	The general conservation objectives for Natura areas are summarised after the Decree on Special Protection Areas, which states in Article 6: "(1) The conservation objectives for Natura areas are: 1. The conservation or achieving of favourable status of plant and animal species and habitat types in areas designated as a Natura area, wherein a favourable status is indicated by the following indicators: – the natural extent of the habitat type and size of areas covered by the habitat type within that extent are stable or increasing; – the existence and in the foreseeable future the probable continued existence of a special structure and natural processes or appropriate use ensuring the long-term preservation of the habitat type; – data on the population dynamic of a species or typical species of the habitat type indicate that such species are being conserved in the long term as a survival-capable component of their habitat types; – the natural area of the extent of a species or typical species of the habitat type is not decreasing and will not decrease in the foreseeable future; – the existence and the probable continued existence of a sufficiently large habitat for the long-term conservation of populations of a species or typical species of the habitat type. 2. Preservation of the integrity of Natura areas in terms of preserving their ecological structures, functions and protection potential. 3. Maintaining the connectivity of Natura areas. (2) In Natura areas that include several habitats of species or habitat types based on which the area has been designated a Natura area,

	mutually coordinated conservation objectives shall be taken into account. (3) The conservation objectives referred to in the first paragraph of this Article shall be defined in more detail and set out for each Natura area in the Management Programme for Natura 2000 Areas".
Management Programme for Natura 2000 Areas (2015–2020)	Detailed conservation objectives for Natura 2000 areas listed below are taken from Annex 6.1 "Objectives and Measures".

Vrbina SAC (SI3000234)

Conservation objectives under the MPN 2015–2020:

- HT 6210* Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites):
  - The size of the habitat type is restored to 47 ha.
  - Mowing after June 30 is resumed.
  - The current regime without fertilisation is maintained or fertilisation is carried out no more than once every 3–5 years using solid manure only.
  - Invertebrates that are characteristic of the habitat type are preserved.
  - Extensive grazing is maintained.
- HT 6510 Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*):
  - The size of the habitat type is restored to 44 ha.
  - Mowing after June 30 is resumed.
  - Mowing 2–3 times a year is resumed.
  - Invertebrates that are characteristic of the habitat type are preserved.
  - Fertilisation is carried out with solid manure only.
  - Extensive grazing is maintained.
- Scarlet flat bark beetle (*Cucujus cinnaberinus*):
  - Population size is restored to the presence of the species in population nuclei.
  - The current size of the habitat is preserved.
  - Older stands of the softwood alluvial forest (poplar, willow, elm, oak, ash) are preserved.
  - A 5% proportion of suitable dead wood biomass of native deciduous trees is established, with preference given to trees over 50 cm in diameter at breast height in different growth stages.
  - Wildlife trees (snags) are preserved.
- European stag beetle (*Lucanus cervus*):
  - A stable population index is determined.
  - The current size of the habitat is preserved.
  - The current state without permanent sources of light is maintained.
  - A 3% proportion of dead wood is preserved from the total wood stock, mainly adult trees over 30 cm in diameter at breast height.
- Hermit beetle (*Osmoderma eremita*):
  - Population size is determined.
  - The current size of the habitat is preserved.
  - Old solitary hollow trees, riparian vegetation, tall-trunk orchards with tree hollows, tree-lined avenues, old trees in hedgerows (with priority to pollard willow trees) are preserved.
- Narrow-mouthed whorl snail (*Vertigo angustior*):
  - The presence of the species is determined.
  - The current size of the habitat is preserved.
  - Mowing of wetland vegetation after June 30 is maintained.
  - The natural hydromorphology of water bodies is preserved.

Lower Sava SAC (SI3000304)

- Danube roach (*Rutilus pigus*):
  - Population size is determined (connectivity).
  - The current size of the habitat (134 ha*) is preserved (corridor).
  - The specific characteristics, structures and processes of the habitat are preserved:
    - spawning grounds inside or outside the area, which ensure the presence of specimens in the corridor (rapid water flow with submersed vegetation and/or pebbles/gravel),
    - positive sediment budget and gravel-bed dynamics,
    - passability of dams and barriers,
    - continuity of watercourses,
    - riparian vegetation,

- aquatic vegetation.

* While the size of the habitat given in the MPN is 134 ha, the actual size of the Lower Sava SAC area is only 117.584 ha.

3.2 Overview of conservation, protection, protected, degraded and other areas in which a different regime is prescribed for environmental protection, nature conservation, protection of natural resources or protection of cultural heritage

Protected areas

According to the Rules, the area of direct impact for the NEK complex is 100 m for all groups, while the area of remote impact for birds, bats, aquatic and riparian habitat types, and beetles is 1,000 m. There are no protected areas within the area of direct impact. The only Natura 2000 area within the area of remote impact is the Vrbina SAC SI3000234. The distance of the area from the site of the planned activity is about 350 m. The stretch of Sava approximately 8 km downstream from NEK has been declared a Natura 2000 area (Lower Sava SAC, SI3000304).

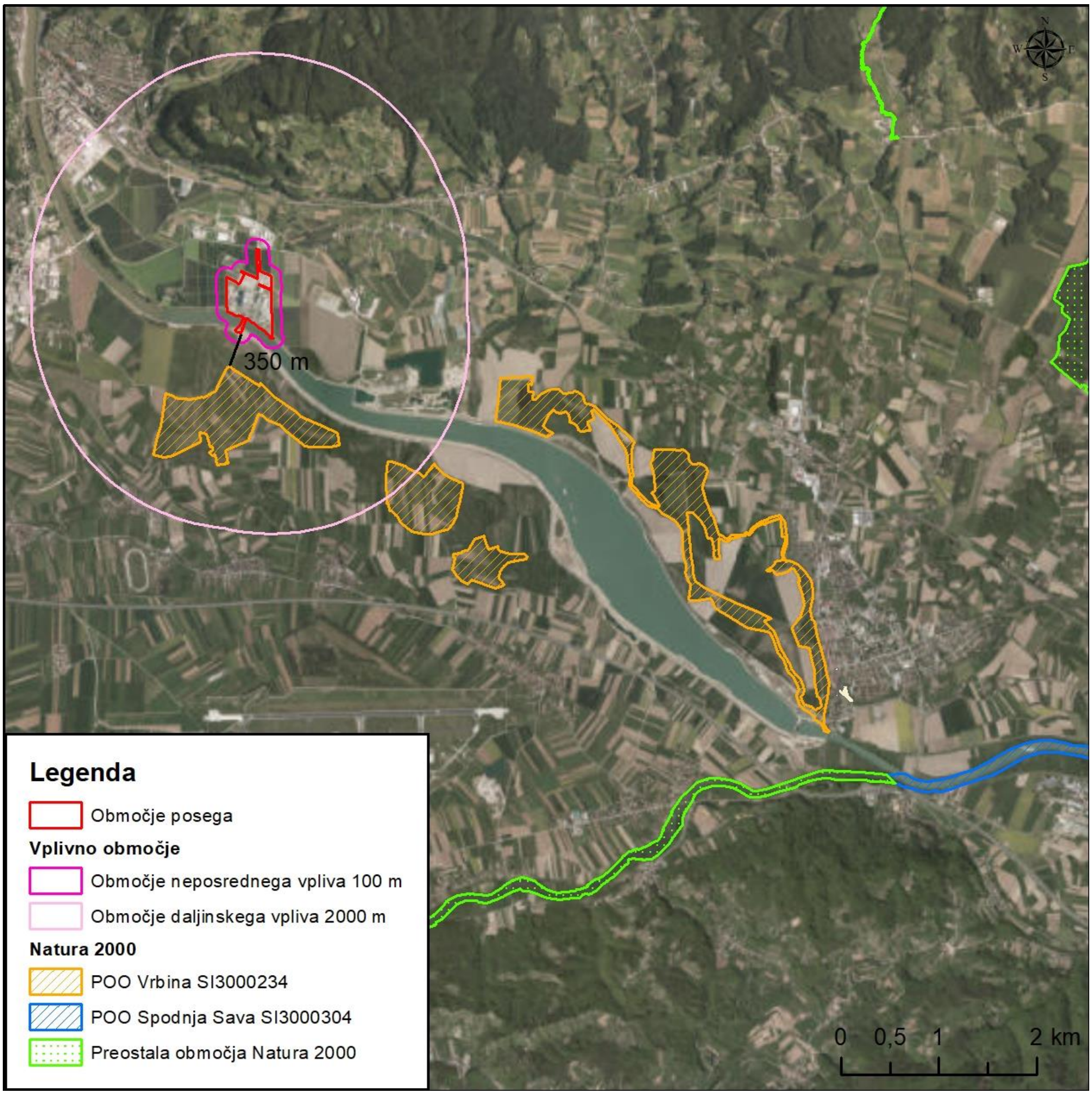

Figure 8: Protected areas within the area of impact (source: Geoportal ARSO, 2020)

Legenda	**Key**
Območje posega	Area of the activity
Vplivno območje	**Impact area**
Območje neposrednega vpliva 100 m	Area of direct impact 100 m
Območje daljinskega vpliva 2000 m	Area of remote impact 2,000 m
Natura 2000	**Natura 2000**
POO Vrbina SI3000234	Vrbina SAC SI3000234
POO Vrbina SI3000304	Vrbina SAC SI3000304
Preostala območja Natura 2000	Other Natura 2000 areas

Ecologically important areas and valuable natural features (VNF)

The area of the activity includes the ecologically important area Sava from Radeče to the national border (ID 63700). This is the stretch of the Sava that crosses the flat Krško/Brežice Polje from Krško to the mouth of the Sotla, where the river creates an extensive flood plain. It is an area with a great diversity of habitats in a relatively small space. Surviving gravel beds, sections of eroded walls, occasionally flooded channels, oxbow lakes, water meadows and fragments of lowland floodplain forest provide a habitat for numerous protected and threatened species. Among the fish are the asp, the streber, the Danubian longbarbel gudgeon and the Balkan loach. Nine species of amphibians are present and there is also a varied avian fauna. Fragments of softwood floodplain forest connected to the remains of poplar plantations and zones of riparian vegetation along the Močnik and Struga streams are a habitat for saproxylic beetles (scarlet flat bark beetle, hermit beetle and European stag beetle) and the narrow-mouthed whorl snail. The surviving fragments of once extensive dry grassland on the right bank in the Vrbina area are important orchid sites (Nature Conservation Atlas, 2021).

There are no valuable natural features within the wider area of controlled use (1,500 m). The nearest valuable natural features are:

- VNF Libna – linden tree next to the church (ID 7860) – a botanical natural feature of local importance; distance from the site of the planned activity is approximately 1,270 m.
- VNF Stari Grad – gravel pit (ID 7861) – an ecosystem and zoological natural feature of local importance; distance from the site of the planned activity is approximately 1,415 m.

Ecologically important areas and valuable natural features are shown in the figure on the next page.

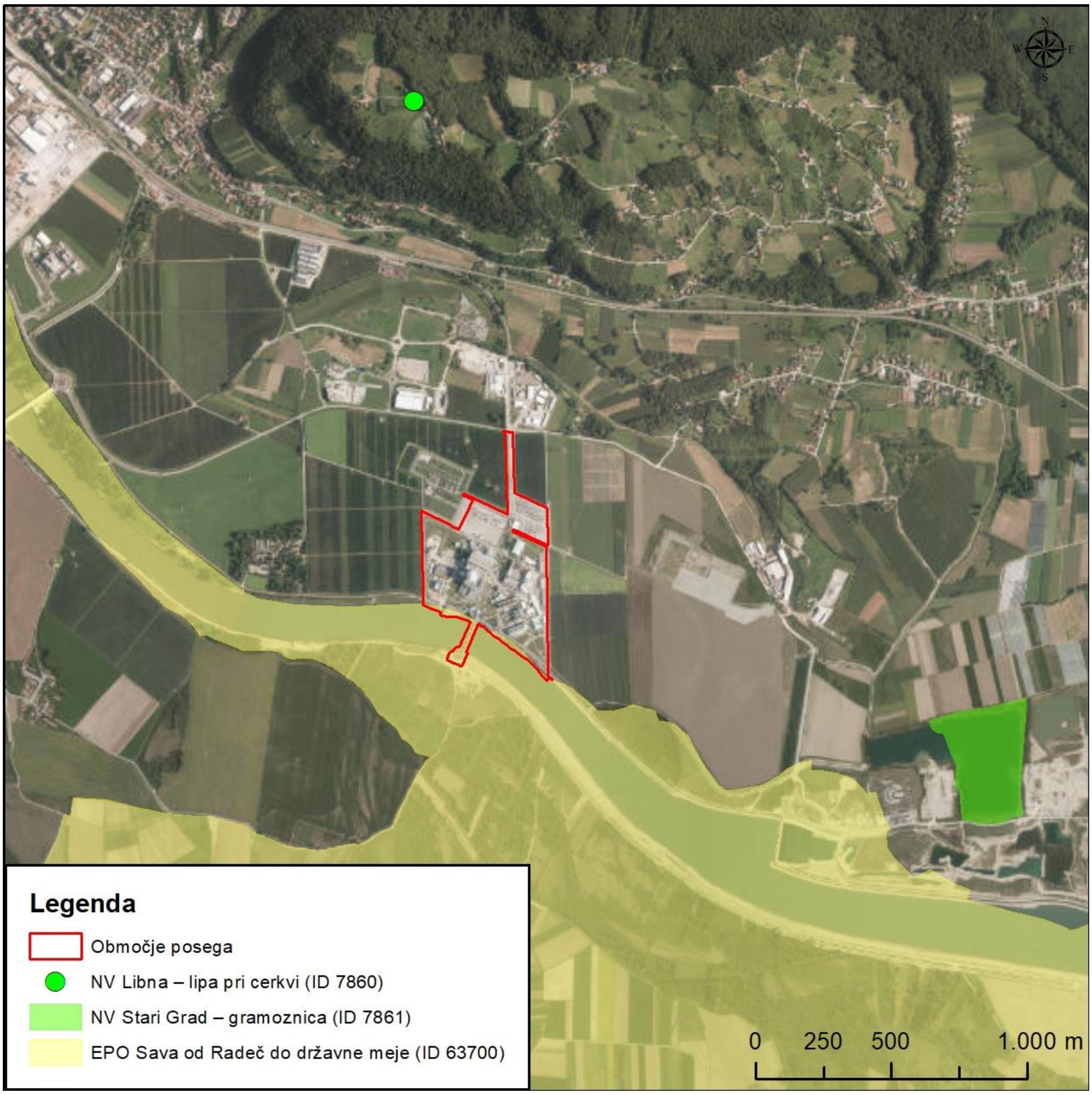

Figure 9: Ecologically important areas and valuable natural features (source: Geoportal ARSO, 2020)

Legenda	Key
Območje posega	Area of the activity
NV Libna – lipa pri cerkvi (ID 7860)	VNF Libna – linden tree next to the church (ID 7860)
NV Stari Grad – gramoznica (ID 7861)	VNF Stari Grad – gravel pit (ID 7861)
EPO Sava od Radeč do državne meje (ID 63700)	Important ecological area: Sava from Radeče to national border (ID 63700)

Forest

There are no forests within the area of the planned activity. Wooded land is more than 450 m away from the site of the planned activity.

Water protection areas

A small part of the southernmost section of the site of the activity (in the vicinity of the dam) is located in the Drnovo WPA (protection regime II), as per the Decree on the protection of groundwater in the area of protection zones of the Krško pumping station-water supply system (Official Gazette of SRS, No. 12/85).

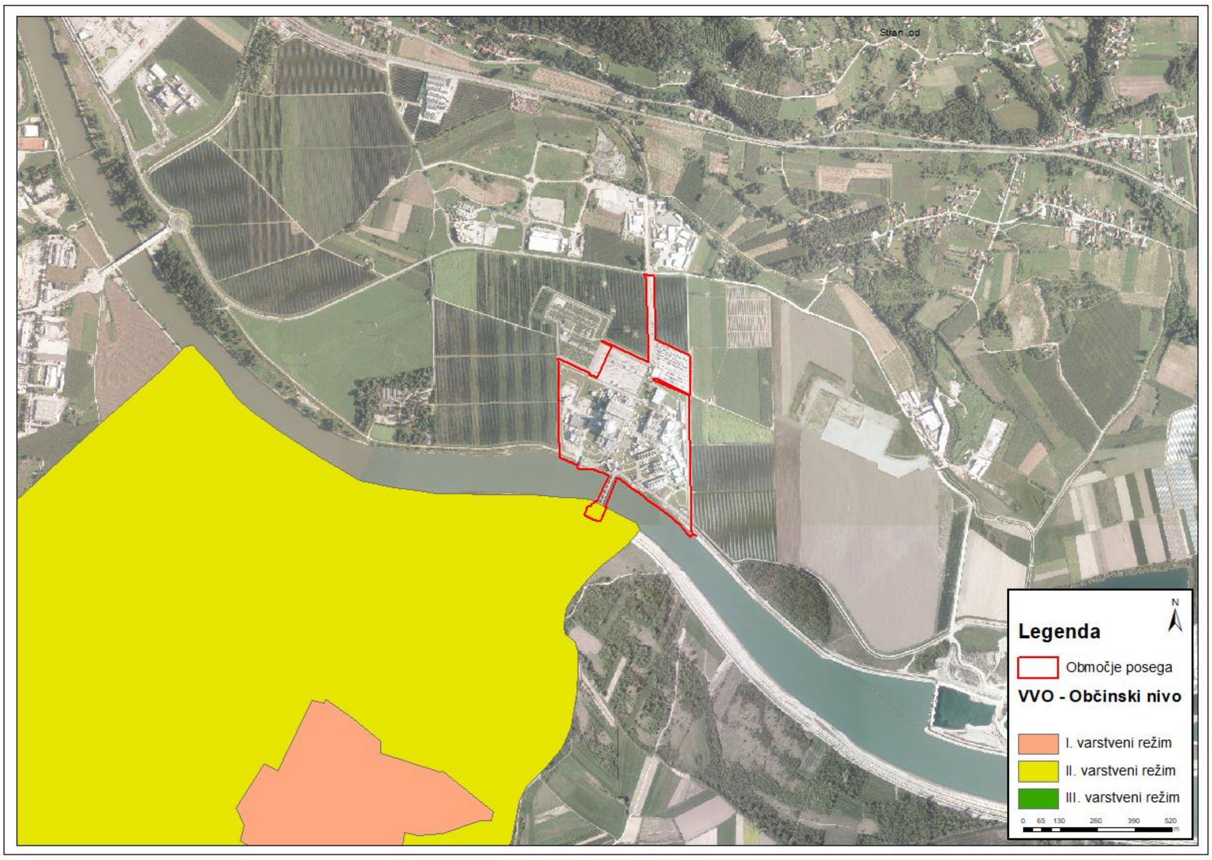

Figure 10: Water protection and catchment areas (municipal level) in the wider surrounding area of the activity (source: EIA)

Legenda	Key
Območje posega	Area of the activity
VVO – Občinski nivo	**Water protection areas – Municipal level**
I. varstveni režim	Protection regime I
II. varstveni režim	Protection regime II
III. varstveni režim	Protection regime III

Cultural Heritage

There are no cultural heritage units within the area of impact of the activity. The nearest cultural heritage unit is Žadovinek – Archaeological site Remen-Tribeže (Heritage No 28988), located more than 550 m south of the area of the activity on the other bank of the Sava.

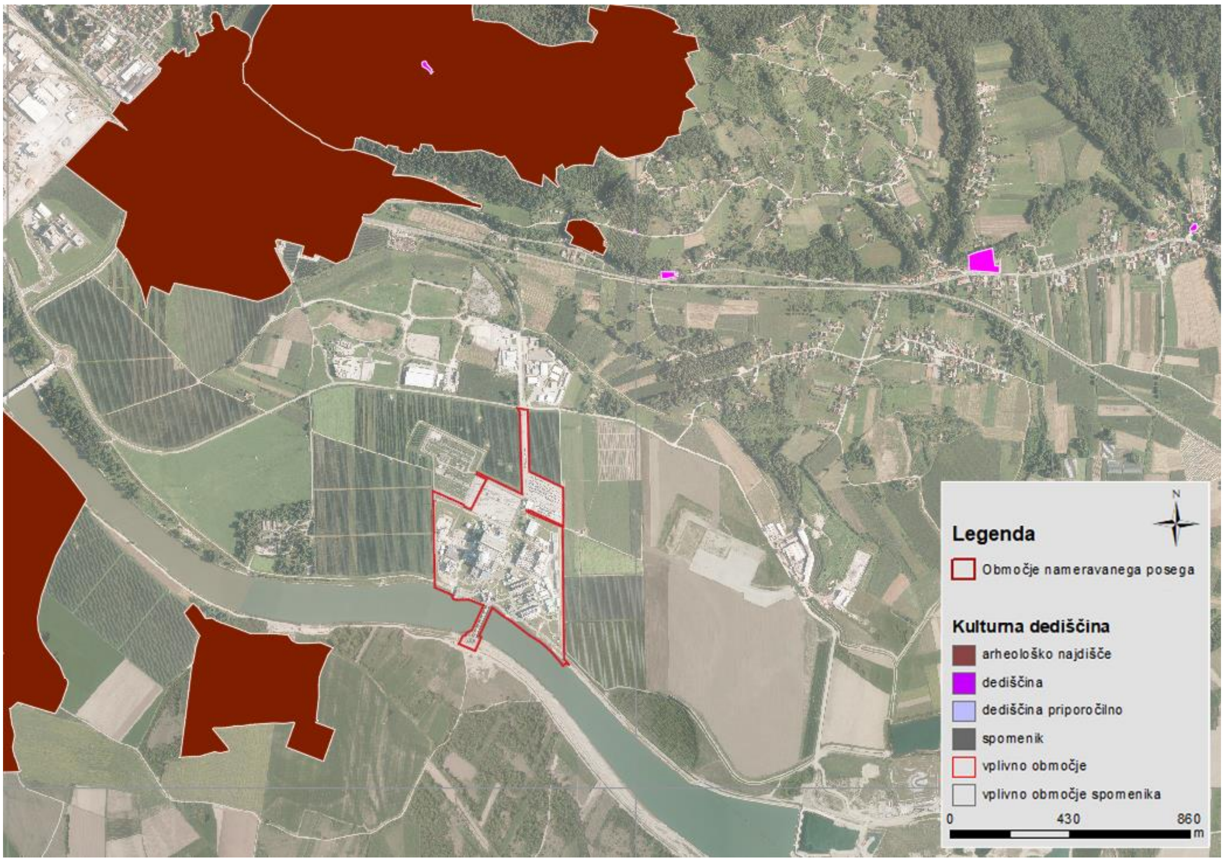

Figure 11: Cultural heritage in the wider surrounding area of the activity (source: EIA)

Legenda	**Key**
Območje nameravanega posega	Site of the planned activity
Kulturna dediščina	**Cultural Heritage**
arheološko najdišče	archaeological site
dediščina	heritage
dediščina priporočilno	heritage recommended
spomenik	monument
vplivno območje	impact area
vplivno območje spomenika	monument impact area

Flood, erosion, landslide and landslide risk areas

Flood zones are present in the surrounding area of the activity. The area is not classified as an erosion zone, while the probability of landslides is negligible.

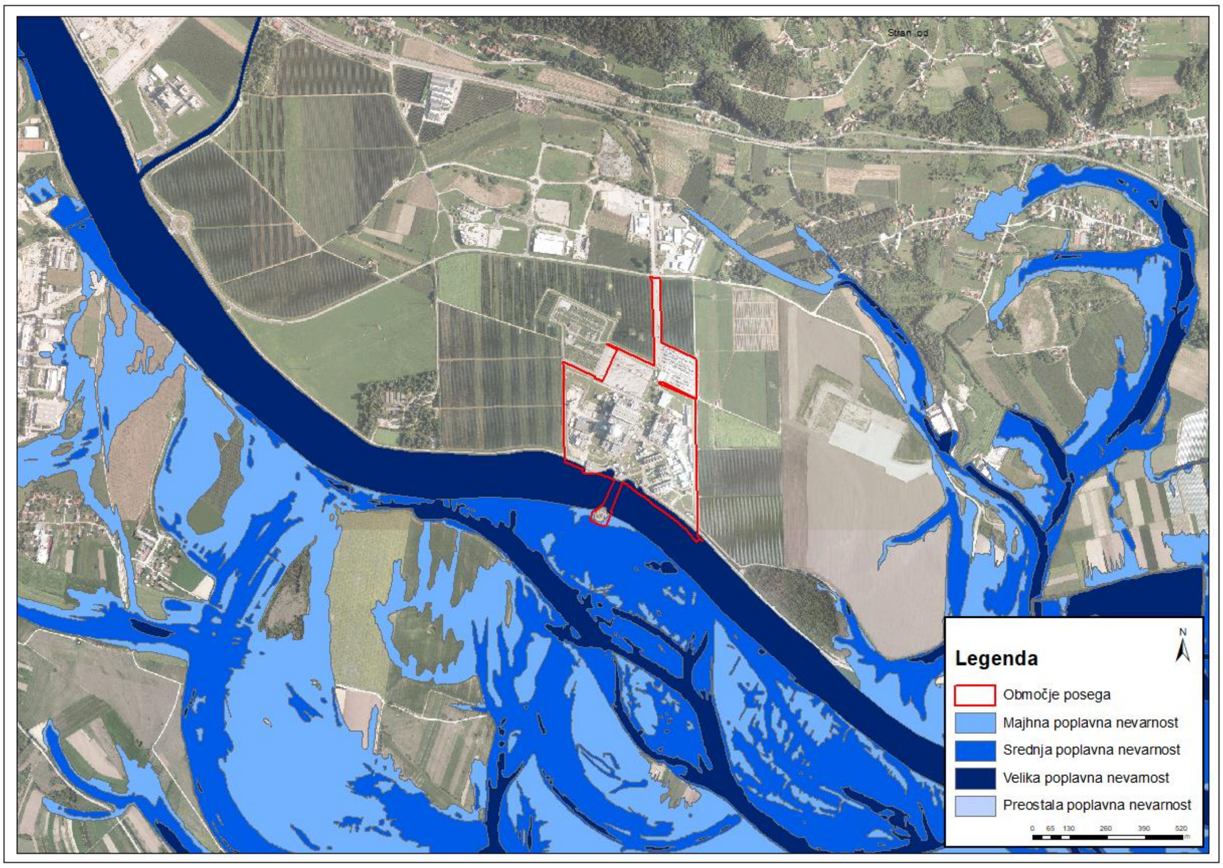

Figure 12: Flood hazard map (source: EIA)

Legenda	Key
Območje posega	Area of the activity
Majhna poplavna nevarnost	Small flood hazard
Srednja poplavna nevarnost	Medium flood hazard
Velika poplavna nevarnost	Large flood hazard
Preostala poplavna nevarnost	Other flood hazards

Degraded areas

There are no degraded areas in the area covered by the national spatial plan (DPN) (Register of Degraded Areas, 2011, Department of Geography, Faculty of Arts, University of Ljubljana).

3.3 Summary of applicable legal regimes in protected areas or their parts, information on the acquisition of nature protection guidelines or background documentation, and the level of compliance

3.3.1 Legal regimes and conservation guidelines

The conservation guidelines for **Natura 2000** areas are defined in the Decree on Special Protection Areas (Natura 2000 areas) (Official Gazette of RS, Nos. 49/04, 110/04, 59/07, 43/08, 8/12, 33/13, 35/13, 39/13, 3/14, 21/16, 47/18), i.e. in Articles 7 and 15.

Table 18: Conservation guidelines and rules of conduct in Natura 2000 areas

Conservation guidelines (Article 7)	Rules of conduct for the conservation of potential Natura areas (Article 15)
(1) Guidelines for the conservation of Natura areas are guidelines for the planning and implementation	(1) Guidelines for the conservation of potential Natura areas are guidelines for the planning and

Conservation guidelines (Article 7)	Rules of conduct for the conservation of potential Natura areas (Article 15)
of interventions and activities and other human actions in such areas with the aim of achieving conservation objectives.	implementation of interventions and activities and other human actions in such areas with the aim of preventing the deterioration of their status.
(2) Interventions and activities in Natura sites shall be planned so as to ensure to the largest possible extent: – preservation of the natural distribution of habitat types and plant and animal habitats; – preservation of the relevant features of the abiotic and biotic components of habitat types, their specific structures and natural processes or appropriate use; – preservation and improvement of the quality of plant and animal habitats, in particular those parts of habitats that are essential for the most important stages in the life cycle, such as reproduction, resting, hibernation, migration and feeding; – the connectivity of the habitats of plant and animal populations and their reconnection if it has been broken.	(2) When carrying out interventions and activities in potential Natura sites, which are planned in accordance with the guidelines referred to in the previous paragraph, all possible technical and other measures shall be taken to minimise the negative impact on habitat types, plants and animals and their habitats, in accordance with the fourth and fifth paragraphs of Article 7 of this Decree.
(3) When carrying out interventions and activities planned in accordance with the previous paragraph, all possible technical and other measures shall be taken to minimise the negative impact on habitat types, plants and animals and their habitats.	(3) For potential Natura areas, an assessment of the acceptability of plans, programmes, spatial planning and other acts, or an assessment of the acceptability of activities affecting nature must be carried out in the manner prescribed by regulations on nature conservation.
(4) The timing of interventions, activities and other actions shall be adapted as closely as possible to the life cycles of animals and plants by: – ensuring that interventions or activities do not coincide, or coincide as little as possible, with periods when animals require peace or are unable to retreat, especially during mating season and when rearing their young, during stationary or low mobility stages of development, and during hibernation, – enabling the seeding, natural planting and other modes of plant reproduction.	(4) Notwithstanding the provision of the preceding paragraph, the assessment of the acceptability of activities affecting nature shall not be required in the cases referred to in the second paragraph of Article 8 of this Decree.
(5) No non-native animal and plant species or genetically modified organisms shall be introduced into Natura areas.	(5) Within any potential Natura area, zones may be designated according to the manner and procedure prescribed in Article 9 of this Decree.
(6) On the basis of conservation guidelines, detailed and specific conservation guidelines shall be determined, which shall be taken into account in spatial planning, the use of natural goods and water management. Detailed conservation guidelines may be determined as part of the management programme referred to in Article 12 of this Decree, or as part of nature protection guidelines, which also include specific conservation guidelines.	(6) Monitoring shall be carried out in potential Natura areas to the extent specified in Article 10 of this Decree.
	(7) In order to prevent the deterioration in status, and in accordance with the second, third, fourth and fifth paragraphs of Article 12 of this Decree, measures and activities for potential Natura areas shall be determined in the management programme, whereby such measures and nature protection tasks shall be subordinate to those implemented in Natura areas with regard to their financing and timing.
	Article 15b (Rules of conduct for an area nominated

Conservation guidelines (Article 7)	Rules of conduct for the conservation of potential Natura areas (Article 15)
	as a Natura area by the European Commission) The first and second paragraphs of Article 15 of this Decree shall be applied to prevent the deterioration of priority habitat types and habitats of priority plant and animal species, as well as any disturbances that could compromise the conservation of species for which an area was nominated as a Natura area by the European Commission.

3.3.2 Information on the acquisition of nature protection guidelines and background documentation

The Institute of the Republic of Slovenia for Nature Conservation (ZRSVN) issued an opinion on the data that the Environmental Impact Assessment Report should contain. The opinion of ZRSVN states that the area of the planned activity is located within the area of remote influence of the nearby Lower Sava SI5000304 Natura 2000 area, designated for the qualifying species Danube roach (*Rutilus pigus*). The Sava also represents a habitat for other protected rheophilic fish species (e.g. Danube barbel, streber, Danubian longbarbel gudgeon, Kessler's gudgeon). ZRSVN further notes that the thermal load on the Sava and the associated reduction in the oxygen content of water is the only recorded impact of NEK on the qualifying species in question. The opinion of ZRSVN summarises the results of the Analysis of changes in radiological and thermal impact by NEK on the environment after the construction of HPP Brežice (Jožef Stefan Institute, Faculty of Civil and Geodetic Engineering, Inženirski Biro Elektroprojekt, 2006), the Environmental report for the NSP for HE Mokrice, June 2013, Geateh d.o.o., and the study of the thermal load on the Sava (Interactions of energy buildings along and on the Sava from the perspective of the heat load on the Sava – Revision A (IBE 2012)). In view of the above, the opinion states that the existing data sets/studies/monitoring results (also in connection with other activities with an impact on the Sava, e.g. HPP Brežice and HPP Mokrice), which address the thermal load on the Sava and its accompanying effects, should be collected, presented, and examined in relation to the impact on rheophilic fish species as part of the environmental impact assessment.

In 2006, NEK filed an application at the Ministry of the Environment and Spatial Planning (MOP) and the Environmental Agency of the Republic of Slovenia (ARSO) for the issuance of an environmental permit for the operation of NEK. On 30 June 2010, the MOP issued Decision No. 35441-103/2006-24, Environmental Permit for the Operation of NEK regarding Emissions into Waters, which defined special conditions for the operation of the facility. On 4 June 2012 and 10 October 2013, Decisions Nos. 3544-103/2006-33 and 35444-11/2013-3, which introduced modifications in paragraphs determining the operating conditions of the facility, were issued.

NEK operates in compliance with the valid water permit for the use of water from the Sava for technological purposes. The initial partial water permit was issued on 15 October 2009, No. 35536-31/2006-16, and was amended due to a change in the amount of water taken from the Sava by Decision No. 35536-54/2011-4 of 8 November 2011 and Decision No. 35530-7/2018-2 of 22 June 2018.

3.4 Presentation of the areas of actual land use

The actual use of land in the immediate vicinity of the area of the activity is predominantly agricultural. The NEK complex is surrounded by intensive orchards and fields. Agricultural land in the surrounding area also includes uncultivated agricultural land. Meadows are present in the vicinity of the settlements, with a larger number found on the neighbouring right bank of the Sava.

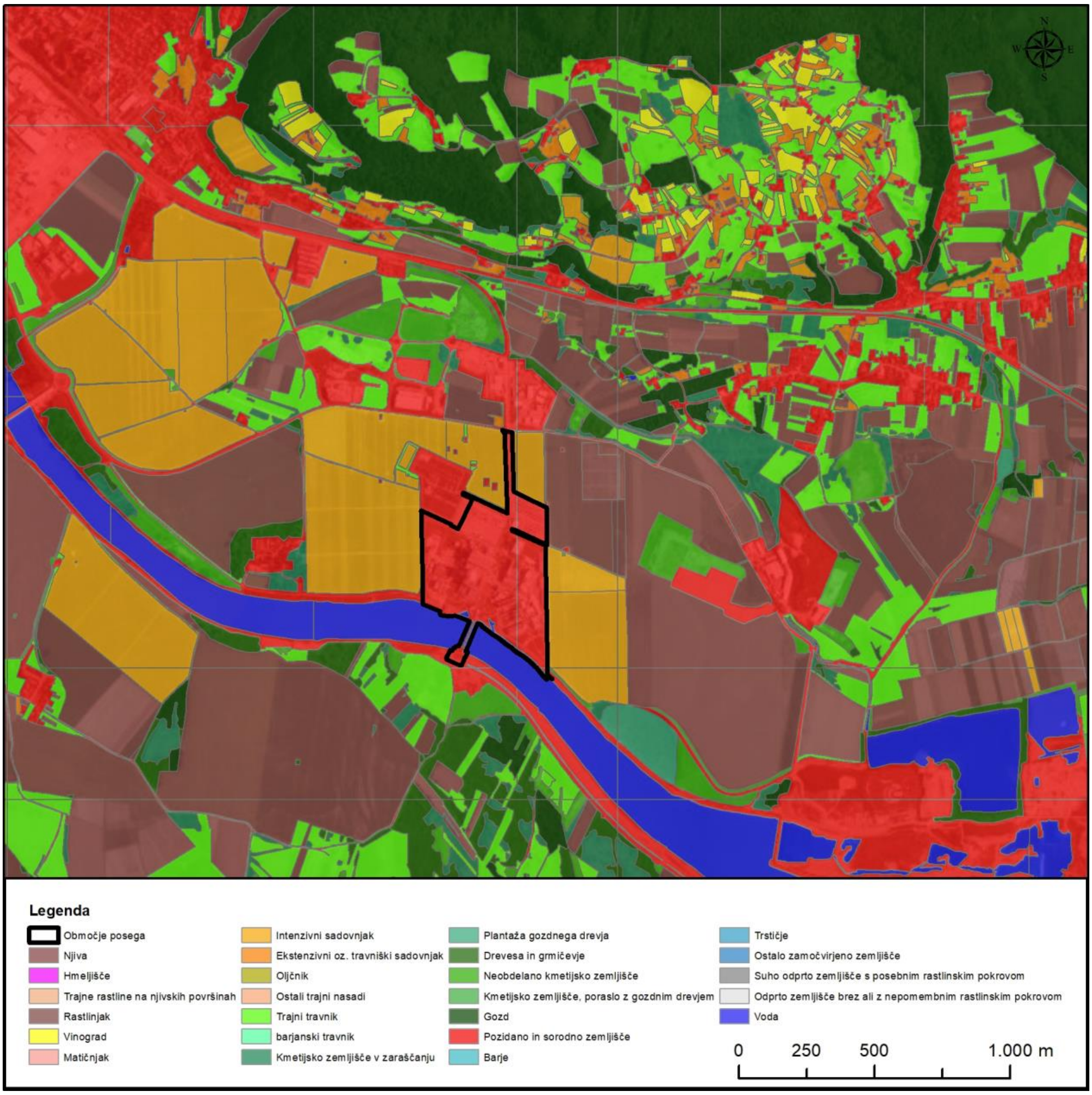

Figure 13: Actual land use in the area covered by spatial planning (Ministry of Agriculture, Forestry and Food, 2020)

Legenda	**Key**
Območje posega	Area of the activity
Njiva	Field
Hmeljišče	Hop garden
Trajne rastline na njivskih površinah	Perennial plants in field areas
Rastlinjak	Greenhouse
Vinograd	Vineyard
Matičnjak	Root stock nursery
Intenzivni sadovnjak	Intensive orchard
Ekstenzivni oz. travniški sadovnjak	Extensive or meadow orchard
Oljčnik	Olive grove
Ostali trajni nasadi	Other perennial plantations
Trajni travnik	Perennial meadow
barjanski travnik	Bog meadow
Kmetijsko zemljišče v zaraščanju	Overgrown agricultural land
Plantaža gozdnega drevja	Forest plantation
Drevesa in grmičevje	Trees and bushes

Neobdelano kmetijsko zemljišče	Uncultivated agricultural land
Kmetijsko zemljišče, poraslo z gozdnim drevjem	Forest trees on agricultural land
Gozd	Forest
Pozidano in sorodno zemljišče	Built-up and related land
Barje	Marshland
Trstičje	Reeds
Ostalo zamočvirjeno zemljišče	Other marshy land
Suho odprto zemljišče s posebnim rastlinskim pokrovom	Dry open land with special vegetation cover
Odprto zemljišče brez ali z nepomembnim rastlinskim pokrovom	Open land without or with insignificant vegetation cover
Voda	Water

3.5 Species and habitat types for which a Natura 2000 area has been designated

Key data on each Natura 2000 area are collected in the Standard Data Form (SDF). Data from the SDF are available on the Natura 2000 Network viewer (http://natura2000.eea.europa.eu/).

3.5.1 Vrbina SAC (SI3000234)

Table 19: Qualifying species in the area of the Vrbina SAC (SI3000234)

Species (common name)	Species (Latin name)	EU species code	Population type	Abundance category	Size and density of the population	Degree of conservation	Degree of isolation	Global assessment	Final assessment of the conservation status
Scarlet flat bark beetle	*Cucujus cinnaberinus*	1086	p	C	B	B	C	B	U1
European stag beetle	*Lucanus cervus*	1083	p	C	C	B	C	B	FV
Hermit beetle	*Osmoderma eremita*	1084*	p	P	C	B	C	C	U2
Narrow-mouthed whorl snail	*Vertigo angustior*	1014	p	R	C	C	C	C	U1

Key:
EU species code: species code listed in Annex II of the Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora).
Population type: p – permanent; r – reproducing; w – wintering.
Abundance category: P – present; C – common; R – rare; V – very rare; n/a – no data for value: 6–10 (I).
Size and density of the population: A: 100% >= p > 15%; B: 15% >= p > 2%; C: 2% >= p > 0%; D: non-significant presence.
Degree of conservation: A: excellent conservation; B: good conservation; C: average or reduced conservation.
Degree of isolation: A: population (almost) isolated; B: population not-isolated, but on margins of area of distribution; C: population not-isolated within extended distribution range.
Global assessment: A: excellent value; B: good value; C: significant value.
Final assessment of the conservation status in the continental biogeographic region (based on the report in accordance with Article 17 of the Habitats Directive): FV: Favourable; U1: Unfavourable–Inadequate; U2: Unfavourable–Bad; XX: Unknown.
* priority species under the Habitats Directive.

Table 20: Qualifying habitat types in the area of the Vrbina SAC (SI3000234)

Habitat type	EU habitat code	Area (ha)	Data Quality	Degree of representativity of the HT in the area	Area covered by the HT in relation to the total area of that HT within the national territory	Degree of conservation of the structure and functions of the HT in the area	Global assessment of the HT conservation status in the area	Final assessment of the conservation status
Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites)	6210*	40.7	G	A	B	A	A	U2
Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*)	6510	25.3	G	B	C	B	B	U2

Key:
EU habitat code: habitat type code listed in Annex I of the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206 of 22 July 1992, p. 7), last amended by Council Directive 2006/105/EC of 20 November 2006 (OJ L 363 of 20 December 2006, p. 368)).
Degree of representativity of the HT in the area: A: excellent representativity; B: good representativity; C: average or reduced representativity.
Area covered by the HT in relation to the total area of that HT within the national territory: A: 100% >= p > 15%; B: 15% >= p > 2%; C: 2% >= p > 0%; D: non-significant presence.
Degree of conservation of the structure and functions of the HT in the area: A: excellent conservation; B: good conservation; C: average or reduced conservation.
Global assessment of the HT conservation status in the area: A: excellent value; B: good value; C: significant value.
Final assessment of the conservation status in the continental biogeographic region (based on the report in accordance with Article 17 of the Habitats Directive): FV: Favourable; U1: Unfavourable–Inadequate; U2: Unfavourable–Bad; XX: Unknown.
* priority habitat type under the Habitats Directive.

3.5.2 Lower Sava SAC (SI30000304)

Table 21: Qualifying species in the area of the Lower Sava SAC (SI30000304)

Species (common name)	Species (Latin name)	EU habitat code	Population type	Abundance category	Size and density of the population	Degree of conservation	Degree of isolation	Global assessment	Final assessment of the conservation status
Danube roach	*Rutilus pigus*	1114	p	P	C	B	C	C	U1

Key:

EU species code: species code listed in Annex II of the Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora).
Population type: p – permanent; r – reproducing; w – wintering.
Abundance category: P – present; C – common; R – rare; V – very rare; n/a – no data for value: 6–10 (I).
Size and density of the population: A: 100% >= p > 15%; B: 15% >= p > 2%; C: 2% >= p > 0%; D: non-significant presence.
Degree of conservation: A: excellent conservation; B: good conservation; C: average or reduced conservation.
Degree of isolation: A: population (almost) isolated; B: population not-isolated, but on margins of area of distribution; C: population not-isolated within extended distribution range.
Global assessment: A: excellent value; B: good value; C: significant value.
Final assessment of the conservation status in the continental biogeographic region (based on the report in accordance with Article 17 of the Habitats Directive): FV: Favourable; U1: Unfavourable–Inadequate; U2: Unfavourable–Bad; XX: Unknown.
* priority species under the Habitats Directive.

3.6 Area management plans and resulting guidelines

In 2015, the Management Programme for Natura 2000 Areas (2015–2020) was developed. Annex 6.1 of the Programme sets out conservation objectives, which generally refer to each species or habitat type in each Natura 2000 area, and derive from the conservation objectives defined by the Decree on Special Protection Areas (Natura 2000 areas). The conservation objectives are available on the website: http://www.natura2000.si/fileadmin/user_upload/pun_2016_6_1.xlsx. The Supplement for Protected Areas includes conservation objectives that contribute to the conservation value of Natura 2000 areas. These objectives have been taken from the aforementioned Programme and are listed in Section 3.1.

3.7 Description of the existing baseline state of the area

Vrbina SAC (SI3000234)
The Vrbina SAC comprises three smaller areas of calcareous dry grasslands with orchid sites, located on the flood plain on the right bank of the Sava between Krško and Brežice, while on the left bank, in Vrbina, there are fragments of softwood floodplain forest connected to the remains of poplar plantations and zones of riparian vegetation along the Močnik and Struga streams, which are a habitat for saproxylic beetles (scarlet flat bark beetle, hermit beetle and European stag beetle) and the narrow-mouthed whorl snail (Nature Conservation Atlas, 2021). The area is approximately 350 m from the site of the activity.

According to the SDF data, the Vrbina SAC covers 273.7840 ha and belongs to the continental biogeographic region of Europe. Most of the area (33.71%) is covered by meadows and shrubs, followed by forest habitats (29.03%), forest monocultures (poplar plantations, etc., 17.11%), other arable land (15.30%), other areas (towns, villages, roads, landfills, mines, industrial areas (4.41%)), inland waters (3.53%), and non-forest cultivated areas with woody vegetation (orchards, plantations, vineyards 0.44%).

Table 22: Qualifying habitat type zones for Vrbina SAC (SI3000234)

EU	Habitat type	HT zone
6210*	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites)	The HT zone covers 40.69 ha. The area of the assessed plan is approximately 460 m from the nearest part of the zone.
6510	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	The HT zone covers 25.29 ha. The area of the assessed plan is approximately 610 m from the nearest part of the zone.

Key:
EU habitat code: habitat type code listed in Annex I of the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206 of 22 July 1992, p. 7), last amended by Council Directive 2006/105/EC of 20 November 2006 (OJ L 363 of 20 December 2006, p. 368)).
* priority habitat type under the Habitats Directive.

Table 23: Qualifying species habitat zones for Vrbina SAC (SI3000234)

EU species code	Species (common name)	Species (Latin name)	Species habitat zone
1014	Narrow-mouthed whorl snail	*Vertigo angustior*	The zone covers 169.12 ha. The area of the activity is approximately 350 m from the nearest part of the zone.
1083	European stag beetle	*Lucanus cervus*	The zone covers 145.96 ha. The area of the activity is approximately 350 m from the

EU species code	Species (common name)	Species (Latin name)	Species habitat zone
			nearest part of the zone.
1084*	Hermit beetle	*Osmoderma eremita*	The zone covers 153.75 ha. The area of the activity is approximately 350 m from the nearest part of the zone.
1086	Scarlet flat bark beetle	*Cucujus cinnaberinus*	The zone covers 123.37 ha. The area of the activity is approximately 350 m from the nearest part of the zone.

Key:
EU species code: species code listed in Annex II of the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206 of 22 July 1992, p. 7), last amended by Council Directive 2006/105/EC of 20 November 2006 (OJ L 363 of 20 December 2006, p. 368)).
* priority species under the Habitats Directive.

Lower Sava SAC (SI3000304)

The Sava from the mouth of the Krka to the national border represents a connecting habitat for Danube roach populations from the Sotla and Krka rivers. Following the findings of a biogeographical seminar (Ljubljana, June 2014), a new area was defined for the species *Rutilus pigus*. The decision of the seminar was that the connectivity of the Danube roach population between the Krka and the Sotla should be ensured. On this basis, the section of the Sava between the mouth of the Krka and the national border with Croatia was defined as a new area. The Danube roach that live in Slovenia actually belong to the species *Rutilus virgo* (common name: cactus roach), once defined as the subspecies *Rutilus pigus virgo*. Today this is defined as a species in its own right that inhabits the Danube basin, unlike *Rutilus pigus*, which naturally inhabits the northern part of the Adriatic basin. Lake populations of *Rutilus pigus* inhabit deep open lakes in Italy, while river populations inhabit tributaries of the Po. The distributions of the two species do not overlap and *Rutilus pigus* does not live in Slovenia. The species *Rutilus pigus* is, however, defined as a qualifying species for all Natura 2000 areas in Slovenia on the reference list of Natura 2000 species, since this name derives from the Habitats Directive and, in the case of Slovenia, covers the species *Rutilus virgo* (interpretation of the Institute of the Republic of Slovenia for Nature Conservation (ZRSVN)).

According to the SDF data, the Lower Sava SAC covers 117.584 ha and belongs to the continental biogeographic region of Europe. Most of the area (77.0%) is covered by inland waters, followed by meadows and shrubs (17.10%), forest habitats (5.0%), other areas (towns, villages, roads, landfills, mines, industrial areas (0.8%)), and other arable land (0.1%). This is the stretch of the Sava that crosses the flat Krško/Brežice Polje from Brežice to the mouth of the Sotla (national border). On the section to Podgračeno, the banks within the flood embankments are to a large extent reinforced. Rheophilic fish species are predominant in the river ecosystem. The migration route between Sotla and Krka is important for the cactus roach.

Table 24: Qualifying species habitat zones for Lower Sava SAC (SI3000304)

EU species code	Species (common name)	Species (Latin name)	Species habitat zone
1014	Danube roach	*Rutilus pigus*	The zone covers 117.58 ha. The quality of the zone is good. The area of the activity is approximately 7,750 m from the nearest part of the zone.

3.8 Key characteristics of habitats or species in the area

The qualifying species and habitat types for which the Natura 2000 area has been designated are listed in Section 3.5. Descriptions of the qualifying species are available on the website of the Nature Conservation Atlas (http://www.naravovarstveni-atlas.si/).

Table 25: Description of the qualifying habitat types for Vrbina SAC (SI3000234) (source: Nature Conservation Atlas, 2019)

EU habitat code	Habitat type	Description of the habitat type
6210*	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites)	This habitat type consists of meadows or pastures on limestone, dolomite or, more rarely, flysch, or on sand and old gravel beds. Growing sites are dry, light and warm. The substrate is neutral or slightly basic, with few nutrients. They do not tolerate fertilisation, except on very arid soil, where they also do well with moderate fertilisation. They grow on the slopes of hills (except north-facing slopes) where the soil is shallow and the ground is bare in places. They do not tolerate high levels of moisture or stagnation of water. They need extensive pasture or mowing 1–2 times a year, first after the majority of meadow plants have finished flowering, without fertilisation, with hay drying in the meadow, and are not damaged by pasture at the end of the season (August–October). In Slovenia, this habitat type appears in scattered form on suitable surfaces (unfertilised, particularly calcareous soils, sunny slopes). Threats include fertilisation of meadows, hay baling, conversion of meadows into fields, overgrowing with woody species and, in places, hill walking and infrastructure developments.
6510	Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*)	Lowland hay meadows thrive on moderately fertilised, damp to moderately dry soils. They are mown 2–3 times a year. In the traditional cultural landscape, they usually appear as part of a mosaic that also includes dry and damp meadows. They are found across Slovenia but are rare in the Slovenian part of the Istrian peninsula and on the Karst plateau. They are not present in high mountain areas. Three forms of this habitat type are present in Slovenia: damp, dry and mesophilic. The last of these is, for the time being, least at risk, while dry grassland is most at risk from overgrowing, and damp grassland from drying out and intensification of meadows (conversion into fields, oversowing with grass mixtures, baling, overfertilisation, over-frequent mowing).

Key:
EU habitat code: habitat type code listed in Annex I of the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206 of 22 July 1992, p. 7), last amended by Council Directive 2006/105/EC of 20 November 2006 (OJ L 363 of 20 December 2006, p. 368)).
* priority habitat type under the Habitats Directive.

Table 26: Description of the qualifying species for Vrbina SAC (SI3000234) (source: Nature Conservation Atlas, 2019)

EU species code	Species	Species description
1014	Narrow-mouthed whorl snail *Vertigo angustior*	The shell of this tiny snail is 1.8 mm high and 0.9 mm wide, sinistral, with five whorls, a finely ribbed surface, red-brown in colour and glossy. The species is found in tall herbs in marshy meadows and valley groves, in sedges and among mosses in bogs, in the leaf litter of waterside shrubs and bushes. It frequently lives on the boundaries of different habitats, for example the boundary between reed beds and marsh or in the transitional zone between grassland and salt marsh. It can also live in completely dry environment such as dry forests. It is sensitive to rapid changes in humidity in its habitat, to changes in grazing conditions (it tolerates grazing to a certain extent) and to physical disturbances. In areas liable to flooding, it is important that higher sections of bogs and reed beds are preserved, since these represent flood refuges.
1083	European stag beetle *Lucanus cervus*	It is among the largest beetle species in Europe. Males, which are usually larger, grow to sizes of between 25 and 75 mm – the difference is typically due to the different quality of food available to the larvae. The body is elongated, broad and partly flattened. The jaws of the male are transformed into an antler-like formation – the origin of the name stag beetle. The head, prothorax and legs are black or dark brown, while the colour of the elytra varies from dark brown to chestnut red. Development is tied to various species of deciduous trees, among which oaks predominate. Female stag beetles lay their eggs on or next to tree stumps or old or fallen trees. The larvae feed on dead or rotting tree roots and pupate in soil (at a depth of 15–20 cm). The full process of development takes place very slowly and can last up to five years. Adult beetles, which only live a few weeks, are mostly active at dusk and feed on a variety of plant secretions. In our assessment, the species is not yet threatened in Slovenia, although it has been placed on the Red List because of the excessive zeal of collectors (particularly for very large specimens of male stag beetles). An unsuitable forestry management intervention from the point of view of the species is cutting trees too low (just above the ground).
1084*	Hermit beetle *Osmoderma eremita*	The hermit beetle is a relatively large (20–35 mm) species of chafer, dark brown to purple in colour and difficult to confuse with other chafers. Larvae develop in deep tree hollows, for the most part in deciduous trees (oak, willow, fruit trees, lime tree, ash), where there is a larger quantity of decaying wood on which the larvae can feed. Development takes two to three or even four years, depending on the nutritional quality of the decaying wood on which they feed. Adult males only live a few days (10–20), while females can live up to a month or two. They feed on plant material and drink sweet tree sap. They are not very mobile and for the most part stay close to their place of development (hence the name "hermit"). For this reason, the proximity or density of tree hollows is important for their survival. As a result of human activity, this density is greatest in anthropogenic environments such as old tree avenues, riparian willow communities or tall orchards. One threat factor is therefore the abandoning of certain customs – e.g. the removal of large, old willow trees from riverbanks, changes in the method of agriculture and the disappearance of tall orchards.

EU species code	Species	Species description
1086	Scarlet flat bark beetle *Cucujus cinnaberinus*	The scarlet flat bark beetle is a small beetle measuring between 11 and 15 mm with an elongated, parallel, flattened body. The head, prothorax and elytra are bright red, while the legs and antennae are black. The head is wrinkled and the prothorax and elytra are ribbed. The species prefers to live under the rotting damp bark of deciduous trees (oak, poplar, maple and beech) or conifers (spruce, fir and pine). In both developmental phases it feeds predatorily, while the larvae also partly feed on wood detritus. The larvae are frequently found together with larvae of woodboring beetles, on which they also feed. Development lasts two years or more. The species is threatened by the forestry management method in which old and dying trees are removed.

Key:
EU species code: species code listed in Annex II of the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206 of 22 July 1992, p. 7), last amended by Council Directive 2006/105/EC of 20 November 2006 (OJ L 363 of 20 December 2006, p. 368)).
* priority species under the Habitats Directive.

Lower Sava SAC (SI3000304)

Table 27: Description of the qualifying species for Lower Sava SAC (SI3000304)

EU species code	Species	Species description
1114	Cactus roach *Rutilus pigus virgo*	The cactus roach is 60 cm long with a laterally flattened body that is silver in colour, passing to grey-green on the back. The mouth is inferior. It lives in moderately rapid flowing medium to large watercourses. At spawning time it also finds its way into smaller watercourses with submerged aquatic plants and/or a gravel bed. Even at this time it prefers faster flowing waters. It spawns from April to May in tributaries and backwaters and usually deposits roe on plants or the stream bed. Males develop large white breeding tubercles on the back and head during spawning. The cactus roach feeds on aquatic plants and aquatic invertebrates. In Slovenia it is found in all watercourses of the Danube basin. The largest populations are in the basin of the Ljubljanica, the lower course of the Sava, the Mirna, the Krka and the Kolpa. It is an endemite of the Danube basin. In terms of ecological characteristics, the cactus roach is classified as a rheophilic, potamic, lithophilic or litho-phytophilic and invertivore fish (Duβling et al. 2004, Podgornik and Urbanič 2014, 2015 in Urbanič et al., 2019) that according to some sources migrates for short distances (Duβling et al. 2004), and according to other sources more than 150 km (Ćaleta et al. 2015).

Key:
EU species code: species code listed in Annex II of the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206 of 22 July 1992, p. 7), last amended by Council Directive 2006/105/EC of 20 November 2006 (OJ L 363 of 20 December 2006, p. 368)).

3.9 Data on seasonal factors and effects of natural disturbances

The Vrbina SAC area with qualifying dry meadows lies in the flood zone of the Sava. These dry meadows are therefore occasionally flooded, and prolonged floods can lead to poorer conditions for the growth of plants adapted to dry habitats during the vegetation season. With its size and flow, the Sava stands out from the average of Slovenian rivers, which are relatively small and consequently have lower flows. Thus in 2005 the average annual minimum daily flow (Q_{np}) at the Čatež 1 gauging station was 75.5 m^3/s, the average annual mean flow (Qs) was 258 m^3/s, and the average annual maximum daily flow (Qvp) was 1,624 m^3/s. During peak times, the lowest annual flow (Q_{nk}) at the Čatež 1 gauging station was 47.8 m^3/s in October 2003, and the highest annual flow (Q_{vk}) was 3,267 m^3/s in November 1990.

4 DATA ON IDENTIFIED IMPACTS AND THEIR ASSESSMENT

4.1 Definition of the identified adverse impacts of the plan or the planned activity affecting nature on the conservation objectives of protected areas and their integrity and connectivity, including cumulative impacts

According to the Rules, the area of direct impact for the NEK complex is 100 m for all groups, while the area of remote impact for birds, bats, aquatic and riparian habitat types, and beetles is 1,000 m. There are no protected areas within the area of direct impact. The only Natura 2000 area within the area of remote impact is the Vrbina SAC (SI3000234). NEK's cooling systems use water from the Sava. The plant has 9 discharges through which waste water flows into the Sava. The stretch of Sava approximately 8 km downstream of the discharges from NEK has been declared a Natura 2000 area (Lower Sava SAC, SI3000304).

The extension of NEK's operational lifetime:
- does not change the position or location of NEK;
- does not change the dimensions and technical design of NEK;
- does not change the production capacity of NEK and its operation mode;
- does not foresee the construction of new buildings or facilities that would change the physical characteristics of NEK.

The only change concerns the operational lifetime of the facility, which is extended by 20 years, i.e. from 40 to 60 years.

Impacts during construction are therefore not considered, as no construction is foreseen.

At the location of the intended activity the permitted activity is already ongoing – Nuklearna elektrarna Krško, d.o.o., Vrbina 12, 8270 Krško, for which an impact assessment has already been completed three times, with respect to:
- the construction of the facility for decontamination, environmental consent no. 35405-04/99 of 26 March 1999;
- the construction of foundations by setting up a backup transformer, environmental consent no. 35405-81/00 of 1 August 2000;
- the construction of the spent fuel dry storage building, environmental consent no. 35405-81/00 of 1 December 2020.

The types of impacts and the amount of annual discharges will not change relative to the current situation. However, their duration, will be extended.

Construction work to remove facilities after the cessation of operation will be subject to other administrative procedures relating to construction and environmental protection, and as such construction work, in the parts relating to impacts resulting from the termination of this activity, is not addressed by this report. In addition, the cessation of NEK's operation will not occur for some time, and in this phase it is impossible to define the construction activity for the decommissioning and demolition of the buildings.

The construction of a LILW repository is planned in the vicinity of NEK at Vrbina, Krško. An environmental impact assessment was carried out for the intended activity and environmental consent no. 35402-29/2017-169 of 30 June 2021 acquired. Supplementary decision no. 35402-29/2017-172 of 5 July 2021 was also acquired. The LILW repository at Vrbina will not have an impact on protected areas.

Vrbina SAC (SI3000234)

During operation, NEK does not emit ionised radiation into the environment that could have an impact on the Vrbina SAC. Safety systems prevent the uncontrolled release of radioactive substances into the environment. The design of safety systems provides safety functions in all operational states, even in the event of specific equipment failure. The release of radioactive material into the environment is prevented by four successive safety barriers. The basic objective of the first three barriers is to prevent radioactive material from passing to the next barrier, whereas the fourth barrier prevents radioactive material from being released directly into NEK's surroundings. The annual dose on the NEK perimeter fence will not exceed the limit of 200 μSv as a result of the extension of operational lifetime. We therefore do not expect impacts from ionising radiation on the Vrbina SAC following the extension of the operational lifetime of NEK.

Light pollution primarily impacts insects that are active at night, which are attracted by artificial light sources and remain fixated on light instead of searching for food or a mate. That impact is of a long-term nature and remote. For the qualifying species of stag beetle (*Lucanus cervus*), the Management Programme for Natura 2000 Areas (MPN) sets the objective of maintaining the current state without permanent light bodies. The illumination of NEK will not change with the extension of its operating lifetime, meaning the current state will be maintained. There will thus be no impact on the aforementioned conservation objective. According to the cataloguing of beetles (Govedič et al., 2008), the densest populations of stag beetles in the Vrbina SAC are on the left bank of the river, around 2.5 km from the NEK complex. Due to that distance, the impact on stag beetles will be negligible. We do not expect any impact on other qualifying species due to light pollution.

A sustained impact on habitat types and qualifying species in the Vrbina SAC could occur in the event of a serious accident resulting in the discharge of radioactive substances into the environment. Numerous safety upgrades have been implemented at NEK. For this reason, the possibility of core damage is very small. NEK was designed to withstand so-called design basis accidents and to manage them using its safety systems. NEK can use the DEC-A equipment to prevent the reactor core meltdown. The DEC-B equipment, however, was intended for managing the occurrence of a very unlikely core meltdown and focuses on protecting the final barrier before release, i.e. the integrity of the containment. The passive filter system serves to relieve the pressure in the containment, while environmentally harmful substances remain trapped in the filters. Direct release into the environment is therefore unlikely.

Cumulative impacts

There are no planned activities in the vicinity that could potentially have a cumulative impact together with the lifetime extension.

The total impact on the Vrbina SAC (SI3000234) is assessed as negligible (**grade B**).

Lower Sava SAC (SI3000304)

NEK uses water from the Sava based on water permit no. 35536-31/2006-16 of 15 October 2009, which was amended under decision no. 35536-54/2011-4 of 8 November 2011 and decision no. 35530-7/2018-2 of 22 June 2018. NEK returns used water to the Sava, and therefore has no impact on the river's hydrological regime. Only emissions of substances and heat by NEK represent potential impacts on the Sava. Such impacts are of a long-term nature (over the entire operational lifetime) and remote. Discussed below are the impacts of various discharges from NEK on the Sava and consequently on the Lower Sava SAC.

During operation, NEK occasionally releases liquids from discharge tanks into the environment in a controlled manner. Liquids with low activity levels are discharged into the Sava via the essential service water channel which is located upstream from the power plant's dam. Radioactive liquids from waste measurement tanks and the steam generator blowdown system are released via that channel. Liquid radioactive waste from NEK is treated in a treatment plant that comprises reservoirs, pumps, filters, an evaporator and two deionisers. Blowdown water from the steam generators is treated separately. Tritium (H-3) is regularly present in liquid effluents from NEK. Tritium is an isotope that emits non-penetrating beta radiation, but it is only slightly radiotoxic (the limit value for tritium in potable water is 100 Bq/l). In 2020, the average monthly activity concentration of H-3 in Krško before NEK (natural background) was slightly below 0.6 kBq/m^3. The long-term average (since 2002) of monthly H-3 activity concentrations in Brežice is 4.0 kBq/m^3. The average over several months (since July 2017) of monthly H-3 activity concentrations at the sampling station in front of the Brežice HPP dam is 2.9 kBq/m^3. The concentrations of tritium activity in Jesenice na Dolenjskem are lower as a result of the additional dilution of the Sava by the Krka and the Sotla. The long-term average of monthly H-3 activity concentrations in Jesenice na Dolenjskem is 2.4 kBq/m^3, and in 2020 it was below 1 kBq/m^3 (IJS, 2021), which is well below the limit value for potable water. The total annual C-14 activity discharge into the Sava was 0.3 GBq in 2020. However, measured C-14 activities in the Sava waters and in fish were lower than current atmospheric activities. I-131 was not detected in liquid effluents from NEK in 2020. Average concentrations of I-131 in the Sava in Brežice are similar to those in the Sava in Ljubljana (3.4 Bq/m^3). The presence of I-131 in the Sava is attributed to discharges from hospitals into the rivers that flow into the Sava upstream from the NEK dam (Ljubljanica, Savinja). I-131 was not detected in fish samples in 2020 (IJS, 2021). The annual liquid discharge of Cs-137 from NEK into the Sava in 2020 was 0.9 MBq, but the contribution of NEK cannot be distinguished from the non-homogeneously distributed global contamination (IJS, 2021). In 2020, the activity of radioactive strontium (Sr-90) discharged into the Sava was 0.04 MBq, but the contribution of NEK cannot be distinguished from the non-homogeneously distributed global contamination (IJS, 2021). Other fission and activation products (Co-58, Co-60, Mn-54, Ag-110m, Cs-134, Sb-125) appear regularly in liquid effluents from NEK. The total activity of these radionuclides in 2020 was at least six orders of magnitude lower than for tritium, and in the last few years none of the said radionuclides were detected in the environment (IJS, 2021). Therefore, when the nuclear plant in Krško is in operation, the concentrations of discharged radionuclide activity – with the exception of the very low-radiotoxic H-3 – in the environment are significantly below the limits of detection (IJS, 2021). The impact from radioactive effluent on cactus roach and the Lower Sava SAC is therefore assessed as negligible.

The pretreatment of water results in waste water in the counter-flow rinsing of filters for the mechanical treatment of raw water, and in the cleaning of membranes and the reverse osmosis system. Waste water accumulates in the waste water pool (PW waste water pool) at outlet no. 11, with final outflow from discharge 7. If the system is rinsed using corrosive chemicals, water from the waste water pool is pumped into a neutralisation tank where the pH value is continuously measured and pH balanced before water is discharged into the Sava. That path is temporary and only used exceptionally, while water quantities are small. For this reason, we assess that the impact on cactus roach and the Lower Sava SAC is and will continue to be insignificant, even after the extension of NEK's operational lifetime.

Before being discharged into the Sava, waste water from NEK is treated at a small municipal treatment plant (SMTP) with a capacity of 700 PE. The SMTP has primary and secondary treatment systems. A total of 10,000 m^3 of waste water was treated at the treatment plant in 2020, while the measured values of COD and BOD at the discharge from the SMTP were well below the permitted values (NLZOH, 2021). The yearly quantity of and burden from municipal waste water from NEK will not change due to the extension of the power plant's operational lifetime, as there is no plan to connect any new users. We therefore do not expect any impact on cactus roach and the Lower Sava SAC.

NEK did not introduce biocides into any system in 2020. The quality of water from the Sava improved significantly following the closure of the VIPAP cellulose plant. For this reason, NEK is not planning to introduce biocides into the tertiary coolant circuit in the future. We therefore do not expect any impact on cactus roach and the Lower Sava SAC, even after the extension of NEK's operational lifetime.

NEK uses water from the Sava for cooling condensers and turbines, and for cooling safety components. Safety components are cooled via the component cooling system. That system represents an additional safety barrier against the potential discharge of radioactive substances and is cooled by the reserve service water system, which extracts water from the Sava. The secondary coolant circuit system (for the condenser and turbine) uses water from the Sava. However, if sufficient cooling is not possible with water from the Sava, NEK uses cooling cells (two batteries per six cells and one battery per four cells). It thus only takes a portion of required water directly from the Sava, while the remaining water is recirculated through the cooling cells where it is air cooled. Waste cooling water is not treated before it is discharged into the Sava. NEK performs regular measurements that ensure compliance with the conditions set out in the valid environmental permit (no. 35441-103/2006-24 of 30 June 2010, which was amended by decision no. 35441-103/2006-33 of 4 June 2012 and decision no. 35441-11/2013-3 of 10 October 2013). The environmental permit stipulates that NEK must ensure that the synergetic action of the discharge of industrial cooling waters and other discharged waste waters does not cause the Sava to exceed its natural temperature by more than 3 K at any time during the year. NEK must activate the cooling water recirculation system in a timely manner via the cooling towers to prevent the temperature of the Sava from exceeding its natural temperature by more than 3 K. If the combined cooling system is insufficient to fulfil this condition, the power of the power plant must be reduced accordingly. The change in the temperature of the Sava (delta T) at the point of full mixing (hypothetical point, defined approximately at the location of the old steel bridge in Brežice) is calculated with a formula that is explained in more detail in Section 4.4.4.1 of the Environmental Impact Assessment Report. In 2020, the daily averages of the emission share of transmitted heat at discharges from the large and small cooling system and the total emission share of transmitted heat never exceeded the limit value set out in the environmental permit (OVD) (NLZOH, 2021). To mitigate the impact of thermal pollution, NEK will have to continue to comply with OVD provisions. Periodic national monitoring of the ecological status of rivers is carried out downstream of discharges from NEK on the Sava–border section water body (SI1VT930), where the measuring point is located in Jesenice na Dolenjskem. The ecological status was assessed as moderate in 2009 and 2011 (the phytobenthos and macrophytes parameter of trophic condition was assessed as moderate in 2009, while the phytobenthos and macrophytes parameter of saprobic condition was assessed as moderate in 2011), while the ecological status was assessed as good in 2010 and in the period 2012–2019. The trophic condition and saprobic condition for phytobenthos and macrophytes, and for benthic invertebrates were actually assessed as very good in 2016 and 2018, which indicates that the Sava is not organically polluted at that point (ARSO, Results of monitoring). Monitoring of the Sava (Cotman, 2020), which is carried out at three points (at the off-take point for cooling water at NEK, upstream from NEK on the right bank of the Sava and in Brežice at the road bridge), indicates that organic pollution was down in 2019 relative to the long-term trend. The highest measured value of COD in 2019 was in November at the sampling location upstream from NEK on the right bank of the Sava, at 10.63 mg/l. The highest measured value of BOD_5 in 2019 was in March, likewise at the sampling location upstream from NEK on the right bank of the Sava, at 1.60 mg/l. According to the Decree on surface water status (Official Gazette of RS, Nos. 14/09, 98/10, 96/13 and 24/16), the limit value of BOD_5 for the very good ecological status of rivers is 1.6 to 2.4 mg/l. According to the Decree on the quality required of surface waters supporting fresh-water fish life (Official Gazette of RS, Nos. 46/02 and 41/04 – ZVO-1), the recommended value for salmonid waters is less than 3 mg/l, while the value for cyprinid waters is less than 6 mg/l. Heat discharges from NEK thus do not cause any deterioration in the living conditions of cactus roach, which is a cyprinid species, in the Lower Sava SAC. Therefore, we do not expect a significant impact due to NEK's operational lifetime extension as long as OVD provisions are complied with..

A sustained impact on the environment and Lower Sava SAC could occur in the event of a serious accident resulting in the discharge of radioactive substances into the environment. Numerous safety upgrades have been implemented at NEK. For this reason, the possibility of core damage is very small. NEK was designed to withstand so-called design basis accidents and to manage them using its safety systems. NEK can use the DEC-A equipment to prevent the reactor core meltdown. The DEC-B equipment, however, was intended for managing the occurrence of a very unlikely core meltdown and focuses on protecting the final barrier before release, i.e. the integrity of the containment. The passive filter system serves to relieve the pressure in the containment, while environmentally harmful substances remain trapped in the filters. In the event of the accidents discussed (DBA and DEC-B) there will be no liquid effluent released into the Sava. All cooling water will be contained inside the containment vessel and auxiliary building, which is designed for systems and components that contain radioactive material (contaminated radioactive water).

Cumulative impacts

A chain of hydroelectric power plants (Vrhovo, Boštanj, Arto-Blanca, Krško and Brežice) has been built on the lower course of the Sava. The completion of that chain is planned with HPP Mokrice in the Lower Sava SAC.

A study by IJS (2006) put forth the opinion that eutrophication could occur due to the increased concentration of phosphates in the Sava from the construction of HPP Brežice on account of the slowed flow rate of the river and higher temperatures in the surface layer of the water in HPP Brežice reservoir. Eutrophication could diminish the quality of the Sava. NEK has no effluents that could increase the nutrient content of the Sava and does not represent a source of eutrophication. According to calculations in the study by IBE (2019), the confinement time in the planned HPP Mokrice reservoir will be the shortest of all reservoirs on the lower course of the Sava, while the flow rates will be highest, meaning a reduced possibility of eutrophication in the Lower Sava SAC.

The potential cumulative impact on the temperature of the Sava as a result of NEK's heat discharges and Sava's slower flow in HPP reservoirs has been examined in the study Thermal loads on the Sava (interactions of energy buildings along and on the Sava from the perspective of the heat load on the Sava – Revision A. IBE 2012). The study found that the increase in the Sava's temperature most likely results from a natural rise in the temperature of river water and not from the construction of HPPs. This analysis was completed in 2012, before HPP Krško was built, so another thermal analysis of the Sava was conducted for the extended HPP chain, which also included the above-average warm summer of 2019 (Energy buildings along and on the Sava. Analysis of river temperatures in the lower reaches of the Sava in July and August 2019 and the verification of past studies – Revision A. IBE, April 2020). Measurements in this latest study showed that there was a drop in the temperature of the Sava between NEK and the discharge from HPP Brežice of 0.54°C in July 2019. The HPP Brežice reservoir thus has a cooling effect on water that flows into the Lower Sava SAC. According to the latest study by IBE (April 2020), increases in the mean monthly temperatures of the Sava in the Čatež area were lower during the last 18 years than in the previous period. It has thus been concluded that the chain of HPPs does not increase the mean temperatures of the river. The study also anticipates that the mean monthly temperature in the flow-through reservoir of the planned HPP Mokrice during the summer will only rise by around 0.1 to 0.2°C relative of the current situation, which is minimal. Given that no significant deterioration in ecological status parameters in the HPP Brežice reservoir was identified (website of HESS, 2019) and that it is evident from the national monitoring of the ecological status of the Sava in Jesenice na Dolenjskem (see description above regarding the impact of heat discharges from NEK) that there was also no deterioration in the downstream ecological status of the Sava following the construction of the chain of HPPs, it is concluded that there will also be no significant deterioration in the ecological status in the case of the HPP Mokrice reservoir. We therefore do not expect any significant cumulative impact on the Lower Sava SAC.

If mitigation measures are implemented, the total impact on the Lower Sava SAC (SI3000304) is assessed as negligible (**grade C**).

Termination of activity

When the activity is terminated, NEK will still ensure control over nuclear materials, and the impact of ionising radiation will be negligible. The fuel will no longer be in the reactor, but stored safely in the spent fuel pool and/or in the dry storage for spent fuel. Cooling of the reactor will thus no longer be required and heat emissions into the Sava will greatly decrease. However, the spent fuel pool will still have to be cooled by means of the essential service water system. The impact of the discharge from this system is localised, and in view of its low emission share of transmitted heat, negligible. Operation of cooling towers will no longer be needed. The impact on protected areas will be negligible (**grade B**).

Table 28: Impact assessment matrix for the Vrbina SAC (SI3000234)

Impact category	**Impact significance**		**Impact on the integrity of the area**	**Impact on the connectivity of areas**	**Impact on the conservation objectives of the area***	
Proportion or impact category of permanent (after project completion) loss of species habitat or habitat type due to direct impact	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	all species and all HT	A	A	A	Table 17 in Section 3.1.	A
Proportion or impact category of temporary (during project implementation) loss of species habitat or habitat type due to direct impact during project implementation	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	all species and all HT	A	A	A	Table 17 in Section 3.1.	A
Impact category of change in specific structures or uses (intensification or abandonment) or natural processes necessary for the long-term conservation of species or habitat type	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	all species and all HT	A	A	A	Table 17 in Section 3.1.	A
Impact category of change in key indicator chemicals (including as a result of pollution), changes in radiation, illumination, noise, dust	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	all species and all HT except stag beetle (*Lucanus cervus*)	B	A	A	Table 17 in Section 3.1.	A
	European stag beetle (*Lucanus cervus*)	B	A	A	The current state without permanent sources of light is maintained.	B
Impact category of change in water regime, natural dynamics of the watercourse (including flooding)	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	all species and all HT	A	A	A	Table 17 in Section 3.1.	A
Impact category of reduction in reproductive success and survival due to habitat fragmentation in the landscape	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	all species and all HT	A	A	A	Table 17 in Section 3.1.	A
Impact category of reduction in reproductive success and survival or change in mortality rate due to artificial barriers in species habitat	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	all species and all HT	A	A	A	Table 17 in Section 3.1.	A

Impact category	**Impact significance**		**Impact on the integrity of the area**	**Impact on the connectivity of areas**	**Impact on the conservation objectives of the area***	
Impact category of reduction in patch area of species habitat or habitat type	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	all species and all HT	A	A	A	Table 17 in Section 3.1.	A
(*for species only*) Impact category or percentage of permanent decline in species population size	Species	Grade	Grade	Grade	Conservation objective	Grade
	all species and all HT	A	A	A	Table 17 in Section 3.1.	A
(*for species only*) Impact category or percentage of temporary decline in population size	Species	Grade	Grade	Grade	Conservation objective	Grade
	all species and all HT	A	A	A	Table 17 in Section 3.1.	A

**The matrix contains a reference to Table 15 in Section 3.1, which lists the conservation objectives for each species.*

Table 29: Impact assessment matrix for the Lower Sava SAC (SI30000304)

Impact category	**Impact significance**		**Impact on the integrity of the area**	**Impact on the connectivity of areas**	**Impact on the conservation objectives of the area***	
Proportion or impact category of permanent (after project completion) loss of species habitat or habitat type due to direct impact	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	Cactus roach	A	A	A	Table 17 in Section 3.1.	A
Proportion or impact category of temporary (during project implementation) loss of species habitat or habitat type due to direct impact during project implementation	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	Cactus roach	A	A	A	Table 17 in Section 3.1.	A
Impact category of change in specific structures or uses (intensification or abandonment) or natural processes necessary for the long-term conservation of species or habitat type	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	Cactus roach	A	A	A	Table 17 in Section 3.1.	A
Impact category of change in key indicator chemicals (including as a result of pollution), changes in radiation, illumination, noise, dust	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	Cactus roach	C	B	A	Table 17 in Section 3.1.	A
Impact category	Species/HT	Grade	Grade	Grade	Conservation objective	Grade

Impact category	**Impact significance**		**Impact on the integrity of the area**	**Impact on the connectivity of areas**	**Impact on the conservation objectives of the area***	
of change in water regime, natural dynamics of the watercourse (including flooding)	Cactus roach	A	A	A	Table 17 in Section 3.1.	A
Impact category of reduction in reproductive success and survival due to habitat fragmentation in the landscape	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	Cactus roach	A	A	A	Table 17 in Section 3.1.	A
Impact category of reduction in reproductive success and survival or change in mortality rate due to artificial barriers in species habitat	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	Cactus roach	A	A	A	Table 17 in Section 3.1.	A
Impact category of reduction in patch area of species habitat or habitat type	Species/HT	Grade	Grade	Grade	Conservation objective	Grade
	Cactus roach	A	A	A	Table 17 in Section 3.1.	A
(*for species only*) Impact category or percentage of permanent decline in species population size	Species	Grade	Grade	Grade	Conservation objective	Grade
	Cactus roach	B	B	A	Table 17 in Section 3.1.	B
(*for species only*) Impact category or percentage of temporary decline in population size	Species	Grade	Grade	Grade	Conservation objective	Grade
	Cactus roach	A	A	A	Table 17 in Section 3.1.	A

**The matrix contains a reference to Table 17 in Section 3.1, which lists the conservation objectives for each species.*

4.2 Findings based on the verification of alternative solutions, indication of verified solutions and reasons for choosing the proposed solution

BASES

Energy, system, environment protection and economic studies have shown that the extension of NEK's operational lifetime constitutes the most favourable alternative to all other technologies that are suitable for the production of electricity in the base-load mode and will have matured for commercial use by 2023.

Its advantages are particularly significant in terms of:

- assuming the role of a support point for the 400 kV network in normal operating conditions and in the event of disruptions;
- the positive impact on Slovenia's management of international obligations regarding CO_2 emissions, as it produces minimal CO_2 emissions, whereas other technologies that use fossil fuels would put Slovenia far off from fulfilling the requirements of the Paris Agreement, the European Green Deal, the Resolution on Slovenia's Long-Term Climate Strategy until 2050 etc.;
- land use, as it does not require any new spatial developments; and
- economics, as its operating costs are considerably lower than any of the alternative technologies, or the purchasing of energy on the market.

The non-extension of the operational lifetime of NEK would threaten Slovenia's energy independence. The deficit in energy would have to be produced using other sources or by purchasing electricity from other countries. The consequences would be economical, political and ecological.

The consequences of the zero variant are described in detail in the study Energy, Systemic, Economic and Ecological Aspects of the Operational Lifetime Extension of the Krško NPP, EIMV, Ljubljana, July 2021.

ENVIRONMENTAL CONSEQUENCES OF THE ZERO VARIANT

Climate
NEK produces a net 696 MW of electricity. In the event of NEK's shutdown, energy would have to be replaced with other sources. The IPCC study from 2006 estimated that throughout its life cycle (construction, operation, decommissioning, uranium ore mining and processing), a nuclear power plant releases 0.012 kg of CO_2 into the atmosphere per each kWh of electricity generated.

On average during its lifetime, the estimate shows that 8.3 kg of CO_2 is generated every hour in the operation of a power plant of the same power output as NEK (direct and indirect emission).

According to extremely conservative assumptions, a coal-fired thermal power plant produces 0.82 kg of CO_2 per each kWh of electricity generated. This means that a 696 MW thermal power plant generates no less than 570,720 kg of CO_2 every hour, releasing it into the atmosphere.

Gas power plants of the same output power produce about half as much CO_2 emissions or 341,040 kg of CO_2 per hour of operation.

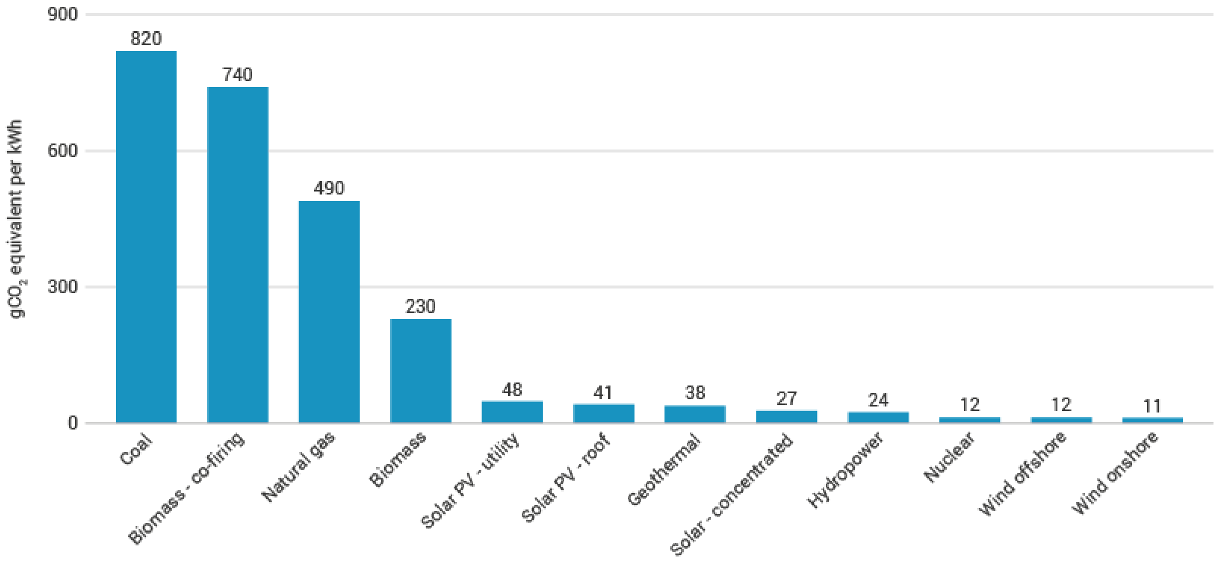

Figure 14: Average emissions of carbon dioxide equivalents in a life cycle of different electricity producers (source: IPCC)

The greatest environmental impact would be caused by the release of greenhouse gases, as there are no other sources whose capacity, reliability and economy could cover the electricity deficit.

Land use

On the assumption that Slovenia wants to replace the existing production capacities, the graph in the figure below shows that nuclear energy has the smallest possible footprint on land use compared to other production sources. With new energy facilities, not only use of land for the facilities themselves, but also the required construction of new transmission line infrastructure for connection of the facilities to the grid must be taken into account.

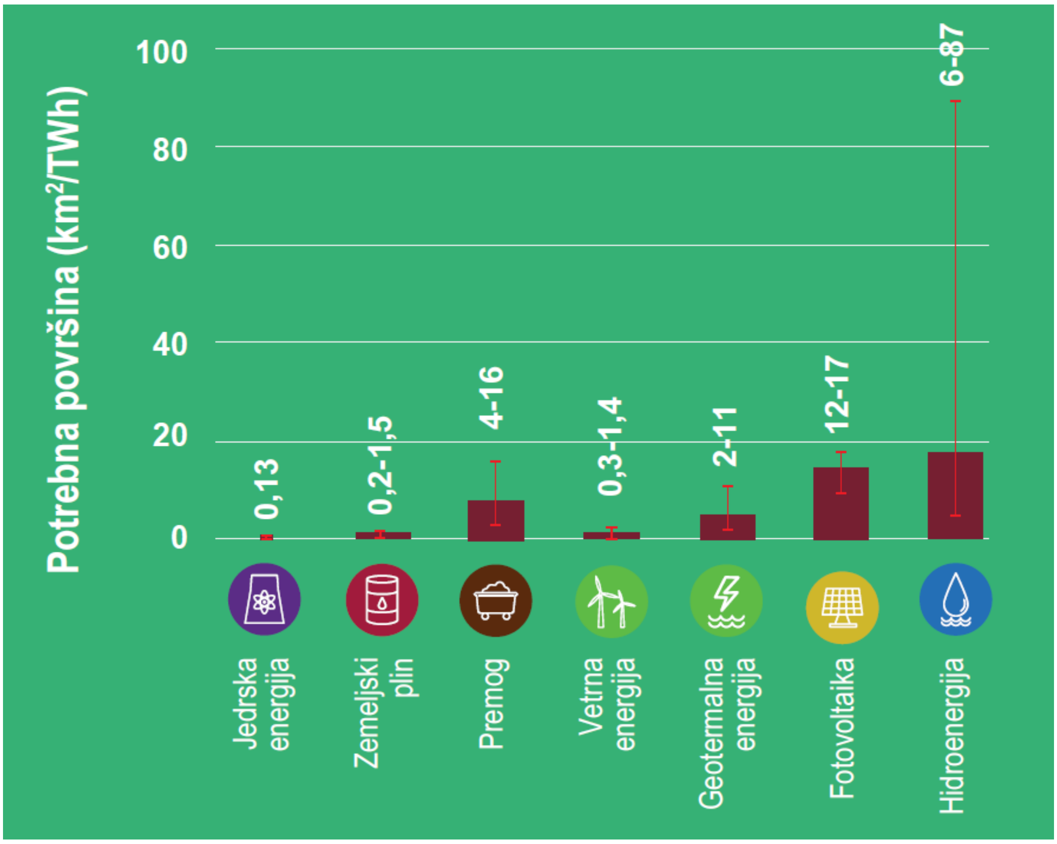

Figure 15: Land use with regard to production source of electricity (source: Trainor, 2016)

Potrebna površina (km²/TWh)	Required surface area (km²/TWh)
Jedrska energija	Nuclear energy
Zemeljski plin	Natural gas
Premog	Coal
Vetrna energija	Wind power
Geotermalna energija	Geothermal energy
Fotovoltaika	Solar photovoltaic
Hidroenergija	Hydropower

It should be further noted that power plants of the same power installed do not necessarily produce the same annual output, e.g. solar power plants do not operate at night and operate at a lower capacity in cloudy weather, the output of wind power plants changes over time, as wind power plants do not operate without wind or at extremely high wind speeds, and even hydroelectric power plants rarely produce electricity at rated power.

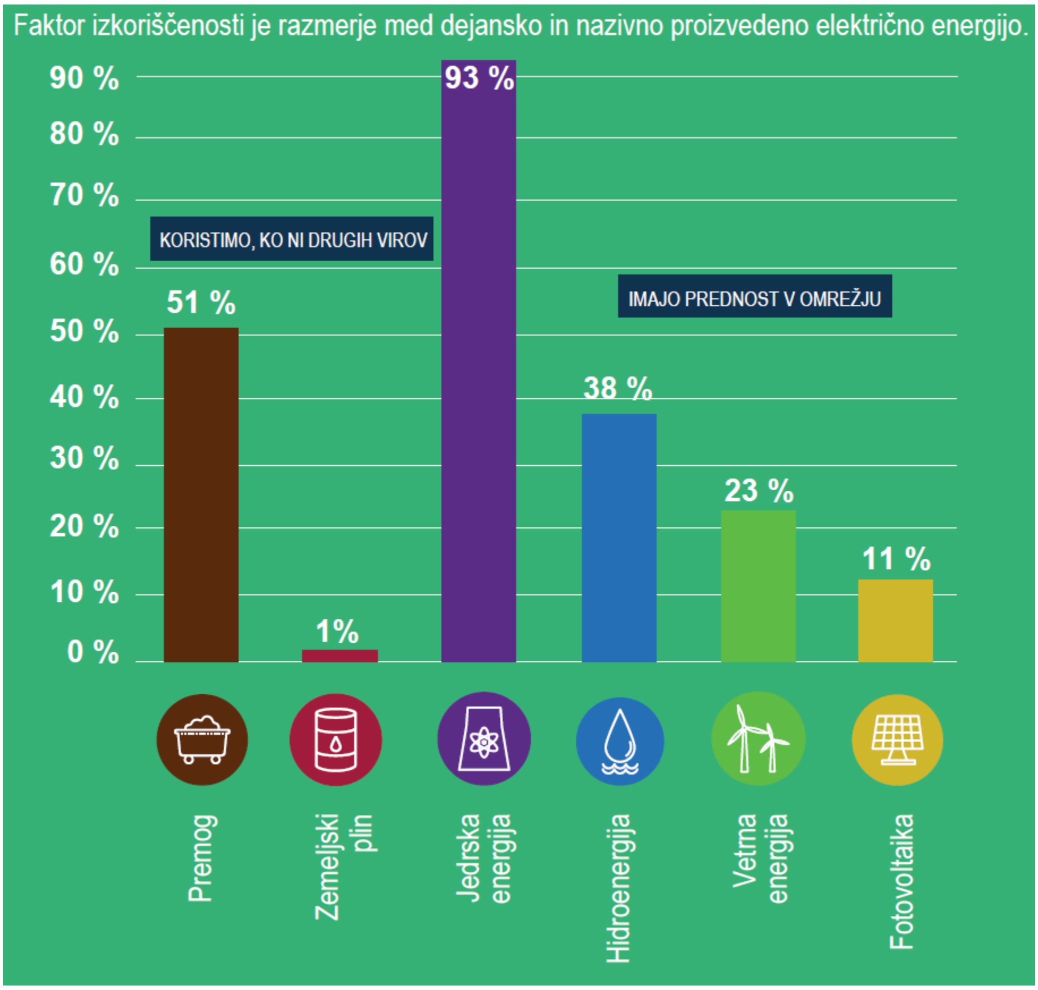

Figure 16: Projected average annual electricity production (output) with regard to installed power (source: Trainor, 2016)

Faktor izkoriščenosti je razmerje med dejansko in nazivno proizvedeno električno energijo.	The utilisation factor is the ratio between actual and nominal production of electricity.
KORISTIMO, KO NI DRUGIH VIROV	USED WHEN THERE ARE NO OTHER SOURCES
IMAJO PREDNOST V OMREŽJU	PRIORITY IN THE GRID
Premog	Coal
Zemeljski plin	Natural gas
Jedrska energija	Nuclear energy
Hidroenergija	Hydropower
Vetrna energija	Wind power
Fotovoltaika	Solar photovoltaic

On average, NEK in total produces 5,900 GWh of electricity in the years with no outages. On average, the annual production (output) of the Brežice hydroelectric power plant (HPP) is 161 GWh, meaning that 36 comparable hydroelectric power plants or 18 for the Slovenian half of the annual output would be required to replace NEK's annual production of electricity. If we take account of the annual output of Slovenia's largest hydroelectric power plant, the Zlatoličje HPP (577 GWh per year), five of these hydroelectric power plants would be required to replace the Slovenian half of NEK's annual output. The Zlatoličje HPP reservoir is 6.5 km in length and covers ca. 1.14 km^2 or 114 ha in area.

The wind turbine with rated power of 2.3 MW in Dolenja vas has an annual energy output of 4.5 GWh, meaning that we would require 655 wind turbines of that size to replace Slovenia's portion of NEK's annual output. The spacing of ca. seven rotor diameters between wind turbines is recognised globally, which given the size of this wind turbine (rotor diameter of 71 m) would correspond to the spacing of ca. 500 m between turbines and the use of ca. 25 ha of land per turbine. A total of 655 wind turbines could be installed in total in an area of 163.75 km^2.

The annual output of a large solar plant within the Lauingen Energy Park complex in Bavaria with a rated power of 25.7 MW, which extends across 63 ha, is ca. 27 GWh. Comparable solar plants to replace the Slovenian portion of NEK's output would cover ca. 6,883 ha or 68.83 km^2 in area.

Other impacts

One of the objectives of Slovenia's Integrated National Energy and Climate Plan (NECP, 2020) in terms of energy safety is to continue to exploit nuclear energy and maintain excellence in the operation of nuclear facilities in Slovenia. In terms of decarbonisation (zero-carbon society), one of the crucial targets is to reach at least 27% of renewable energy sources in final energy consumption by 2030, of which 43% is produced by the electricity sector. It can therefore be concluded that in the event of the non-extension of NEK's operational lifetime, we can expect the missing output to be replaced with imports, at least in the initial stage, and with renewable energy sources in the medium term.

In addition to positive impacts, all energy sources also have adverse effects on the environment. The type and intensity of impacts differ depending on the technology used, geographic location and on a number of other factors. While much is known to the professional and general public regarding the effects of non-renewable sources on the environment, certain renewable sources of energy are often treated as completely unproblematic in terms of their environmental impacts. The impact of environmental burdens arising from renewable energy sources is largely or completely overlooked (solar energy: production and decommissioning of solar panels and energy storage units – batteries, wind energy: low-frequency noise and birds, hydro power plants: invasion of natural habitats and excessive growth of algae).

A brief overview of the potential negative environmental effects of renewable sources is given below.

Table 30: Summary of potential adverse effects of renewable sources of energy

Renewable energy sources	Potential adverse effects
Production of biomass: centralised systems	adverse effects characteristic of vast plantations: degradation of land, use of water, impairment of water quality, adverse effects on the ecosystem, etc.
	decreasing the land area earmarked for the production of food, rise in food prices
Production of biomass: dispersed systems	impoverishment of forests, disruptions to the natural environment due to human activity
Burning (combustion) of biomass	air pollution, release of CO_2 (for now, wood is the most effective form of long-term storage of CO_2)
Solar energy: centralised systems	degradation of vast areas – covered by solar panels
	resulting in the loss of habitats in these areas
	indirect pollution during the production of solar panels and energy storage units

Renewable energy sources	Potential adverse effects
	generation of hazardous pollutants during decommissioning
Solar energy: dispersed systems	in urban areas the heating of installed panels can contribute to the heat island phenomenon
	interference with treetops around buildings with the installed solar panels – removal of trees that cast shade on the panels
	possibility of fire
Wind power: centralised systems	noise from turbines (low-frequency, infra)
	visual degradation and casting shade (locally)
	interference with the flight path of birds
	adverse impact on the ecosystem due to lower wind speeds behind the turbines
	TV signal disruptions
	pollution due to oil spills in case of accidents
	additional occupation of space/area with access routes and transmission lines
Hydropower: centralised systems	loss/destruction of habitats (forests, meadows)
	impairment of water quality
	greenhouse gas emissions due to the decay of accumulated vegetation
	obstacle in the river course, altered hydrodynamics
	change in living conditions for aquatic organisms, suspending contact between populations
	possibility of barriers collapsing or embankments giving way
	change to the local micro climate
Hydropower: small HPP and micro HPP	similar effects as with larger systems
Ocean thermal energy conversion (OTEC)	impact on marine ecosystems: change in water temperature
	change in the chemical composition of the water
	eutrophication and algal bloom
	application of biocides
Geothermal energy	land in use/nuisance
	subsidence/sinking of ground, micro earthquakes
	noise
	thermal pollution
	air pollution (hydrogen sulphide, methane, ammonia, radon)
	water contamination
Waste incineration	air pollution (especially dioxins, furans and toxic metals), production of hazardous and non-hazardous waste

ECONOMIC CONSEQUENCES OF THE ZERO VARIANT

Both owners of NEK have already invested in the modification and replacement of equipment as a safety upgrade. Besides discouraging investments, both owners (the Republic of Slovenia and the Republic of Croatia) would have to provide the missing funds for NEK's decommissioning and radioactive waste disposal in the coming 10-year period.

If NEK operates for another 20 years, these financial resources will be collected as levies in both funds earmarked for NEK's decommissioning.

The additional economic sensitivity analysis, which compared two scenarios – the shutdown of NEK in 2023 and the extension of NEK's operational lifetime – has demonstrated that the eligibility criterion for continued operation has been met (Minutes, 2015).

Even if NEK's production of electricity is replaced by other energy sources, these sources cannot be replaced directly after NEK's lifetime expires due to the protracted siting procedures and also due to an additional period required for the construction of the replacement facilities. This means that initially, directly after 2023, the Republic of Slovenia and the Republic of Croatia would have to completely compensate for the missing portion of energy (on average 5,900 GWh in total in the years with no outages) by leasing electricity from other countries.

SITING (SPATIAL POSITIONING)

The planned activity for the extension of the operational lifetime of NEK does not change the position or location of the facilities or transmission line connections, meaning that there is no solution in terms of siting that would be more appropriate.

4.3 Explanation of the possibility of mitigating adverse effects, indicating the appropriate mitigation measures and reasons for choosing a specific mitigation measure

NEK operates in accordance with the relevant environmental permit (no. 35441-103/2006-24 of 30 June 2010, which was amended by decision no. 35441-103/2006-33 of 4 June 2012 and decision no. 35441-11/2013-3 of 10 October 2013). As the mode of operation of NEK will not change with the extension of its operational lifetime, all measures and compliance monitoring are already being implemented. NEK also carries out all necessary safety inspections and measures to prevent a serious accident. While additional mitigation measures are therefore not necessary, NEK must continue to implement all measures to prevent excessive burdens due to the discharge of waste waters into the Sava, thus ensuring that waste water parameters remain below the limit values set out in the environmental permit.

4.4 Specification of the timeframe for the implementation of mitigation measures, persons/bodies responsible for their implementation, and method of monitoring the effectiveness of implemented mitigation measures

NEK operates in accordance with the relevant environmental permit (no. 35441-103/2006-24 of 30 June 2010, which was amended by decision no. 35441-103/2006-33 of 4 June 2012 and decision no. 35441-11/2013-3 of 10 October 2013). As the mode of operation of NEK will not change with the extension of its operational lifetime, all measures and compliance monitoring are already being implemented. NEK also carries out all necessary safety inspections and measures to prevent a serious accident. While additional mitigation measures are therefore not necessary, NEK must continue to implement all measures to prevent excessive burdens due to the discharge of waste waters into the Sava, thus ensuring that waste water parameters remain below the limit values set out in the environmental permit. The effectiveness of implemented measures (compliance with the parameters specified in the environmental permit) should be monitored to the same extent as before. The implementation of measures and their monitoring must be ensured until the decommissioning of NEK.

4.5 Indication of planned or considered nature conservation initiatives that may affect the area in the future

There are no planned or considered nature conservation initiatives that could affect the area in the future.

5 DATA SOURCES AND METHOD OF DATA ACQUISITION, AND METHODS USED TO PREDICT AND ASSESS IMPACTS

5.1 References and sources

- ARSO, Results of monitoring of the ecological status of watercourses in 2009, 2017. https://www.arso.gov.si/vode/reke/ocena%20stanja/Ekolosko_stanje_reke_2009.pdf
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5.2 Legislation

- Nature Conservation Act (Official Gazette of RS, Nos 56/99, 110/02, 119/02, 22/03, 41/04, 96/04, 61/06, 63/07, 117/07, 32/08, 8/10, 46/14 – ZON-C, 21/18 – ZNOrg, 31/18 and 82/20).
- Decree on the categories of valuable natural features (Official Gazette of RS, Nos 52/02 and 67/03);
- Rules on the designation and protection of natural values (Official Gazette of RS, Nos 111/04, 70/06, 58/09, 93/10, 23/15 and 7/19).
- Decree on Special Protection Areas (Natura 2000 areas) (Official Gazette of RS, Nos 49/04, 110/04, 59/07, 43/08, 8/12, 33/13, 35/13, 39/13, 3/14, 21/16, 47/18).
- Decree on Ecologically Important Areas (Official Gazette of RS, Nos 48/04, 33/13, 99/13, 47/18).
- Rules on the assessment of the acceptability of effects caused by the execution of plans and activities affecting nature in protected areas (Official Gazette of RS, Nos 130/04, 53/06, 38/10, 3/11).
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.
- Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds.
- Ionising Radiation Protection and Nuclear Safety Act; Official Gazette of RS, Nos 76/17 and 26/19 (abbreviated: ZVISJV-1)
- Rules on radiation and nuclear safety factors (Official Gazette of RS, Nos. 74/16 and 76/17 – ZVISJV-1); JV5 Rules.

5.3 Methods used

Data used in the report were obtained from publicly available literature and graphical data of the Institute of the Republic of Slovenia for Nature Conservation (ZRSVN).

The impact of the activity on the conservation objectives of protected areas and their integrity and connectivity were assessed in accordance with the Rules on the assessment of the acceptability of effects caused by the execution of plans and activities affecting nature in protected areas (Official Gazette of RS, Nos 130/04, 53/06, 38/10, 3/11):
A – No impact or positive impact
B – Negligible impact
C – Negligible impact due to implementation of mitigation measures
D – Significant impact
E – Devastating impact

Impact categories **A, B, C** “IMPACTS OF THE ACTIVITY ARE NOT ADVERSE”.
Impact categories **D, E** “IMPACTS OF THE ACTIVITY ARE SIGNIFICANT AND ADVERSE”.

The impacts of the activity on the qualifying/key species were assessed according to the Rules on the assessment of the acceptability of effects caused by the execution of plans and activities affecting nature in protected areas. The impact assessment and evaluation are based on acquired professional experience and expertise.

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