ORLEN SYNTHOS GREEN ENERGY

SMALL MODULAR NUCLEAR POWER PLANT

PROJECT INFORMATION SHEET

INVESTOR

BWRX-300 Włocławek sp. z o.o.

with its registered office in Warsaw,

Al. Jana Pawła II 22

00-133 Warsaw

CONTRACTOR

Team of authors: ORLEN Synthos Green Energy Sp. z o.o.

WARSAW, JULY 2023

Investor	**BWRX-300 Włocławek sp. z o.o.**	
Contractor	**Team of authors: ORLEN Synthos Green Energy sp. z o.o.**	
Team manager	Name	Signature
	Robert Truszkowski	Robert Truszkowski

TABLE OF CONTENTS

ABBREVIATIONS AND DEFINITIONS

I&C	Instrumentation and controls
OH&S	Occupational Health and Safety
NSRP	Nuclear Safety and Radiation Protection
Power Unit	Modular nuclear reactor in the BWRX-300 technology, control room building, turbine hall (turbine, generator)
BWR	Boiling Water Reactor
BWRX-300	The 10th generation of the BWR with a power output of 300 MW offered by GEH, the technology selected by the Investor
CLC2018	Corine Land Cover – European spatial database of land cover/land use in Europe
CNSC	Canadian Nuclear Safety Commission
CWS	Circulating Water System
DEC	Decision on environmental conditions for the project
Birds Directive	Directive of the European Parliament and of the Council 2009/147/EC of 30 November 2009 on the conservation of wild birds (OJ L 20/7, 26.1.2009)
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 206/7, 22.7.1992)
NPP	Nuclear Power Plant
EOC	Emergency Operation Center
GDOŚ	General Director for Environmental Protection
GE	General Electrics
GEH	GE-Hitachi Nuclear Energy Americas LLC
GIG	Central Mining Institute
GWe	Gigawatt of electric power
GWh	Gigawatt hour
GZWP	Major groundwater reservoir
IAEA	International Atomic Energy Agency
ICS	Isolation Condenser System
Investor	BWRX-300 Włocławek sp. z o.o., 100% of whose shares are owned by Orlen Synthos Green Energy Sp. z o.o.
Investment Project, Project	The Investment Project involving the construction and operation of a nuclear power plant with a power output of up to 2000 MWe, which is the subject of the procedure for issuing a decision on environmental conditions
ISOK	IT System of National Protection
SWB	Surface water body
PIS	Project Information Sheet

KOBiZE	National Center for Emission Management
KPPzOPiWPJ	National Plan for Handling Radioactive Waste and Spent Nuclear Fuel
NPS	National Power System
LCOE	Levelized cost of electricity
LCOH	Levelized cost of heat
LOCA	Loss of Coolant Accident
Site	An area of geodetic plots, in the area of which the foundation of nuclear power plant power units is planned, including auxiliary buildings and all necessary technical infrastructure.
IAEA	International Atomic Energy Agency
MCR	Main Control Room
MIT	Massachusetts Institute of Technology
LDP	Local Development Plan
MWe	Megawatt of electric power
MWh	Megawatt hour
Site Area	An area within 5 km of the boundaries of the planned Site of the nuclear facility
ONR	UK's Office for Nuclear Regulation
OSGE	ORLEN Synthos Green Energy sp. z o.o.
RES	Renewable energy sources
PCV	Primary Containment Vessel
PCW	Plant Cooling Water
EMF	Electromagnetic radiation
PEP2040	Polish Energy Policy 2040
PIG-PIB	Polish Geological Institute – National Research Institute
Prescreening	Works and analysis to make a preliminary determination of the suitability of the Site for the construction of a nuclear power plant
PNPP	Polish Nuclear Power Program
PSE	Polskie Sieci Elektroenergetyczne S.A. (Polish Power Grid Company)
PWR	Pressurized Water Reactor
EMP	Environmental Management Plan
EIA Report	Environmental impact report
Site Region	An area within 30 km of the boundaries of the planned Site of the nuclear facility
EIA Ordinance	Ordinance of the Council of Ministers of September 10, 2019 on projects that may have a significant impact on the environment (Journal of Laws of 2019, item 1839, as amended)
RPV	Reactor Pressure Vessel
SDF	Standard Data Form

SUiKZP	Study of Conditions and Directions of Spatial Development
SMR	Small Modular Reactor
SRD	Strategy for Responsible Development until 2020 (with the perspective until 2030)
U.S. NRC	United States Nuclear Regulatory Commission
EU	European Union
ERO	Energy Regulatory Office
EIA Act	Act of October 3, 2008 on providing access to information on the environment and its protection, public participation in environmental protection, and on environmental impact assessments (Journal of Laws of 2023, item 1094, as amended)
Atomic Law	Act of November 29, 2000 – Nuclear Law (Journal of Laws of 2023, item 1173)
Construction Law	Act of July 7, 1994 – Construction Law (Journal of Laws of 2023, item 682, as amended)
Cooling water	Water for making-up the power plant's cooling circuit
ZUOP	Zakład Unieszkodliwiania Odpadów Promieniotwórczych – public utility company

1 INTRODUCTION

This study is the Project Information Sheet (PIS) for the construction and operation of a nuclear power plant (NPP) with a power output of up to 2,000 MWe (Project, Investment Project) at the Włocławek site in the Municipality of Włocławek and is part of the formal and legal documentation prepared by the Investor in order to obtain the Decision on environmental conditions (DEC) for the planned Investment Project.

The Project will include the construction and operation of up to six Small Modular Reactors (SMR) in the BWRX-300 technology with a total power output not exceeding 2,000 MWe, including all necessary auxiliary facilities and associated technical infrastructure. The planned Project will be implemented in the Kuyavian-Pomeranian Voivodeship, Włocławek District, Municipality of Włocławek, City of Włocławek, cadastral districts: Leopoldowo, Kawka, Azoty, Rózinowo, Korabniki.

The location of the planned Investment Project is described in Chapter 4.2 Location of the Project.

The Applicant is BWRX-300 Włocławek Sp. z o.o. (Investor), 100% of whose shares are owned by ORLEN Synthos Green Energy sp. z o.o. (OSGE) with its registered office in Warsaw.

The Project Information Sheet was prepared by the OSGE team.

2 OBJECTIVE AND SCOPE OF THE PROJECT INFORMATION SHEET

In accordance with Article 71 section 2 point 1 of the Act of October 3, 2008 on providing access to information on the environment and its protection, public participation in environmental protection, and on environmental impact assessments (Journal of Laws of 2023, item 1094, as amended, EIA Act), an environmental impact assessment is required for projects that may always have a significant impact on the environment (the so-called group I projects), the catalog of which is listed in the Ordinance of the Council of Ministers of September 10, 2019 on projects that may have a significant impact on the environment (Journal of Laws of 2019, item 1839, as amended, EIA Ordinance).

With reference to § 2 section 1 point 4 of the aforementioned EIA Ordinance, projects that may always have a significant impact on the environment include: nuclear power plants and other nuclear reactors, including their decommissioning, excluding research plants for the generation or processing of fissile or fuel materials with a nominal power output of no more than 1 kW at continuous thermal load.

Taking into account the above, the Investment Project in question involving the construction and operation of a nuclear power plant including all necessary auxiliary facilities and associated technical infrastructure is on the list of projects that may always have a significant impact on the environment, for which preparation of an environmental impact report (EIA Report) is required.

In fulfillment of the obligation set forth in Article 74 section 1 point 1 of the EIA Act in conjunction with Article 69 section 1 of the same Act, the applicant, when submitting an application for a decision on the environmental conditions for the project, may submit, instead of the EIA report, a project information sheet together with an application for determining the scope of the EIA Report.

The scope of this study is in accordance with the requirements of Article 62 a section 1 of the EIA Act, according to which the PIS should contain only basic information about the planned project to determine the scope of the EIA Report (Table 2).

The required point of the scope of the study compliant with Article 62a section 1 of the EIA Act, concerning	Place in documentation
type, characteristics, scale and location of the project	Chapter 4
the area of occupied real estate, as well as the civil structure and their previous manner of use and vegetation cover of the real estate	Chapter 4 Chapter 8
technology type	Chapter 6
possible options of the project	Chapter 7
expected amounts of water, raw materials, materials, fuels and energy to be consumed	Chapter 9
solutions to protect the environment	Chapter 10
types and estimated amount of substances or energy released into the environment by using the solutions aimed to protect the environment	Chapter 11
possible cross-border environmental impact	Chapter 12
areas subject to protection under the Act of April 16, 2004 on nature protection and ecological corridors, located within the range of significant impact of the project	Chapter 13
ongoing and completed projects located in the area where the project is planned to be implemented and in the area of impact of the project, or whose impacts fall within the area of impact of the planned project – to the extent that their impacts may lead to cumulative impacts with the planned project	Chapter 14
risk of a serious accident or natural and construction disaster	Chapter 15
expected amounts and types of waste generated and their impact on the environment	Chapter 16
demolition works concerning projects likely to have a significant impact on the environment	Chapter 17

Table 2. Contents of the PIS in accordance with Article 62a of the EIA Act

THE RATIONALE FOR THE CONSTRUCTION OF A NUCLEAR POWER PLANT BASED ON SMALL NUCLEAR REACTORS 3

In connection with the Investor's plans to implement an Investment Project involving the construction and operation of a nuclear power plant, which will include up to six modular nuclear reactors in the BWRX-300 technology, the current situation of the National Power System (NPS) and its development plans were briefly analyzed.

THE ENERGY MIX OF POLAND 3.1

Electricity supplied to final customers is generated at power plants and combined heat and power plants. In Poland, these are mainly thermal power plants and combined heat and power plants (fired by lignite, hard coal or natural gas) and power plants classified as renewable energy sources (RES), which include wind, photovoltaic, hydropower and biogas plants.

According to data published by the Energy Regulatory Office (ERO), the volume of gross domestic electricity production in 2022 was at a higher level compared to the previous year, amounting to 175,157 GWh (a 0.9% increase compared to 2021). In the discussed period, gross domestic electricity consumption amounted to 173,479 GWh, decreasing by (-)0.53% compared to 2021.

The ERO also indicates that in 2022, the installed capacity of the NPS was 60,446 MWe, an increase of 12.7% compared to 2021. The average annual power demand in 2022 was at 23,389 MW, with a maximum demand of 27,296 MW, a drop of 1.20% and 1.16%, respectively, in relation to the data from the previous year.

The structure of electricity production in Poland has changed slightly compared to 2021, continuing to be dominated by fossil fuels, i.e., hard coal and lignite, whose share in electricity production in 2022 amounted in total to approx. 77%. There has been a decrease in production at hard coal-fired power plants (a drop of approx. 6%) and an increase in production at lignite-fired power plants (an increase of approx. 3%). A noticeable change is the significant increase in the share of production using renewable energy sources. Electricity production from wind sources increased from 8% to 10% and the production from other renewable sources increased from 3% to 5%. Production at gas-fired power plants and combined heat and power plants amounted to 5.44 % of total electricity production (Figure 1).

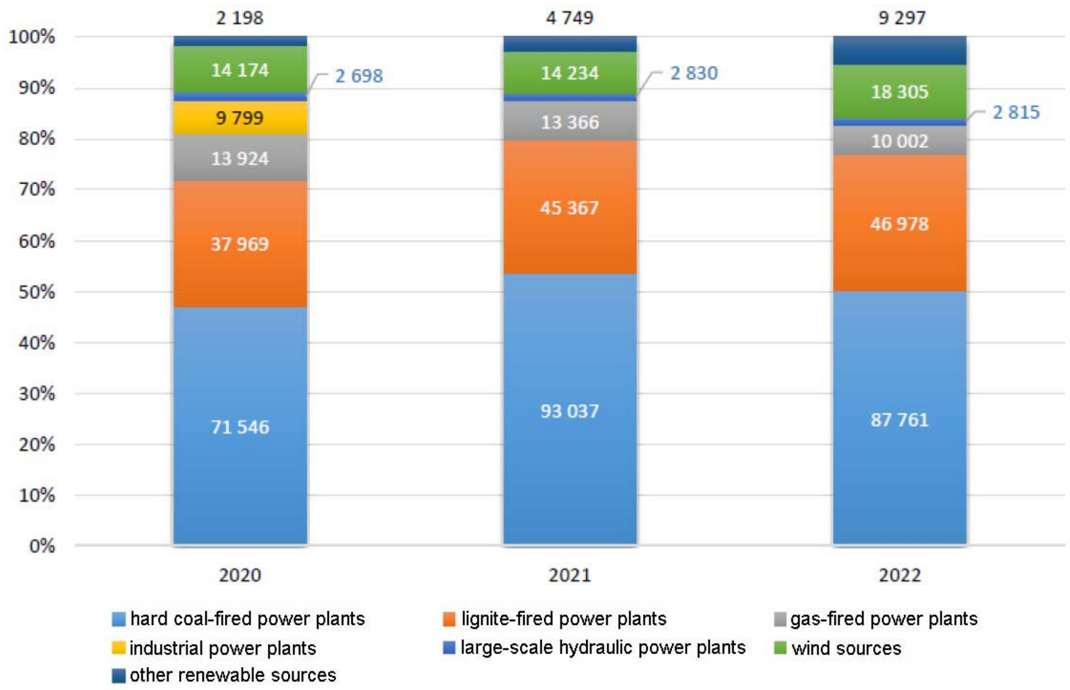

Figure 1. Comparison of the structure of electricity production in 2020–2022 [GWh], (Source: ERO Report 2022)

EMISSIVITY OF THE POWER SYSTEM 3.2

Due to the large share of conventional power plants and combined heat and power plants in electricity production, Poland's electricity supply system is characterized by high carbon dioxide emissions per MWh of electricity produced. According to a report by the National Center for Emission Management (KOBIZE) titled "CO_2, SO_2, NO_x, CO and total dust emission factors for electricity based on information contained in the national database on emissions of greenhouse gases and other substances for 2021", the average CO_2 emission for each MWh of electricity considering all sources, including renewable ones, in 2021 was 761 kg. The KOBiZE report also indicates the average emissions of other pollutants produced during the electricity generation process at fuel combustion plants (Table 3).

Pollutant	Emission factor [kg/MWh]
Carbon dioxide (CO_2)	761
Sulfur oxides (SO_x/SO_2)	0.543
Nitrogen oxides (NO_x/NO_2)	0.543
Carbon monoxide (CO)	0.255
Total dust	0.023

Table 3. Emission factors expressed in [kg/MWh] for electricity produced in fuel combustion plants in 2021 (source KOBIZE report: CO_2, SO_2, NO_x, CO and total dust emission factors for electricity based on information contained in the national database on emissions of greenhouse gases and other substances for 2021).

Table 4 compares CO_2 emissions by plant type. Emission values according to the "Carbon Neutrality in the United Nations Economic Commission for Europe Region: Integrated Life-cycle Assessment of Electricity Sources" were adopted for the calculations. One nuclear power unit in the BWRX-300 technology with a net power output of 285 MWh and a capacity utilization factor of 93% was used as a reference for the calculations. Annual electricity production in this case will be approx. 2.3 TWh, which will translate into emissions for the full cycle of approx. 13,000 tons of CO_2/year. Compared to the production of the same amount of electricity generated by a hard coal-fired power plant, emissions will be 2.1 million tons of CO_2/year, a lignite-fired power plant – more than 2.5 million tons of CO_2/year, and for gas-fired power plants more than 1 million tons of CO_2/year. For renewable sources, emissions will range from 27,000 to 40,000 tons of CO_2 for wind farms (onshore and offshore, respectively) and from 100,000 to 170,000 tons of CO_2/year for photovoltaics and hydropower plant. Operation of the BWRX-300 reactor will allow for preventing the emission from approx. 15,000 to approx. 2.5 million tons of CO_2 annually, which will translate into improved air quality both locally and regionally.

Plant type		CO_2 emissions [full life cycle] [kg CO_2/MWh]			Emission [Mg CO_2/year]	Avoided emissions [Mg CO_2/year]
		min.	medium	max		
Nuclear Power Plant	BWRX-300	5.1	**6**	6.4	13,350.57	-----
Coal-fired power plant	hard coal	751	**923**	1095	2,143,056.47	2,129,705.91
	lignite	966	**1094**	1221	2,538,929.85	2,525,579.28
Gas-fired power plant	CCPP system (CCGT)	403	**458**	513	1,063,401.80	1,050,051.24
Hydropower plant		6	**77**	147	177,620.61	164,270.04
Wind farms	onshore	7.8	**12**	16	27,629.87	14,279.30
	offshore	12	**18**	23	40,632.17	27,281.60
Photovoltaics		8	**46**	83	105,643.63	92,293.06

Table 4. CO_2 emissions by source (Source: own study)

CLIMATE GOALS 3.3

In December 2020, the European Council set a goal for the EU to reduce greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, with further efforts to achieve climate neutrality by 2050. Under European climate law, these goals are binding on the EU and its member states. To achieve these goals, EU member states must take specific measures to reduce emissions and decarbonize the economy.

To fulfill these commitments, the Polish power system must undergo a rapid and profound energy transition, with the overriding goal of completely replacing conventional sources (fossil fuel-fired thermal power plants and combined heat and power plants) with zero-carbon sources. In view of the above, it is essential that Poland's energy transition be based on a foundation of sustainable development. Key sustainability criteria for NPS sources include:

- guarantee of security of electricity supply
- guarantee of moderate electricity prices, conducive to the economic development of the country
- guarantee of counteracting climate change
- ensuring environmental protection.

Taking into account the overarching goal of achieving climate neutrality in the next 30 years and the above criteria, it is necessary to introduce a safe, low-carbon and economically efficient power system[1].

NATIONAL ENERGY POLICY 3.4

With the EU's climate and energy policy in mind, including the long-term vision of moving toward climate neutrality by 2050, the Government of the Republic of Poland has developed a number of documents that define the country's development directions in the long term. They include the strategic goals to be achieved to become climate neutral. It should be noted that the national energy policy provides for the development of both nuclear and other clean energy sources. The Investor's desire to develop and implement distributed generation sources in the form of modular nuclear power plants, which are sustainable, stable, and, at the same time, clean sources of electric power, is consistent with both the direction of development of Poland (as defined in official government documents) and the trends observed in other EU countries and North America.

Strategy for responsible development 3.4.1

A national document indicating the need to build stable and zero-carbon generation sources is, among others, the Strategy for Responsible Development (SRD) until 2020

1 https://www.gov.pl/web/polski-atom/atom-ratuje-klimat-czyli-transformacja-energetyczna-z-udzialem-energetyki-jadrowej-i-odnawialnych-zrodel-energii

(with the perspective until 2030). The document states that ensuring energy security requires diversification of sources, raw materials and means of energy generation and distribution, and priorities include: guaranteeing stability and continuity of supplies and diversification of energy sources. According to the SRD, the challenges that condition the directions of development of Poland's energy policy point to the need to modernize and expand the low-carbon district heating sector to increase security of supplies and increase access for new customers. Indeed, a developed and modern zero-carbon district heating network is one of the ways to reduce the phenomenon of so-called low emissions[2] in urban areas. It is therefore recommended to use cogeneration in heat generation due to its emission neutrality especially at the level of local boiler houses[3].

Polish Energy Policy until 2040 3.4.2

The main strategic government document titled "Polish Energy Policy 2040" (PEP2040), developed by the Ministry of Climate and Environment and published in 2021, states that meeting primary energy demand is one of the main elements of the country's energy security. Therefore, measures are required to expand the generation infrastructure and ensure the efficiency of electricity transmission and distribution. PEP2040 indicates that with the involvement of domestic industry, an energy transition will be carried out that will affect the development of the economy and reduce emissions, while ensuring energy security. The energy transition should be based on three pillars:

1. Just transition – means transforming coal regions by providing new development opportunities in the areas most negatively affected by the transition, while providing new jobs and building new industries that participate in the transformation of the energy sector.
2. Zero carbon – means decarbonizing the energy sector through the implementation of nuclear power, among other things. This pillar addresses the long-term direction of the energy transition.
3. Good air quality – means improving air quality through investments in transforming the district heating sector or electrifying transportation, among other things.

PEP2040 also pays particular attention to the need to develop the district heating and cogeneration sector. The development of system-based district heating is treated by PEP2040 as a strategic direction of development – in addition to the ecological aspect, it is also an opportunity to stimulate local economic potential. The development of cogeneration, i.e., simultaneous generation of electricity and heat based primarily on low-carbon sources, will play a key role in achieving the strategic goals for heat

2 Low-stack emissions, which are emissions of dust and gases up to a height of 40 meters, mainly from inefficient combustion of coal from home heating stoves, or local coal-fired boiler houses.

3 Based on the Strategy for Responsible Development (SRD) until 2020 (with the perspective until 2030)

engineering development[4].

Works are currently underway to update PEP2040 to neutralize or mitigate risks associated with potential emergencies, such as the war in Ukraine. The revision of the document aims to ensure energy sovereignty by making the domestic economy independent of imported fossil fuels. In terms of nuclear power implementation, the PEP2040 update mentions, in addition to works related to the construction of Poland's first nuclear power plant, small modular reactors as an alternative to conventional units in power and heat generation. SMRs are indicated as part of the diversification of the electricity generation structure, which is a strengthening of energy security at the local level.

Polish Nuclear Power Program 3.4.3

In addition to the above-mentioned documents, it should also be pointed out that on October 2, 2020, the Council of Ministers adopted a Resolution on updating the multi-annual program entitled "Polish Nuclear Power Program" (PNPP). The document states that the main arguments in favor of implementing nuclear power in Poland are:

1. Energy security – the implementation of nuclear power will mean strengthening energy security, mainly by diversifying the fuel base and directions of supply of energy carriers and replacing the aging fleet of high-emission coal-fired units.
2. Climate and environment – nuclear power means a dramatic reduction in atmospheric greenhouse gas emissions from the power sector and low environmental external costs. The examples of large, industrialized and highly developed countries and regions such as France, Sweden and the Canadian province of Ontario prove that nuclear power contributes to the effective, rapid and profound decarbonization of the power sector. In all of these cases, emissions have been drastically reduced to well below 100 kg CO_2/MWh, relying mainly on nuclear power (France) or a combination of nuclear and large hydropower (Sweden, the Canadian province of Ontario).
3. Economy – in the economic context, nuclear power plants can stem the increase in energy costs for customers, or even lower them, counting the full bill for the final customer. This is due to the fact that they are the cheapest energy sources when taking into account the full calculus of costs (investor, system, network, environmental, health, other external) and the factor of long operation time after the depreciable life. This applies to both individual and business customers, and especially safeguards the development of energy-intensive enterprises (e.g., metallurgical, chemical industries). Nuclear power, due to its long operation period reaching up to 80 years, is also an important investment through which

4 Based on the "Polish Energy Policy 2040" (PEP2040) developed by the Ministry of Climate and Environment of February 2, 2021.

intergenerational solidarity is realized[5].

3.5 RATIONALE FOR THE CONSTRUCTION OF THE SMR

The SMR implementation project fits perfectly into the framework and assumptions of the cited strategic documents on:

1. Just transition – the implementation of the proposed technology will mainly take place in industrial areas replacing conventional generating units with modern zero-carbon and innovative generating units providing stable, well-paid jobs that will give a boost to the development of entire regions. The transition will also favorably influence the emergence of new, innovative industries providing services to the nuclear industry.
2. Zero-carbon energy system – the proposed technology represents a zero-carbon energy source, the implementation of which in place of high-carbon conventional units will benefit both local air quality, which will directly translate into the quality of public health, and global CO_2 emissions responsible for climate change. The use of SMRs to generate heat and electricity (cogeneration) will also help reduce low emissions from combusting coal in domestic stoves, which have negative health effects on the area's population.
3. Economy – the implementation of the BWRX-300 technology guarantees the delivery of stable and predictable energy over the long term at an acceptable price. The price of nuclear fuel, which is the main operating cost of a nuclear power plant, due to the directions of its origin (Canada, Australia, France, USA) is stable and does not fluctuate wildly due to speculative activities as is the case with natural gas or coal prices. In addition, due to zero-emission, the final price of the electricity and heat generated will not be charged for CO_2 emissions.
4. National energy security – aging conventional generating units (commercial power plants powered by hard coal and lignite) and the ever-increasing demand for electricity create the risk of electricity supply interruptions. Such a case occurs when the ability to import electricity proves insufficient to cover the domestic deficit, and thus the country's energy security may be threatened. Taking into account the above and the contents of the strategic government documents cited above, it should be concluded that the development of nuclear energy plays a key role in ensuring stable and zero-carbon generation sources. It also makes it possible to fulfill the key tasks facing the commercial power industry today, i.e. ensuring the country's energy security (stable supply of large volumes of electricity or heat) and meeting short-, medium- and long-term commitments to climate protection and

5 Based on the Polish Nuclear Power Program (PNPP) (Resolution No. 141 of the Council of Ministers of October 2, 2020 on updating the multi-annual program entitled “Polish Nuclear Power Program”)

climate neutrality by 2050 (zero-carbon energy source). A very important point requiring special attention is the current geopolitical situation in the region. The armed attack by the Russian Federation on Ukraine and the resulting economic sanctions have translated into the mood of global markets, i.e. the rise in prices of energy raw materials. This applies primarily to prices of coal, oil and natural gas (including liquefied natural gas). The impact of high prices of raw materials translates into a drastic increase in energy prices on the Polish Power Exchange, which in turn adversely affects the domestic economy and industry. Both energy-intensive enterprises and small craftsmen are currently facing unprecedented increases in electricity prices. Certainly, ensuring a stable supply of electricity at a price that is predictable over the long term will have a positive effect manifested in economic recovery.

Basing the decarbonization of Poland's electricity system solely on the potential of RES generation sources is not possible due to the instability of electricity generation in such sources. RES are inherently unstable and uncontrollable, which means they need balancing. Currently, balancing is done through conventional power plants, mainly coal-fired, and in the future gas-fired, but their operation is uneconomical in the long term. Further fuel combustion, moreover, poses a real risk of failing to meet the deadlines declared for achieving climate neutrality. The ideal solution to support RES is to generate electricity using the modular nuclear power plant technology, which is a stable, fully controllable and flexible generation source that can operate either in the base of the system (continuous operation at maximum power output) or as a balancing unit.

DESCRIPTION OF THE PROJECT 4

SCALE AND FEATURES OF THE PROJECT 4.1

The Project involves the construction and operation of a nuclear power plant, which will include:

- up to six Power Units (each power unit contains, among others, a BWRX-300 modular nuclear reactor, control room building, turbine hall (turbine, generator)) with a total power output not exceeding 2,000 MWe;
- auxiliary buildings (including, among others, spent fuel storage facility, interim radioactive waste storage facility, office buildings, workshop);
- necessary technical infrastructure (including, among others, water intake, pumping station, cooling water pipelines, cooling systems' infrastructure (mechanical/natural draft cooling towers), electrical switchyard, direct line to the industrial plants of Anwil from the ORLEN Group, power output to the NPS).

The purpose of the Investment Project is to generate electricity or electricity and heat (cogeneration) using nuclear energy. The electricity generated will be able to supply the industrial plants of Anwil from the ORLEN Group located near the planned power plant through a direct line, as well as the National Power System (NPS) using a power connection. The heat, in turn, can be used in the production processes of nearby factories or will feed the local district heating network (the implementation of a connection for district heating needs is not included in the scope of this application for a decision on environmental conditions, it will be implemented on the basis of separate administrative decisions).

Currently, the Investor does not yet have the conditions for connection to the power system issued. Connection conditions will be determined in cooperation with the Transmission Network Operator – Polskie Sieci Elektroenergetyczne S.A. (PSE) at a later stage of the Investment Project. Taking into account the topography of the power system and the fact that the "Włocławek Azoty" 220/110 kV substation is located in the Site vicinity, it has been assumed that the connection point will be located at this substation. Eventually, however, the connection point and technical parameters will be determined at the stage of the feasibility study of connection lines to the NPS.

The final installed power output of the power plant, and therefore its final parameters, will be determined at a later stage of the Investment Project. It is envisaged that the planned Investment Project will directly supply electricity to the industrial plants of Anwil from the ORLEN Group located in close vicinity, as well as supply electricity to the NPS. This will improve environmental quality by reducing atmospheric emissions of CO_2, NO_X, SO_X, CO, and dust. The planned location of the direct line connection point to the Anwil plant will be at the “Anwil” 110 kV substation located approximately 1.5 km from the power plant Site.

Implementation of the project also includes the construction and operation of a spent fuel storage facility and an interim radioactive waste storage facility. Currently, the Investor has not decided what type of storage facility (dry, wet) will be built at the Site.

Staging of the Project 4.1.1

It is anticipated that the Project may be implemented in stages. All the Power Units will be built using the same BWRX-300 reactor technology, and the total installed capacity of the Project will not exceed 2,000 MWe, while the number of reactors, whether and how many stages the Investment Project will be divided into, and how long the interval between the implementation of successive stages will be, have not been definitively determined at present. However, it should be emphasized that within the framework of the procedure in question, the Project with parameters encompassing all possible stages together is covered by the application for an environmental decision.

The effects of staging of the Project will be the subject of an environmental impact assessment and will be described in the EIA Report. In turn, the individual stages will be defined and characterized in detail at the stage of preparing the building permit design, taking into account the parameters set for the whole Project.

PROJECT LOCATION. 4.2

The planned site of the Investment Project is in the Kuyavian-Pomeranian Voivodeship, Włocławek District, City of Włocławek, cadastral districts: Kawka, Leopoldowo, Rózinowo, Azoty, Korabniki.

Figure 2. Project Site (Source: Own study based on using OpenStreetMap data and the State Register of Borders (PRG))

The planned Site is located at the western border of the City of Włocławek, at a distance of:

- approx. 22 km northwest of the Site, there is the center of the Town of Ciechocinek
- approx. 23 km northeast of the Site, there is the center of the Town of Lipno
- approx. 9 km southeast of the Site, there is the center of the City of Włocławek
- approx. 11 km south of the Site, there is the center of the town of Brześć Kujawski
- approx. 29 km west of the Site, there is the town of Radziejów (Fig. 3).

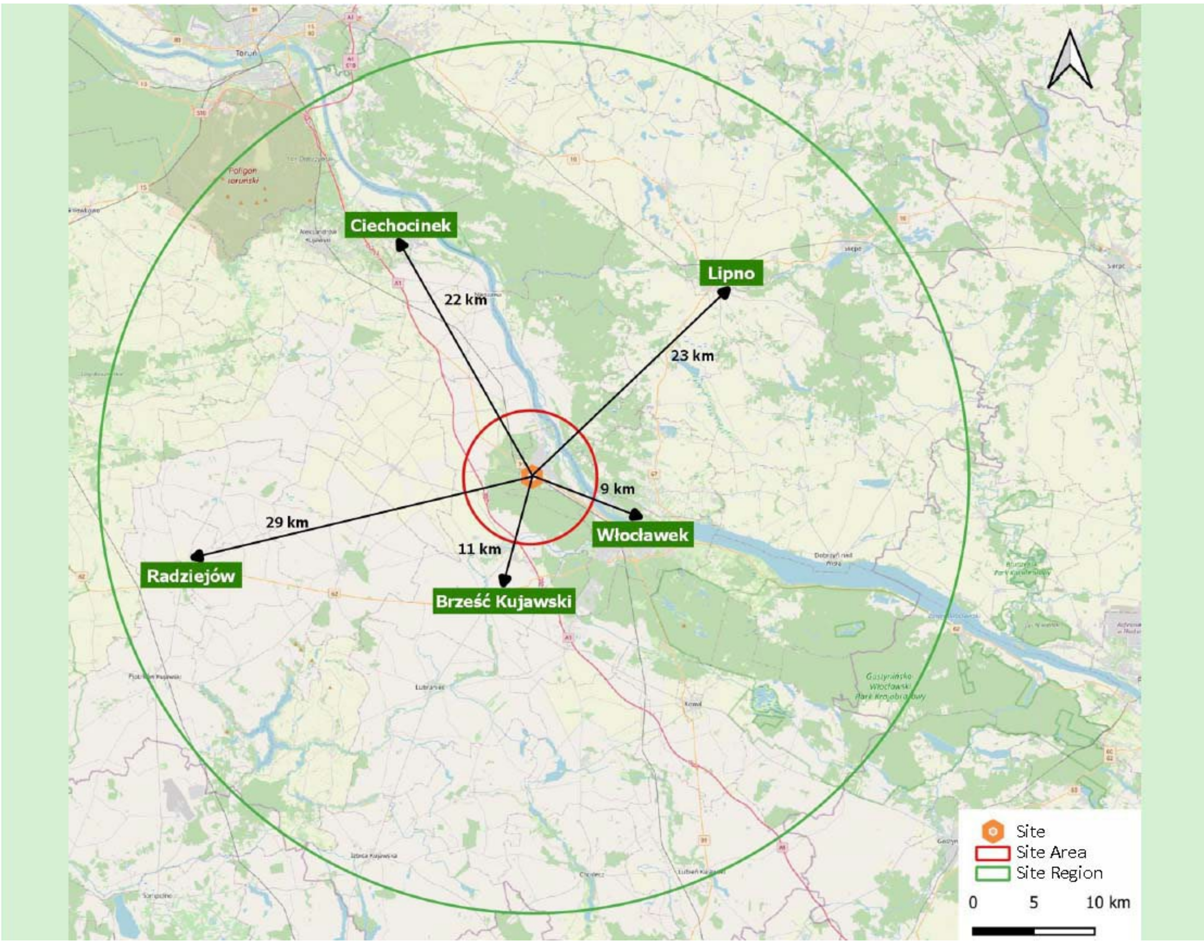

Figure 3. Distance of the Site to the nearest urban centers (Source: Report on preliminary analysis and site evaluation for nuclear facility (Włocławek, Włocławek District), Central Mining Institute, Katowice 2023)

The area of the planned Investment Project is the westernmost part of the city of Włocławek constituting an industrial complex, which includes, among others, Anwil industrial plants, CCGT Włocławek, and a logistics company. The planned Site is bordered by:

- from the north-east – the "Włocławek Azoty" 220/110 kV substation, national road No. 91, Anwil industrial zone
- from the east – uncontrolled greenery areas, a residential estate, Brzezie railway station and a construction company at a distance of approx 0.3 km
- from the west – a single farm and forest areas
- from the south – forest areas (Fig. 4).

A railway line runs through the Site area. It is not expected that implementation of the Investment Project will require relocation of the line or modification of its route. The main part of the project, i.e., the power units, will be constructed on the western side of the tracks, and the area on which they will be built, will be fenced. High-voltage and extra high voltage lines or cables, as well as water pipelines, will cross the railway line.

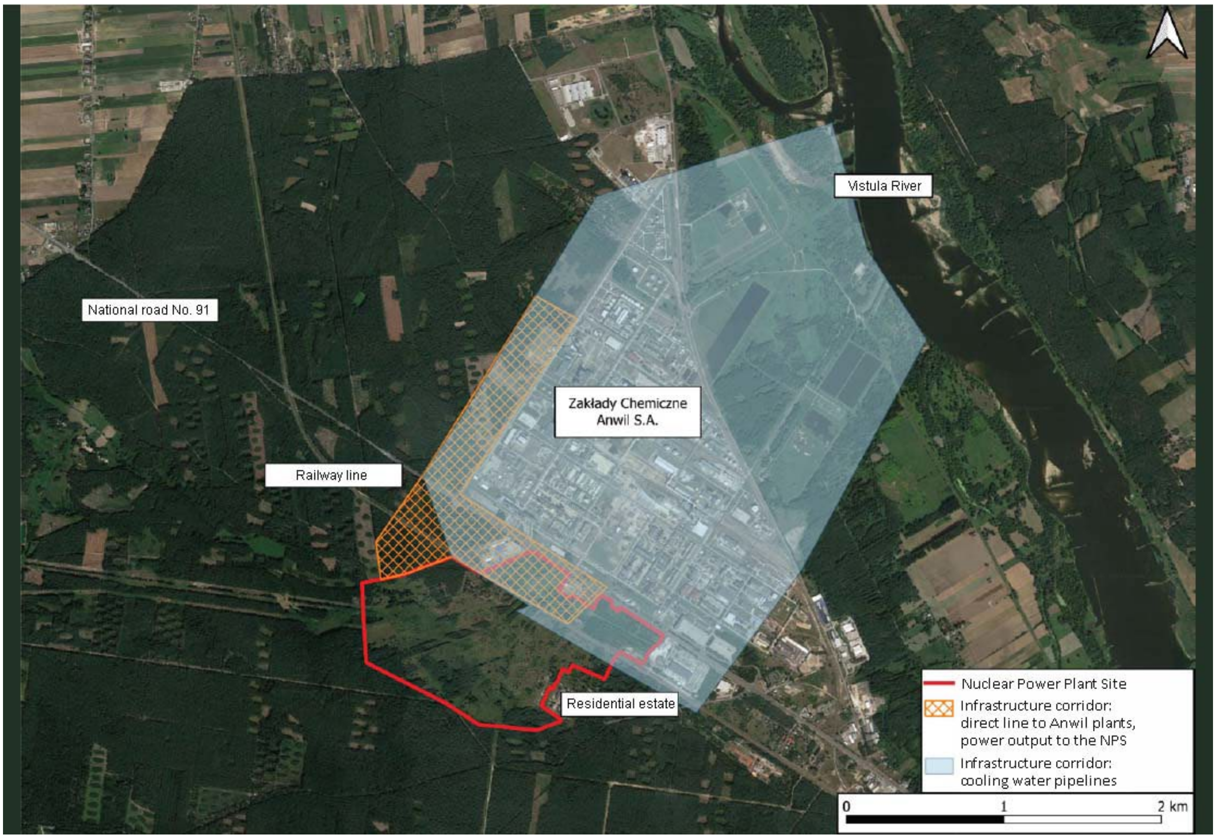

Figure 4. Areas adjacent to the planned Site (Source: own study using Google maps data)

Due to the diversity of spatial location, the Project can be divided into:

- the power part, i.e., the power unit including auxiliary buildings and all necessary technical infrastructure (excluding water intake, cooling water pipelines, direct power line to industrial plants of Anwil from the ORLEN Group, power output to the NPS) located on the premises of the Site
- water intake, pumping station, and cooling water pipelines
- direct line to industrial plant of Anwil from the ORLEN Group and power output to the NPS.

Project Site (power part) 4.2.1

The part of the Project comprising the Power Units including the electrical switchyard, auxiliary buildings (with the spent nuclear fuel storage facility and the radioactive waste storage facility) and all necessary technical infrastructure will be located within the borders of the city of Włocławek, Włocławek district, Kuyavian-Pomeranian Voivodeship, and covers the site with a total area of approx. 135 ha (Fig. 5), of which the area allocated for the development of the power plant (fenced area) will be approx. 110 ha.

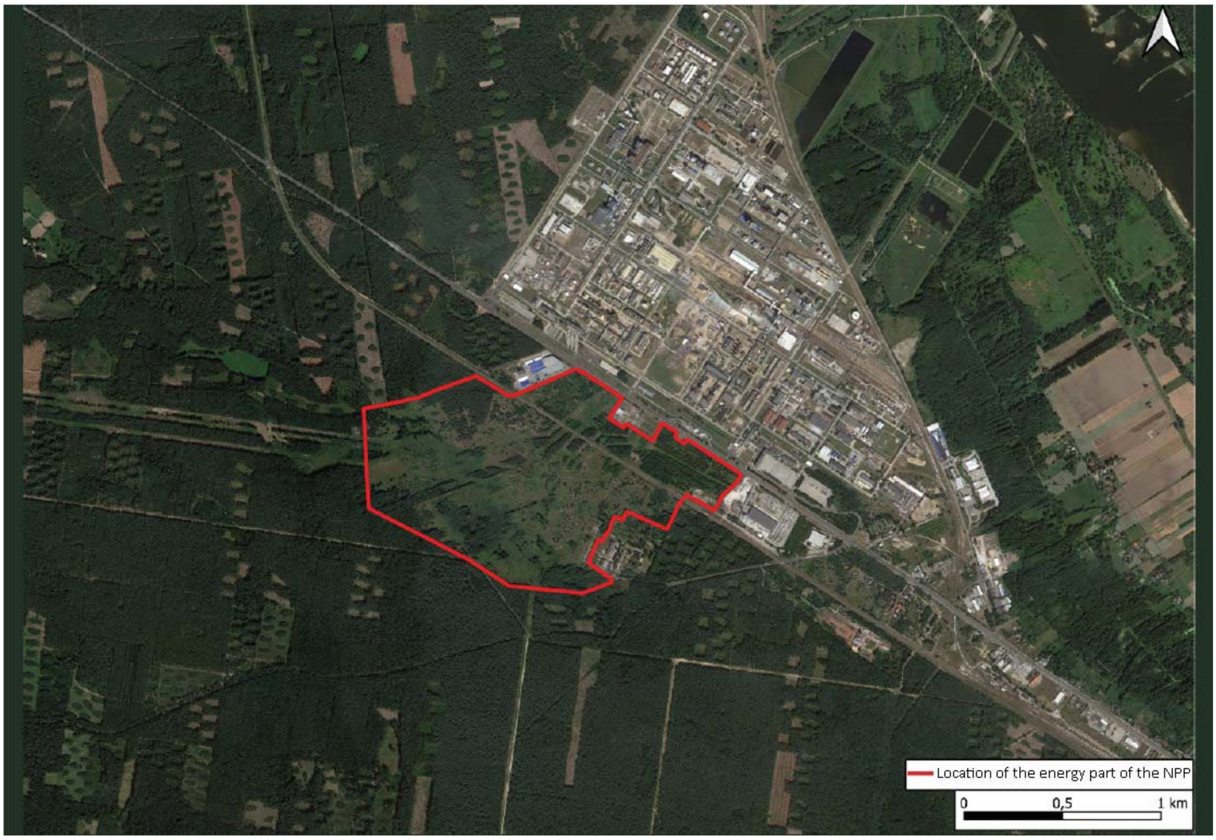

Figure 5. Location of the power part of the Project (Source: own study using Google maps data)

Project Site (water intake, pumping station, and water pipelines) 4.2.2

The location of the cooling water infrastructure corridor is shown in Fig. 6. The water intake, pumping station, and pipelines will be located in the municipality of the City of Włocławek, Włocławek District, Kuyavian-Pomeranian Voivodeship.

The Investor also allows the possibility of constructing a wastewater discharge line within the cooling water infrastructure corridor.

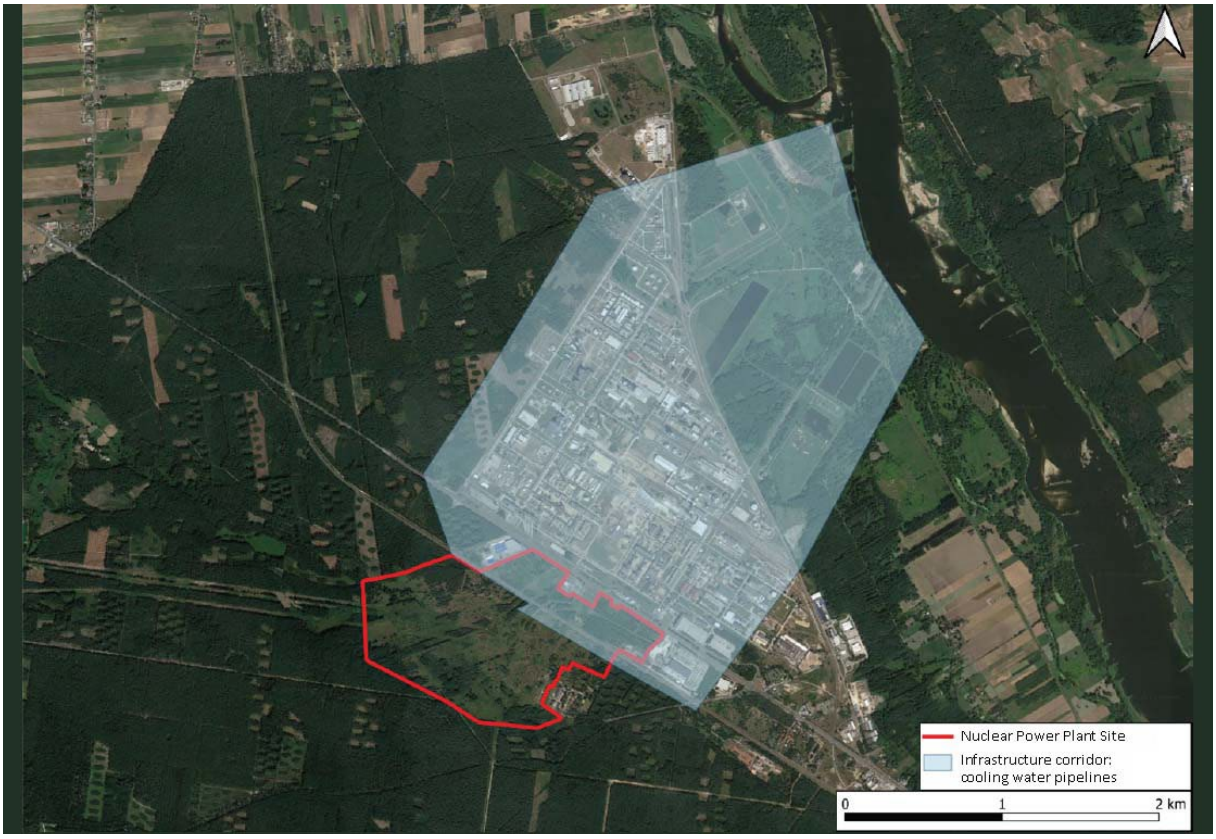

Figure 6. Infrastructure corridor – cooling water pipeline (Source: own study using Google maps data)

Regardless of the selected cooling system for the power plant (once-through or closed-circuit), the preferred source of cooling circuit water is the Vistula River located about 3 km northeast of the planned power plant. Cooling water will be pumped from the Vistula River to the power plant by means of pumps and pipelines after the construction of a surface water intake. Depending on the type of cooling selected, the final power output of the power plant, and the amount of water, the number of necessary pipelines and their diameter will be determined. The pipelines will be located in a designated infrastructure corridor approximately 1.5 km wide. The cooling water pipeline infrastructure corridor will mostly run within the premises of the Anwil plants. Only the water intake along with the pumping station and the section of pipelines closest to the Vistula riverbed will be located in an undeveloped area. At the current stage of preparing the Investment Project, the use or expansion of the existing water intake infrastructure of the Anwil plants is also being considered.

For a description of the cooling systems under consideration, see Chapter 7.1 Technical options of the cooling system.

The identified water body will be subjected to further and in-depth analyses to determine and clarify possible technical options of the cooling system, location of the water intake, pumping station, and the route of cooling water pipelines, taking into account factors such as the quantity and quality of available water, as well as analyses of the technical feasibility of implementing the various elements of the cooling system, including potential locations of water intakes and discharges (in the case of a once-through cooling system), land development, and the presence of technical obstacles or natural conditions.

Project Site (power output) 4.2.3

It is planned that part of the power generated by the nuclear power plant will power the industrial plants of Anwil from the ORLEN Group located approximately 500 m northwest of the planned Site (the "Anwil" 110 kV substation approximately 1.8 km to the north). The technical parameters of this connection will be selected depending on the transmitted power. It is expected that the connection will be made by cable or overhead line with a voltage of at least 110 kV (Fig. 7).

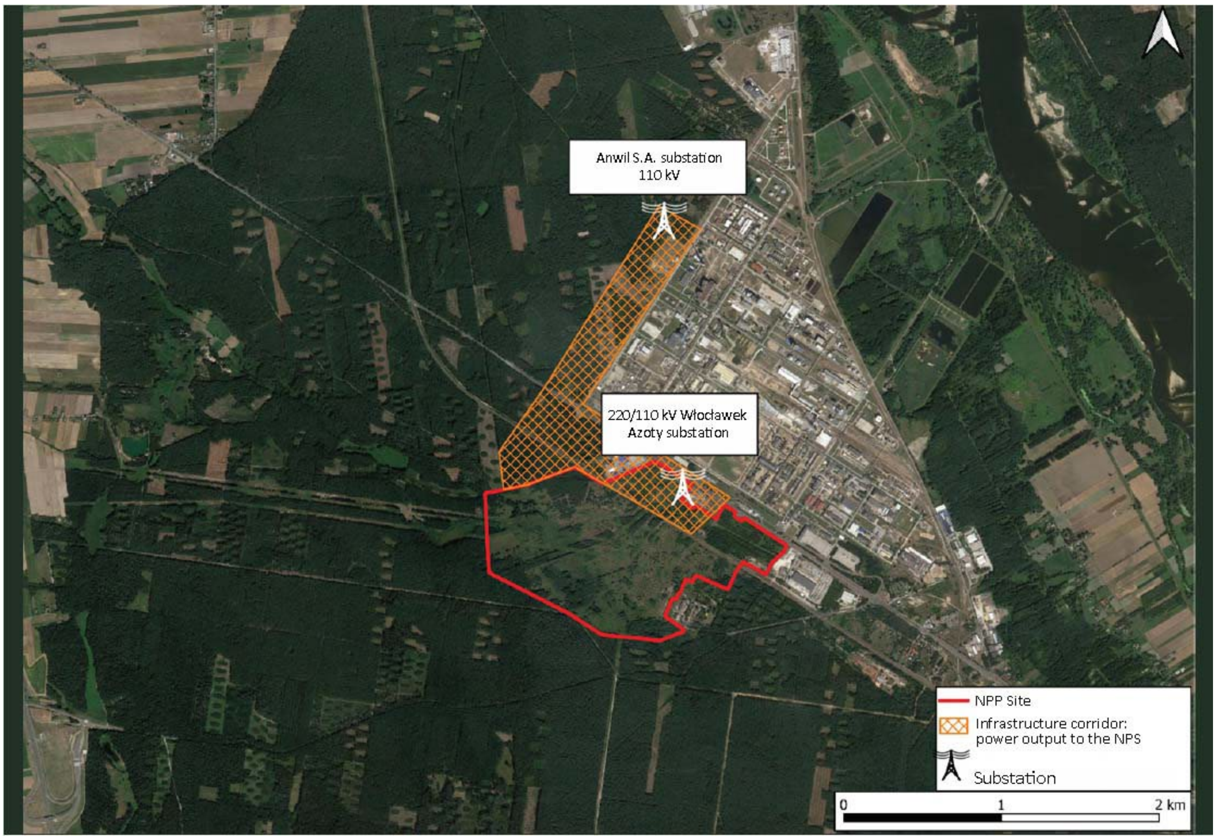

Figure 7. Considered directions for implementation of the grid connection (Source: own study using Google maps data)

Given the planned power output of the power plant, a power output system to the national power system using 220 kV or 400 kV voltage levels is considered. Based on the analysis of available connection capacities and the topography of the power system, connection of the power plant to the NPS is possible at the "Włocławek Azoty" 220/110 kV substation located in the immediate vicinity of the planned Investment

Project. It was therefore assumed that the connection point would be at this particular substation. However, it should be emphasized that ultimately the connection point determining the length of the connection and the technical parameters of this connection, particularly the rated voltage, will be determined in cooperation with the Transmission System Operator – PSE S.A. at the stage of the application for the issuance of conditions for connection to the power system.

The approximate route of the infrastructure corridor within which the power infrastructure that constitutes the power output from the power plant will be implemented is shown in Fig. 7.

The entire area designated for the location of the power output will be subject to an environmental survey. Options for corridors of power output infrastructure will be analyzed in detail at the stage of the EIA Report.

Development of the Project site 4.2.4

The site of the planned NPP has not been used for industrial purposes in the past. Currently, three extra high voltage power lines with 220 kV working voltage and three high-voltage lines with 110 kV working voltage run through the Site. These lines run through the central part of the Site. Prior to the start of construction works, these lines will be relocated outside the Site. The final route of the power lines is not yet known.

The Ośla River belonging to the surface water body No. RW20001727929 runs through the Site Area. During the site visits, the flow in the upstream river bed was found and its disappearance was observed in the Site area. Reconstruction of the riverbed will be necessary in connection with the Project implementation. At this stage, no final decision has been made on the river transformation. Among the possible solutions the following are considered:

- regulation of the riverbed and redirection of water away from the Site area
- constructing a canal for a section of the river at the Site area.

The infrastructure corridor for the implementation of cooling water channels was planned within the area used for industry purposes by the Anwil plants. Only the water intake along with the pumping station and the section of pipelines closest to the Vistula riverbed will be located in an industrially undeveloped area.

The direct line connecting the power plant to the Anwil plants will run in a non-urbanized area along the Anwil plants. Due to the proximity of the presumed grid connection point, the manner of developing the site for power output is identical to the development of the site for the nuclear power plant.

According to the information in CLC2018 (Corine Land Cover – European spatial database of land cover/land use in Europe), the area within the boundaries of the planned Site and the area where the power line is planned to be constructed as a power output to the NPS are in the class 231 Meadows and pastures. The area covered with perennial vegetation consisting of various species of grasses and fabaceae and herbs, forming a meadow sward. Areas of permanent grazing lands used as pastures or meadows.

The areas of infrastructure corridor within which the cooling water pipelines are planned to be constructed are industrial or commercial areas of class 121 according to CLC2018. Most of the area is not covered in vegetation: there are numerous industrial buildings and paved surfaces. Areas in the vicinity of the Vistula River are mainly of class 231 (meadows and pastures) and class 324 (forests and shrub vegetation in the state of change) consisting mainly of shrub or green vegetation with scattered trees. These are formations that are the result of forest degradation or regeneration.

The area where the direct line to the Anwil plants is planned to be constructed is mainly of class 312 – coniferous forests, i.e., vegetation composed mainly of trees, as well as brush and shrubs. It is dominated by coniferous tree species[6] (Fig. 8).

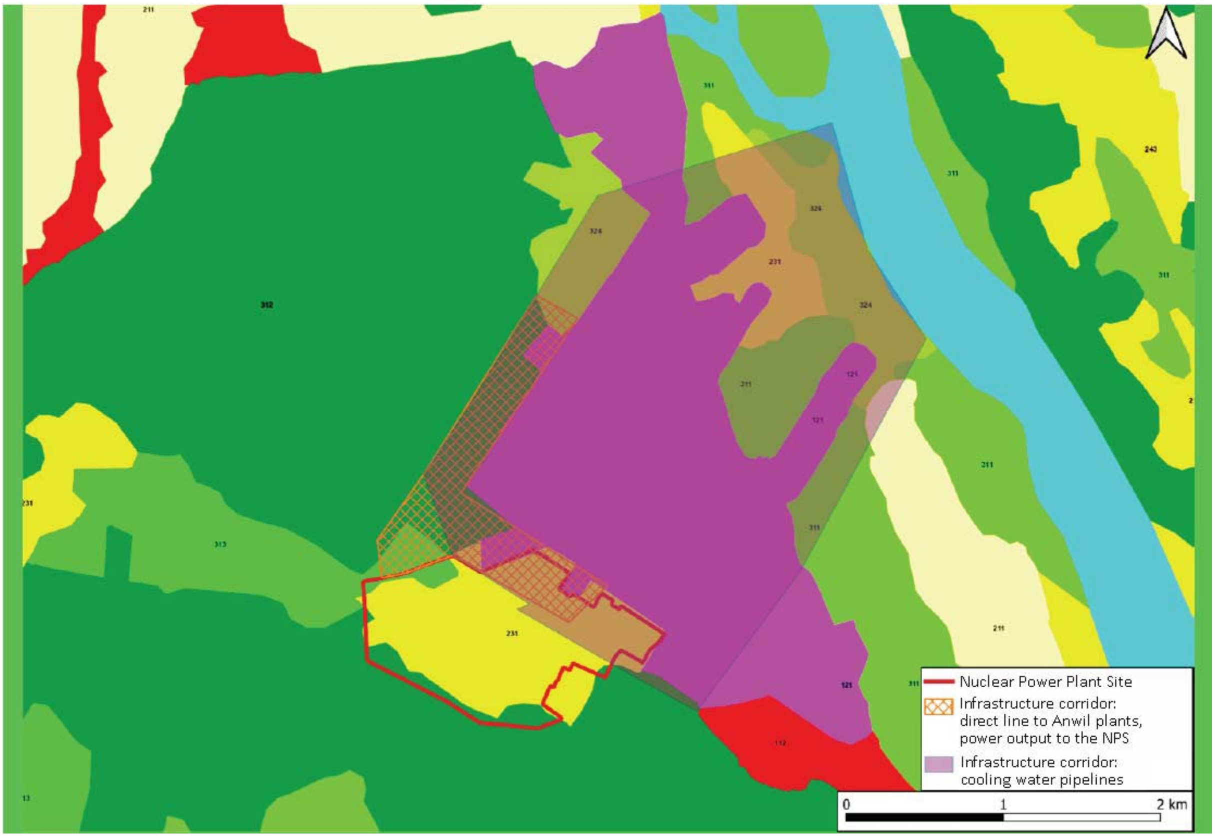

Figure 8. Land cover forms (Source: own study using Corine Land Cover 2018)

Power, gas, sewage, water supply, and telecom systems are, among others, located on the area of the project plots. Prior to the start of construction works, all infrastructure

6 Based on Corine Land Cover 2018

elements will be relocated outside the area of the Project implementation.

The Site area is divided into two parts by the railway line No. 18 Kutno-Piła Główna. The line is electrified, included in the first line category, and has been classified as a railway line of national significance. The power part of the Investment Project will be implemented on the west side of the railroad rails. The power units will be located at a safe distance from the railway line. Detailed analyses considering the line route in relation to the designed Investment Project will be carried out at the stage of site surveys, and their results will be presented in the siting report, which will constitute an appendix to the application for a construction permit for the NPP.

Anticipated surface area of the Site 4.2.5

According to information provided by the technology supplier – GE-Hitachi, construction of one 300 MWe power unit using the BWRX-300 technology requires the estimated surface areas specified in Table 5.

Facility	Estimated surface area [ha]
Office buildings	0.4
Parking area	0.3
Spent nuclear fuel storage facility (dry)	0.2
Maintenance buildings (workshops)	0.8
Power Unit including the turbine hall building	1.3
Electrical switchyard	1

Table 5. Estimated surface area of the real estate required for the construction of a 300 MWe nuclear power plant using BWRX-300 technology (based on data provided by the technology supplier, GE-Hitachi, BWRX-300 Generic Plant Parameter Envelope 005N3953 Rev. D).

Table No. 5 does not include facilities whose dimensions depend on the specifics of the site or for which no final decision has been made at this stage of the works regarding the planned technical solution (e.g. cooling system).

It is assumed that the estimated surface area of land required for the construction and operation of one 300 MWe power unit including the technical infrastructure is approx. 10 hectares. For the duration of construction, a site back-up facilities will be established that will be used as a parking and repair area for construction machinery, a storage area for prefabricated power plant components, or a warehouse for construction materials. The site back-up facilities will occupy a surface area of approx. 10 ha.

Depending on field conditions affecting the spatial distribution of nuclear power plant components, the developed area of the real estate may change. In addition, it should be noted that in the case of the construction of a multi-unit nuclear power plant, the total developed area per one power unit will be smaller due to the presence of common elements like parking areas, office buildings and workshops.

At the current stage of preparation of the Project; however, it is not possible to precisely determine the occupied surface area. The final surface area of occupied area will be determined at the stage of EIAR preparation.

The area required for the construction of cooling water pipelines of up to several hectares should be added to the surface area of the Investment Project, depending on the chosen method of cooling the power plant and its final power output.

The surface area required for the direct line connecting the planned NPP with the ORLEN Group's Anwil plants will be several hectares. The surface area of a site allocated for power output to the NPS will depend on the connection point specified in the connection conditions.

The areas occupied for the construction of infrastructure in the form of water pipelines for cooling and the power line will be determined at the stage of the EIA Report.

Local Development Plan 4.2.6

The Site is subject to the provision of the Local Development Plan (LDP) adopted by the Włocławek City Council: Resolution No XXXIX/1/2014 of the Włocławek City Council of January 27, 2014. According to the adopted LDP, the areas intended for the various elements of the Project are designated as follows:

- planned construction site of power units with auxiliary buildings and technical infrastructure: P – industry, KD-L – local road, P/U/E – industry/services/electricity equipment area
- planned construction site for cooling water pipelines: KD-Gp – fast traffic trunk roads – local road, 22P – industry, P/ZZ – industry/direct flood risk area
- direct line, power output: P/U/E – industry/services/electricity equipment area, KD-Gp – fast traffic trunk roads, P – industry, KD-L – local road, ZL – forest area.

As a rule, any investment project that is carried out should comply with the provisions of the LDP, if it is in force in the area where the investment project is to be carried out. However, this rule does not apply to nuclear power facilities or associated investment projects.

Non-compliance of the planned Investment Project with the Municipal Development Plan does not affect the possibility of constructing the nuclear power facility. Pursuant to Article 9 section 2 of the Act of June 29, 2011 on the preparation and execution of investments in nuclear power facilities and accompanying investments (Journal of Laws of 2021, item 1484, as amended), the nuclear power facility site permit is binding upon the competent authorities in terms of the preparation of the study of conditions and directions of spatial development, as well as local development plans. The Province Governor should immediately submit the issued nuclear power facility site permits to competent commune heads (town mayors, city presidents). The commune authority should state that the plan provisions are not binding upon it by adopting a resolution expressing a positive opinion on the investment project.

Pursuant to Article 80 section 2 of the EIA Act, the competent authority issues the decision on environmental conditions having ascertained the compliance of project location with stipulations set out in the local development plan, if the plan was adopted. This does not apply to the decision on environmental conditions issued for investment projects in the construction of nuclear power facilities or accompanying investment projects.

Taking into account the above, it should be concluded that the planned Investment Project is incompatible with the function specified in the Local Development Plans for the analyzed area; however, in view of the regulations cited above, such compliance is not required.

5 NUCLEAR POWER – GENERAL INFORMATION

The history of nuclear power development dates back more than 70 years. Its beginning was in the 1950s. Initially, the development of nuclear technologies was closely linked to military objectives. The main purpose of building nuclear reactors was to produce enriched uranium used to make nuclear bombs. Over time, military objectives have been extended with activities for civilian power sector. In 1951, heat from a reactor was used for the first time in the United States to generate steam and drive a steam turbine. This represented a milestone in the further development of the sector. In 1954, the first nuclear power plant with a capacity of 5 MW was commissioned in Obninsk in the Soviet Union.

Now, after a stagnant stage in the development of nuclear power worldwide, its implementation or development is planned in 35 countries. As of April 2023, 420 nuclear power reactors with a total capacity of 374,827 GWe are in operation, while 56 reactors are under construction[7].

7 Data based on IAEA Power Reactor Information System PRIS as of April 2023.

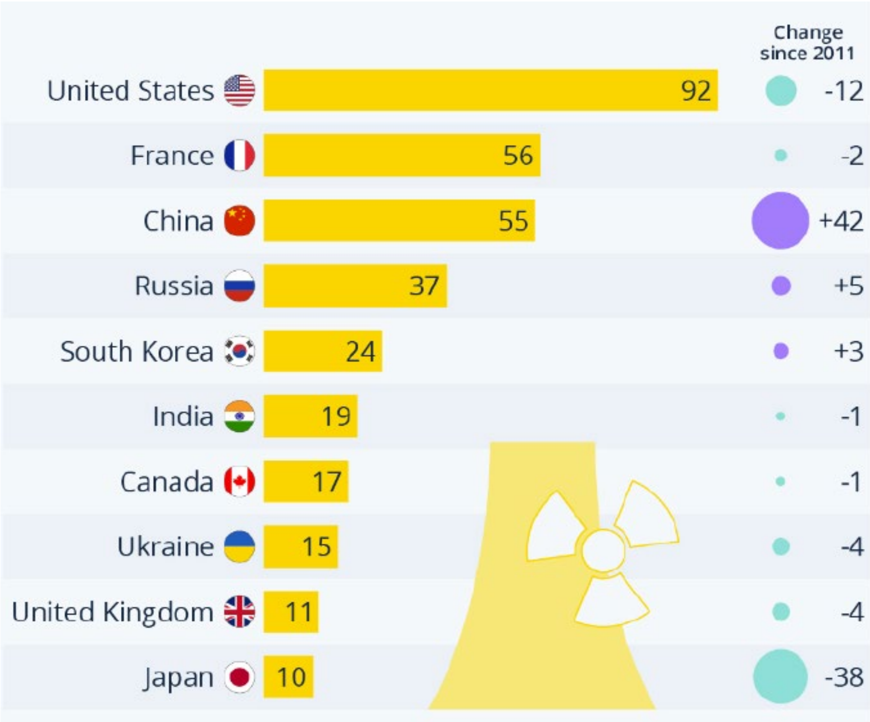

Figure 9. Countries with the largest number of nuclear power plants as of 2011 (source: World Nuclear Industry Status Report 2022, www.statista.com)

NUCLEAR POWER PLANT – PRINCIPLE OF OPERATION 5.1

The general principle of operation of a nuclear power plant, as far as the process of generating electricity is concerned, is not significantly different from that of a conventional thermal power plant – the main difference here is the heat source. While in a traditional power plant the heat is generated by burning coal or gas in a combustion chamber, in a nuclear power plant the heat is the result of the fission reaction of nuclei of uranium atoms inside the reactor.

Fission reaction 5.1.1

The fission reaction involves the fissioning of uranium nuclei under the influence of neutrons. The reaction is a chain reaction – the reaction products (neutrons) initiate subsequent reactions. A single fission reaction creates two nuclei of lighter elements with high kinetic energy (the main part of the energy from the reaction), neutrons, and gamma radiation. Fission products undergo further nuclear transformations, while continuing to emit energy. The neutrons created in the reaction cause subsequent fission reactions of subsequent uranium nuclei, making the reactions of a chain nature.

The rate at which the reaction takes place in the reactor is controlled by the amount of neutrons using the so-called control rods made of neutron-absorbing materials. The course of the fission reaction is illustrated in Fig. 10.

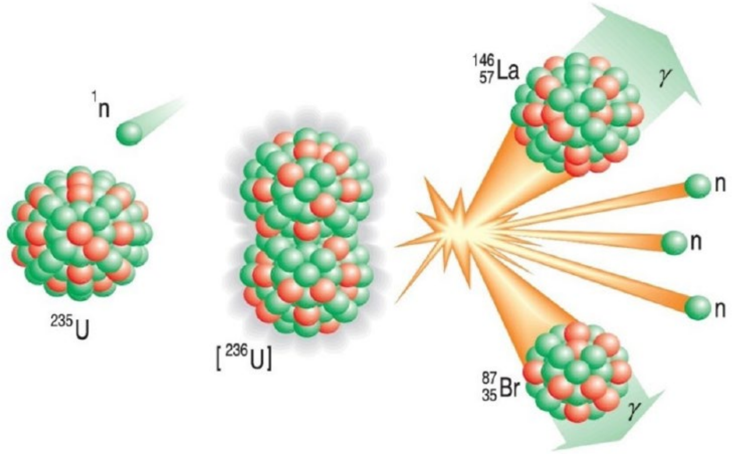

Figure 10. The schematic view of the fission reaction (“Energia jądrowa i promieniotwórczość” [Nuclear Energy and Radioactivity], A. Czerwiński, Oficyna Edukacyjna Krzysztof Pazdro, Warsaw 1998, http://www.pazdro.com.pl/)

Nuclear fuel 5.1.2

Uranium in a natural or enriched form is the fuel in nuclear power plants in the natural or enriched form. The type of fuel used depends on the type of a nuclear reactor. Uranium is formed into special pellets with a maximum length of approx. 15 mm and a diameter of approx. 10 mm. Pellets are then placed in long tubes called fuel rods, which are placed in fuel assemblies consisting of dozens of fuel rods depending on the type and design of a reactor. A set of fuel assemblies forms the reactor core, where a controlled nuclear chain reaction takes place.

Water – moderator and coolant 5.1.3

The element that makes it possible to sustain the chain reaction in the reactor is the so-called moderator. In most cases, it is high-purity demineralized water. The main task of the moderator is to slow down neutrons to a velocity that facilitates fission of the uranium nucleus (neutrons with too high velocity do not cause the fission reaction in sufficient capacity). The second extremely important function that water performs is cooling the reactor core. Water acts as a medium for transferring thermal energy to subsequent stages of conversion. In addition, ensuring that there is enough water in the reactor protects its core from overheating and a serious accident involving core meltdown.

Energy generation 5.1.4

Water, flowing between fuel elements in the reactor core, receives the heat generated during nuclear chain reactions and is transformed into steam (this happens in the so-called boiling water reactors) or, while obtaining a sufficiently high temperature, is sent to a steam generator, where, giving up heat, it causes the formation of steam in the secondary circuit (this happens in pressurized water reactors). In BWR-type reactors, water at a pressure of approx. 7.0 MPa evaporates directly in the reactor core and, when dried, is directed to the turbine, where thermal energy is converted into mechanical energy in the form of a rotating motion of the turbine shaft driving a generator, where mechanical energy is converted into electrical energy. Generated electricity receives proper parameters for the power system it feeds (Fig. 11) using transformer systems.

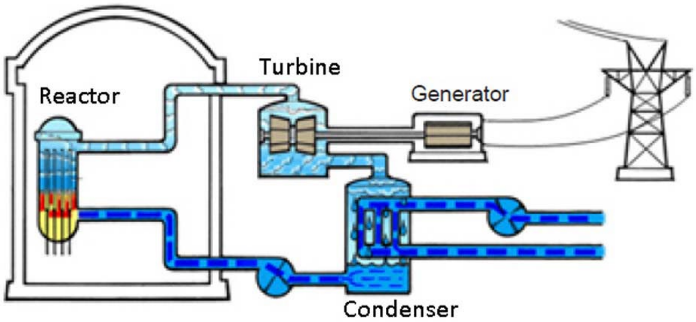

Figure 11. General process flow diagram of a NPP with the BWR reactor (https://www.nrc.gov)

Reactor power is controlled using control rods. The insertion of control rods into the reactor core lowers the intensity of the fission reaction and, as a result, reduces the reactor power. Control rods are inserted between fuel elements when the reactor needs to be shut down also in emergency situations[8].

COMPONENTS OF A NUCLEAR POWER PLANT 5.2

A typical nuclear power plant can be divided into two parts including:

- **Nuclear**

  a nuclear island – a nuclear reactor and safety systems building

- **Non-nuclear**

  turbine hall – turbine units, generator

8 https://swiadomieoatomie.pl/Energetyka-jadrowa/Kompendium-wiedzy/Elektrownia-jadrowa/Jak-dziala-elektrownia-jadrowa

cooling circuit
electrical switchyard
power output infrastructure
administration buildings
interim radioactive waste storage facility
auxiliary and associated infrastructure

POWER PLANT COOLING CIRCUIT 5.3

All thermal power plants, including nuclear power plants, are capable of converting only part of the thermal energy into electricity, while the rest of the heat generated must be discharged as waste heat.

When output from the reactor, steam with correct parameters is supplied to the turbine, while setting it into rotating motion (conversion of thermal energy into mechanical energy). The turbine drives a generator, where electricity is generated (conversion of mechanical energy into electrical energy). After passing through the turbine, the steam is directed to a condenser, where condensation takes place, i.e. the water state of matter aggregation of steam is changed from gas to liquid. Heat removed from the condenser has parameters that limit its further use in a technological process (due to its too low temperature), so it is considered waste heat. Condensate (condensed steam) then flows through a system of pumps (a condensate pump and feedwater pump) and a system of regenerative heat exchangers and, having correct parameters (pressure and temperature), returns to the reactor, closing the primary circuit of a BWR-type power plant.

The cooling circuit of the power plant is intended to dissipate heat from the condenser with water as the working medium. The cooling circuit in a BWR-type power plant is a secondary circuit, i.e., heat is received in a condenser and water working in the cooling circuit does not come into direct contact with water working in the primary circuit of a power plant. There are two main types of cooling circuits:

- **once-through cooling system**
- **closed-circuit cooling system**
  natural draft cooling towers
  mechanical draft cooling towers

Once-through cooling system 5.3.1

In a once-through cooling system, cooling water is taken via cooling water channels from rivers, seas or other water bodies. As the water flows through the condenser, it receives heat, and then heated water returns to the same source from which it was taken. The heat is returned entirely to the water body. Due to the fact that after leaving the cooling system, the water has a higher temperature compared to the temperature of the liquid in the source from which it was taken, the water intake and discharge system must be properly designed so that discharged waters do not mix with intake waters causing them to heat up, which will consequently reduce the efficiency of the entire cooling system.

Closed-circuit cooling system 5.3.2

PRINCIPLE OF OPERATION OF COOLING TOWERS

Water flowing through the condenser removes heat from the primary circuit of the power plant. The heated water is then piped to the inlet manifold of the cooling tower and distributed through a system of internal pipes to the spray nozzles, whose task is to break up the water jet into small droplets dispersed evenly at a suitable place inside the cooling tower (above the fill packs). As it falls, the water gives up heat to the air flowing from the bottom to the top (in a countercurrent flow). Air movement is forced by the draft created in the cooling tower due to its geometry. Cooling of water is obtained mainly by evaporation of a small part of the water stream (approx. 1.5%) and due to heat exchange between water and air by convection.

The cooled water accumulates in a collection basin at the bottom of the cooling tower, from where it is sucked up by circulating pumps. The water is then directed to a condenser. Water circulates in a closed-circuit cooling system – it removes heat from the condenser and discharges it to the environment through the atmospheric air. In the system, there are losses associated with evaporation, drift and the need to demineralize the circulating water.

Due to the large height of cooling towers and the heating of air inside, a stack effect is created, forcing air from the bottom to the top of the cooling tower without the use of fans.

PRINCIPLE OF OPERATION OF A MECHANICAL DRAFT COOLING TOWER

Physical processes leading to the reduction of water temperature that take place in a mechanical draft cooling tower are the same as those of a cooling tower without fans. The difference between the two types of cooling towers is that in mechanical draft cooling towers the airflow is usually generated by an axial propeller fan located at the top of the cooling tower above the water distribution system. Louvers – drift eliminators are placed above the fill pack, stopping water droplets lifted by strong air currents, thus reducing drift losses. The capacity and parameters of the fan are selected to ensure that the heat is removed from the water supplied to the cooling tower. Air flows into the cooling tower through inlet windows below the fill pack. The use of fans makes it possible to significantly reduce the size of mechanical draft cooling towers relative to natural draft cooling towers.

Regardless of the cooling option chosen, it is necessary to build cooling water channels (in the form of pipelines) that will supply raw water from the water reservoir to the power plant to make up for water losses occurring in the cooling system.

For a description of the cooling options for the proposed nuclear power plant at the Site see Chapter 7.1. Options of the cooling technology.

DESCRIPTION OF THE TECHNOLOGY SELECTED FOR IMPLEMENTATION – BWRX-300 6

GENERAL INFORMATION 6.1

The boiling water reactor (BWR) is a common type of the power reactor. It is a nuclear reactor moderated and cooled with water circulating in a single circuit – water converted to steam in the reactor is supplied directly to the turbine that drives the generator, then cooled and condensed steam is returned to the reactor.

So far, during more than 60-year history of development of BWR type reactors, 113 boiling water reactors have been constructed and commissioned in the world, and two ABWRs are currently under construction. There are currently 48 BWR-type reactors in operation worldwide. The highest concentration of boiling water reactors is in the USA, where 31 of 93 reactors currently in operation are BWR-type units[9]. Outside the USA, the technology is used in Sweden, Finland, Spain, Switzerland, Japan, and Taiwan, among others.

The BWRX-300 reactor is a boiling water reactor designed to achieve optimum investment cost while maintaining safety standards and minimal environmental impact at every stage of the investment project life.

The BWRX-300 design is the 10th generation of the boiling water reactor technology, and it is based on proven solutions drawn from past operating experience. Features of the BWRX-300 reactor:

- it is the 10th generation boiling water reactor;
- it represents an evolutionary development of the ESBWR project certified by the

9 Data based on IAEA Power Reactor Information System PRIS as of April 2023.

U.S. Nuclear Regulatory Commission (U.S. NRC)[10];

- it has a world-class defense line;
- it has the ability to operate with variable power according to demand;
- it provides an ideal solution for electricity generation, heat generation and industrial applications (process steam generation);
- design solutions reduce construction time (erection of prefabricated modules on the construction site) and reduce environmental impacts;
- it is a cost-optimized project.

In addition, it should be noted that the BWRX-300 reactor technology undergoes various licensing processes in the in the USA, Canada, and the UK.

Ensuring the safe operation of the BWRX-300 reactor is based on the use of passive systems, the operation of which is based on natural physical phenomena (convection, gravity). The reactor design reduces the number of active components in the safety systems, increasing their reliability. Having the safety of a nuclear power plant operation rely on passive systems has undoubted advantages in that the proper operation of these systems does not depend on actions taken by the operator, nor do they depend on the availability of external power supply. These systems also cannot fail in such a manner that can occur in other technologies based on the operation of solenoid valves or pumps. Passive systems provide effective cooling of the reactor core during normal operation, as well as in the event of accident conditions. The system will work even if there is no electric power supply.

The BWRX-300 design is a direct evolutionary development of the design of the large 1520 MWe ESBWR reactor, which successfully passed the certification process of the U.S. Nuclear Regulatory Commission (U.S. NRC). Compared to its larger and older predecessor, the BWRX-300 is distinguished by its ten times smaller size of the reactor concrete shield. The reactor core contains about 5 times less fuel (resulting in less fission products produced) and approx. 5 times less thermal power, which has an impact on the lower requirements for heat removal from the reactor (including residual heat in adverse events). GNF2-type fuel rods manufactured by GE Hitachi Nuclear Energy are used as the fuel for the reactor. Water is used as a coolant and neutron moderator.

The BWRX-300 design is based on proven fuel, materials, and manufacturing processes, while incorporating innovative solutions such as passive and simple design concepts.

BWRX-300 reactors are characterized by a high degree of standardization, which allows for mass production of components and, as a result, a reduction in costs and potential environmental impact. The most important advantages of SMRs are lower reactor construction costs compared to large BWR-type units, while maintaining the

10 https://www.nrc.gov/reactors/new-reactors/large-lwr/design-cert/esbwr.html

safety standards of these reactors.

The main components of the BWRX-300 reactor will be manufactured in specialized production facilities and will be delivered to the construction site in the form of prefabricated components ready for erection. The preparation of components in specialized factories enables high standards of their quality to be maintained. Such a solution allows a significant reduction in construction time and the scope of the necessary construction works at the site, which is associated with a lower environmental impact during the construction of such a facility.

The BWRX-300's design enables clean power generation with high reliability and flexibility at costs competitive with natural gas-fired power plants. Expected services include:

- electricity generation operating at the base load of the power system (continuous operation at the fullest possible capacity);
- generation of electricity with variable capacity depending on the load, generally in the range from 50 to 100 percent of capacity (power system balancing);
- large-scale heating engineering;
- production of other process heat;
- use of electricity for green hydrogen production.

What distinguishes BWRX-300 (following ESBWR – previous generation) from older types of BWR reactors is the use of natural circulation of coolant in the reactor core instead of circulating pumps. The use of such a solution both reduces investment costs and improves safety, as the number of moving parts that could potentially be a source of failure is reduced. The very principle of the steam generation system remains characteristic of boiling water reactors: water supplied as coolant boils in the reactor and is supplied as steam directly to the turbine. Steam from the turbine is condensed in a condenser and routed back to the reactor vessel (through filtration, demineralization systems and heaters).

The BWRX-300 design ensures optimization of construction, operation, repair, maintenance and decommissioning costs. These costs have been minimized while maintaining the highest safety class by safety strategy based on sequences of defense lines in accordance with the defense-in-depth concept of the International Atomic Energy Agency (IAEA). The concept and other safety-related solutions are described in chapter 11 Solutions protecting the environment.

CONCEPTUAL OUTLINE OF THE BWRX-300 POWER UNIT DESIGN 6.2

The main part of the investment project, according to the preliminary concept, will be the power unit, which will include, among others (Fig. 12):

- Reactor Building
- Turbine Building
- Control (Room) Building
- Radwaste Building

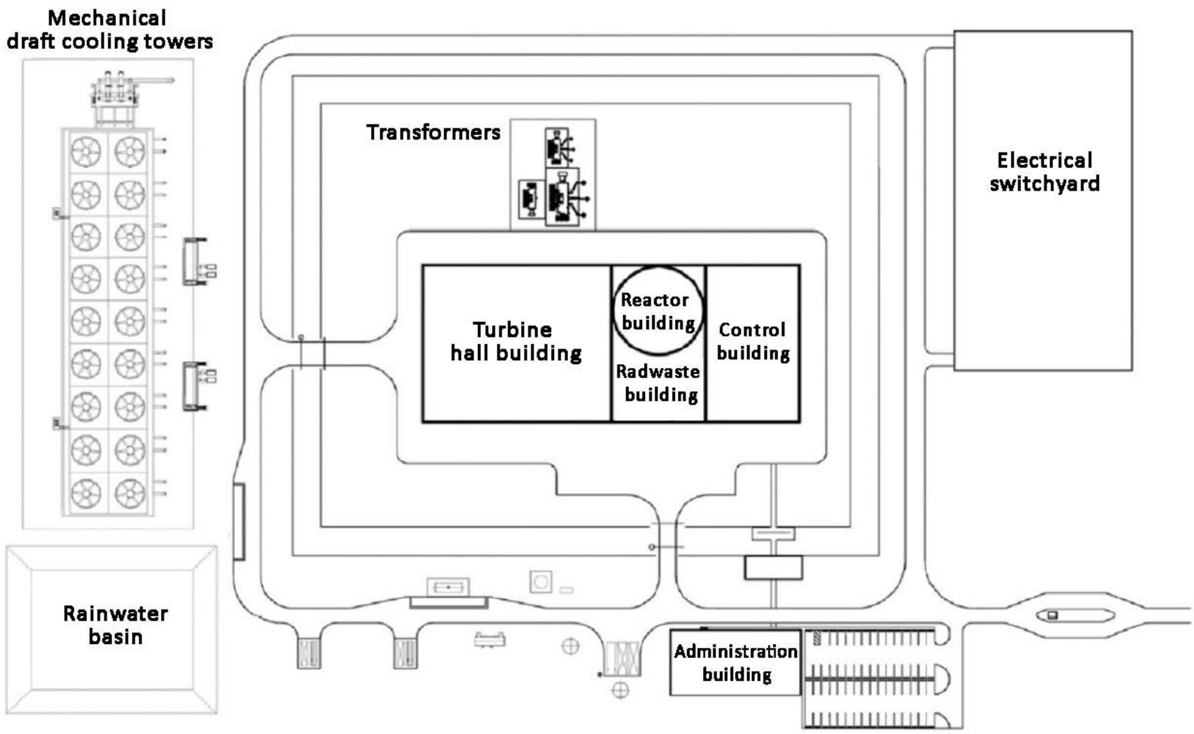

Figure 12. Example location of power plant buildings (source: GE-Hitachi)

The power unit together with auxiliary buildings and technical infrastructure will occupy an area of approximately 10 hectares (Fig. 13). The approximate dimensions of the power unit buildings are shown in Table 6. The specified values are subject to change depending on the final building permit design, which will be developed at a later stage of the project.

Building	Length [m]	Width [m]	Height [m]
Reactor Building	40	40	40
Turbine Building	75	65	35
Control Building	40	15	15
Radwaste Building	40	40	30

Table 6. Example of dimensions of the main buildings of the BWRX-300 power unit (Source: technology supplier GE-Hitachi).

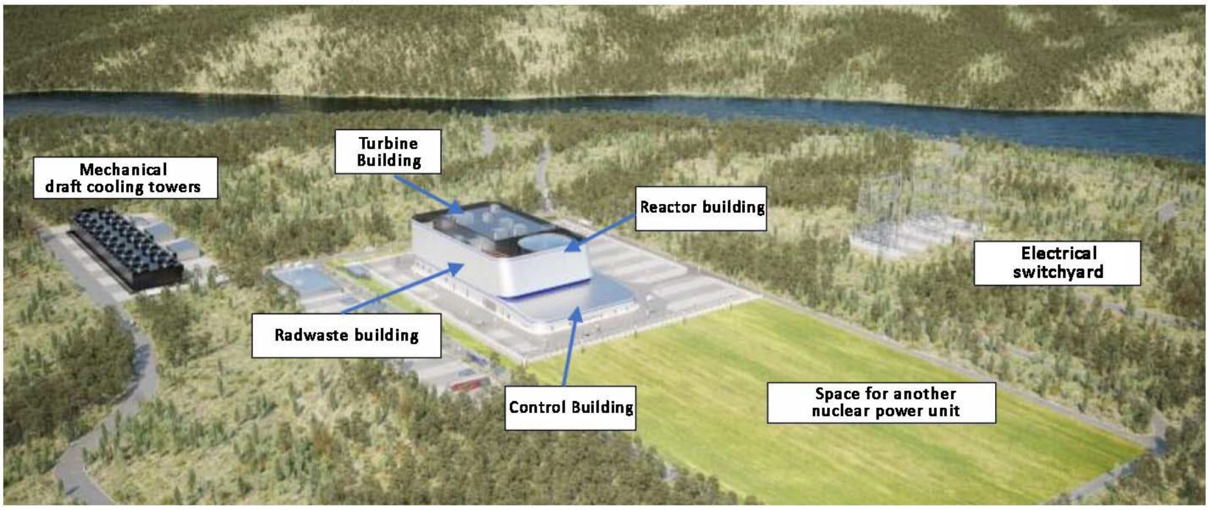

Figure 13. Visualization of a power plant with the BWRX-300 reactor (source: GE-Hitachi)

Reactor Building 6.2.1

The main building of the power unit as well as the entire nuclear power plant is the Reactor Building. The Reactor Building (Fig. 14) extends below the ground level, where the Primary Containment Vessel (PCV) and the Reactor Pressure Vessel (RPV) are partially located, forming the centerline of the Reactor Building with a cylindrical shape. The reactor core is located inside the reactor pressure vessel. The Reactor Building is distinguished from nuclear power plants (NPPs) by its unique design and construction method. The building is a cylindrical structure set in a vertical excavation approx. 36 m below ground level and approx. 40 m in diameter.

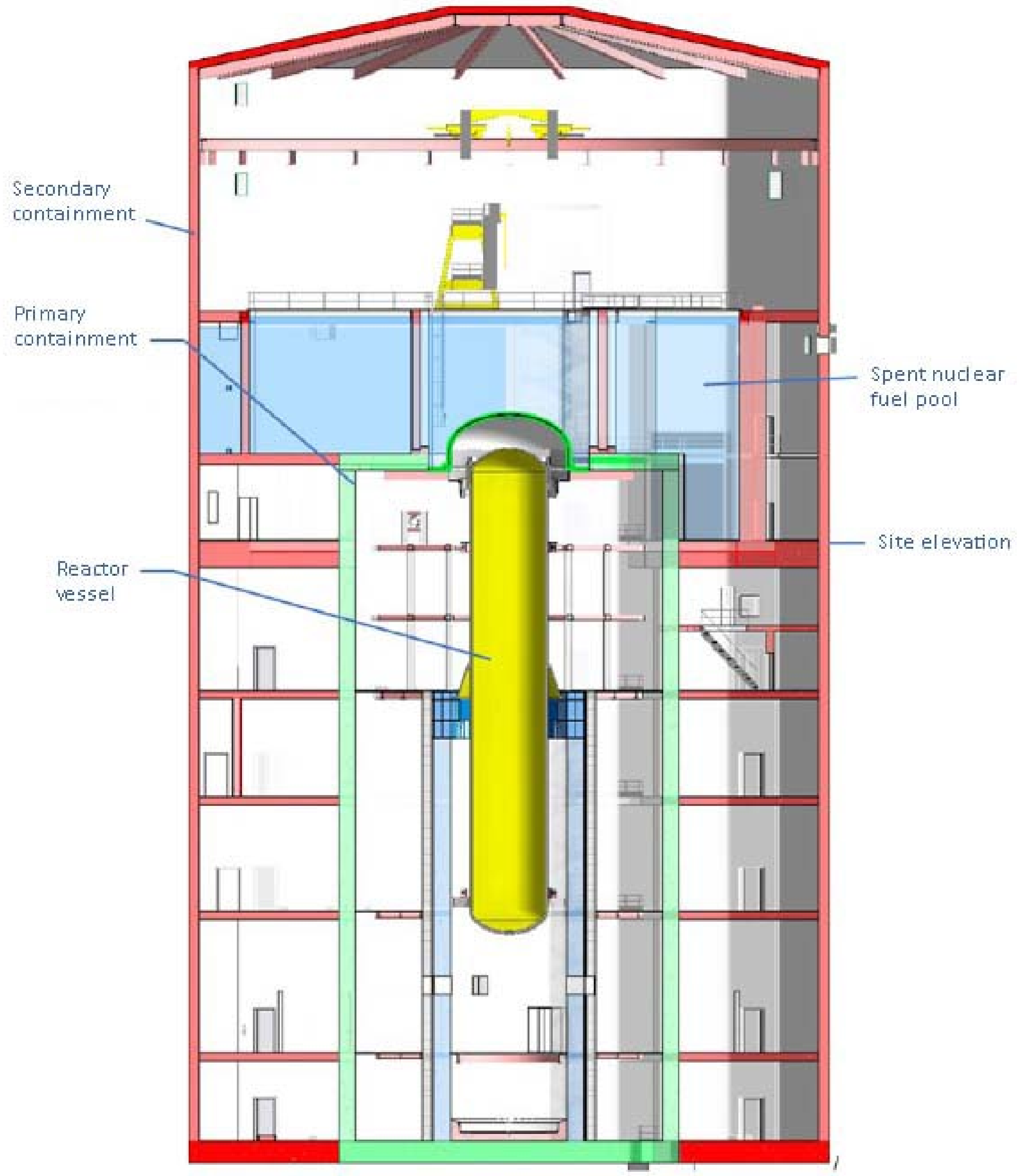

Figure 14. Reactor Building – Schematic cross-section through the primary containment of the BWRX-300 reactor (source: GE Hitachi)

The excavation will be performed using techniques commonly used in mining and construction. The underground structure of the reactor building minimizes the need for concrete compared to the surface installation of the reactor pool. Above the primary containment there is a pool in contact with the containment head that provides a backup source of reactor cooling water in the event of an accident.

The Reactor Building is equipped with safety systems to protect against potential consequences of a reactor failure. It has been designed to withstand any external event such as earthquakes, floods, fires, extreme weather conditions or aircraft impact.

The spent fuel pool is located at the ground level in the Reactor Building and has enough capacity for the storage of spent fuel from eight years of operation and a full discharge of the core.

The Reactor Building is designed in such a way that in the event of an adverse event, its structural integrity is fully preserved, so that systems, structure and equipment components that perform safety-related functions are not compromised.

Turbine Building (turbine hall) 6.2.2

The turbine building is where the electricity is physically generated. Steam from the reactor via pipelines is transferred to the turbine hall, where it drives the turbine (Fig. 15) connected to the electric generator, in which electricity is generated.

Figure 15. Example of a steam turbine (source: GE-Hitachi)

The turbine hall houses the turbine unit (turbine and generator) along with pipelines supplying steam from the reactor building, auxiliary systems of the turbine unit, condenser system, condensate circulation system, and cooling water fed back to the reactor building, along with auxiliary systems for filtration and preheating.

Control (Room) Building 6.2.3

The Control Building is intended for automation and control systems. The building houses the Main Control Room (MCR), where operators monitor and control operating parameters of the reactor, the Emergency Operation Center (EOC), and the electronic and structural components that make up the instrumentation and control (I&C) system without measurement and transmission parts located in other buildings. The design of the Control Building ensures safe working conditions for reactor operators and does not adversely affect systems, structures and components responsible for performing safety functions in the event of adverse events.

Radwaste Building 6.2.4

A special-purpose building for the management of interim radioactive waste generated during reactor operation. It includes systems, structures and equipment responsible for waste volume reduction, segregating waste by category or subcategory and preparing it for transport or storage as well as gas filtration systems using carbon absorbers. The building structures are designed adequately to the activity of the substance in accordance with the standards of radioactive waste management buildings.

Main design solutions of the BWRX-300 6.2.5

Although the BWRX-300 is predominantly a traditional boiling water reactor, several simplification features have been incorporated into its design resulting in an improved concept for mitigating adverse events and leading to lower costs. The following features should be mentioned:

- reactor vessel isolating valves: the BWRX-300 reactor pressure vessel is equipped with isolating valves that provide fast isolation of the broken pipeline, helping to mitigate the consequences of a Loss of Coolant Accident (LOCA). All large fluid transfer piping systems are provided with double isolating valves that are an integral part of the reactor pressure vessel;
- no pressure relief valves: pressure relief valves have been eliminated from the BWRX-300 design. The high-capacity Isolation Condenser System (ICS) provides protection against overpressurization of the reactor. Historically, safety valves were the most likely cause of LOCA, therefore they were eliminated from the BWRX-300 design, and their function was replaced with another solution (ICS);
- the passive nature of the emergency reactor core Isolation Condenser System (ICS): this system performs its function without the need for power, using the gravity and natural convection, which determines its high reliability;
- the use of a dry containment: the BWRX-300 reactor has a dry-type containment, which provides effective containment of steam, water, and fission product emissions following a hypothetical LOCA;
- passive cooling system for the primary containment: ensuring that the temperature and pressure inside the containment are maintained within design limits. The system performs its function when required without the need for power supply and using the law of gravity and natural convection, which determines its high reliability.
- the use of standard commercially available equipment: due to its smaller size, the

BWRX-300 design makes greater use of standard commercially available equipment than previous boiling water reactors. This makes it possible to adapt technical solutions proven in the non-nuclear industry.

The design solutions used ensure that safety design goals are met. Even in the event of a hypothetical accident, with estimated frequency of occurrence is less than 1 in 10,000,000 years of reactor operation, safety functions will remain preserved (safe shutdown of the reactor, ensuring effective cooling, and protecting against releases) for 7 days without the need for operator action or external resources. In existing nuclear power plant designs, the design self-sufficiency time is 72 hours. In BWRX-300, the time margin has been significantly extended, assuming a backup for external operations even in the most extreme adverse event scenarios (experience from the Fukushima accident events).

The technical design of the BWRX-300 virtually eliminates the risk of a major accident resulting in the release of radioactive substances into the environment (probabilistic analyses estimate the probability of a major accident at less than 1 in 10,000,000 years of reactor operation).

A simplified diagram of the BWRX-300 design showing concepts of operation is presented in Figure 16.

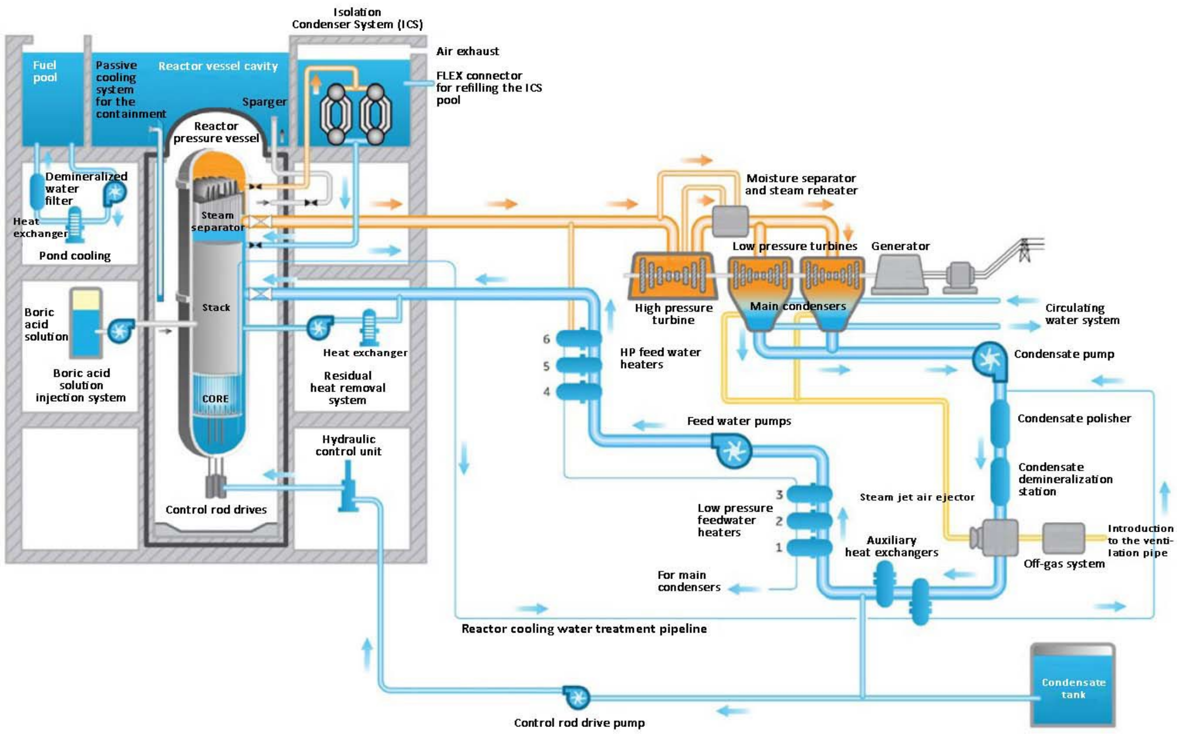

Figure 16. Simplified diagram of the BWRX-300 systems (source: GE-Hitachi)

PROGRESS OF BWRX-300 TECHNOLOGY LICENSING PROCESSES IN THE WORLD 6.3

At present, licensing or preliminary approval processes for BWRX-300 technology are taking place in several countries including those with a long tradition and extensive experience in nuclear power plant operations such as Canada, the United States and the United Kingdom. Poland is also among the countries actively involved in the BWRX-300 technology project evaluation process.

Canada 6.3.1

The world's most advanced licensing process for BWRX-300 technology is taking place in Canada, where an experienced nuclear power plant operator that is also the largest energy producer in the Ontario province – Ontario Power Generation (OPG) – applied to the Canadian Nuclear Safety Commission (CNSC) on October 31, 2022 for construction license for a nuclear power plant at the DNNP-1 Darlington site in the Ontario province. OPG's works schedule calls for the plant to begin operation in 2028.

The actual licensing process for the technology in Canada began in 2019, when GE Hitachi applied to the CNSC for an early Vendor Design Review (VDR) of the proposed technology. The VDR is a non-mandatory, optional early technology review process intended to evaluate whether adopted design solutions meet the requirements of Canadian nuclear regulations. The CNSC's review of design documentation consisted in identifying any design issues that could become significant obstacles in the construction licensing process for new nuclear projects using BWRX-300 technology. Canada's VDR process ended in March 2023 with a positive CSNC review. Based on the documents reviewed, the CNSC concluded that the BWRX-300 reactor does not have any significant design features that would prevent the issuance of a permit for its construction.

The selection of the BWRX-300 technology by OPG, with which OSGE is working closely, is an important factor for the implementation of the Investment Project in Poland. It means that Poland's first BWRX-300 nuclear power plant will be a NOAK (Next of a Kind) project, and the Canadian project as FOAK (First of a Kind) will become a reference project for the Polish project. This will enable the use of Canadian experience in the development, preparation of the investment process, licensing, construction and operation of a nuclear power plant of the same type in Poland.

United States 6.3.2

The Tennessee Valley Authority (TVA) – which is the largest public electricity supplier in the United States (USA) – is also interested in developing BWRX-300 SMRs. TVA is planning to build BWRX-300 reactors in the Clinch River near Oak Ridge, Tennessee. The works schedule calls for the first BWRX-300 reactor to begin operation in mid 2032.

The licensing process for the project in the USA began at the end of 2019. The U.S. nuclear regulator has so far approved several reports describing individual technical solutions used in the project (Licensing Topical Report – LTR), with the remaining LTRs in the review phase. LTRs in the USA serve a similar function to the VDR process in Canada. During the process, the safety functions of individual systems and organizational and technical solutions affecting the overall safety of reactor operation are evaluated. The individual LTRs contain data and information that can be evaluated independently in a process unrelated to the issuance of construction license for the power plant. Conclusions of review of LTRs by the U.S. NRC can however be used in the process of evaluating individual construction license applications for reactors being built at different sites and included in different projects. According to the U.S. NRC, such a procedure primarily minimizes the time and effort required to process applications for subsequent licenses for identical designs.

The United Kingdom 6.3.3

In December 2022 GE-Hitachi submitted an application to the UK's Office for Nuclear Regulation (ONR) to begin evaluating the BWRX-300 reactor under the Generic Design Assessment (GDA) procedure.

The GDA is a pre-licensing procedure under which an initial technical and environmental assessment is performed for a nuclear power techlonogy. This is not a mandatory procedure required by law. The GDA's project evaluation concludes with a preliminary safety analysis report and an environmental impact assessment of the technology being evaluated. The GDA process is not connected to a specific site and concerns design assumptions only.

Poland 6.3.4

Polish regulations also provide for a preliminary assessment of applied organizational and technical solutions for the proposed nuclear technology. In accordance with Article 39b of the Act of November 29, 2000 – Nuclear Law Act (Journal of Laws of 2023, item 1173), the applicant may apply to the President of the National Atomic Energy Agency (PAA) for a general opinion on the applied organizational and technical solutions of the planned nuclear power plant.

The general opinion by the President of the PAA is to assess whether the proposed technology or organizational and technical solutions are characterized by the presence of significant deficiencies that may affect the safe operation of the nuclear power plant. However, the issuance of such an opinion is not a substitute for the process of obtaining a construction license for a nuclear power plant. The general opinion by the President of the PAA is an optional tool, and it is the applicant that may or may not request an assessment of technology or organizational and technical solutions.

In July 2022 OSGE requested the President of the PAA to assess the proposed organizational and technical solutions for the BWRX-300 technology. On May 23, 2023 the President of the PAA issued a positive opinion stating the correctness of the BWRX-300 design assumptions adopted in accordance with nuclear safety requirements. In the opinion issued it was concluded that the assumptions adopted in the design of the technology are correct and meet the requirements of the Nuclear Law Act and selected ordinances on the safety of nuclear facilities. The conclusions presented by the PAA will be used in the development of the detailed design for the GE Hitachi (GEH) reactors to be constructed in Poland.

The opinion emphasized that a complete analysis of the reactor's nuclear safety aspects will be possible after the applicant submits safety analysis, which will take place at the stage of the construction license application to the President of the PAA.

It should also be noted that for the first time in history a private Polish company is participating in the development of nuclear power technology. In March 2023 Synthos Green Energy Spółka Akcyjna (Joint Stock Company) signed an agreement with OPG, TVA and GEH to co-finance the development of the BWRX-300 technology. The agreement calls for investments in the development of the GEH-led BWRX-300 project, the total amount of which will exceed $400 million. Due to these activities, a standard design of the nuclear power plant with the BWRX-300 reactor will be prepared, as well as detailed designs for, among other things, the reactor building along with the equipment inside, including the reactor.

In summary, the BWRX-300 technology has been pre-assessed for safety by nuclear regulators in the United Kingdom (ONR), the United States (U.S. NRC), Canada (CNSC), and Poland (PAA) during which the technical solutions used in the project were evaluated to meet the regulatory requirements and guides of those countries. It should be noted that the countries listed are among the most experienced in the nuclear power field, and the legal systems and safety requirements are consistent with those of the IAEA.

7 CONSIDERED OPTIONS FOR THE PROJECT

In accordance with the provisions of both international (Espoo Convention, Aarhus Convention, EIA Directive) and national requirements (EIA Act), the Investor is free to determine the possible options for the planned operation. According to the referenced documents, the environmental impact assessment should analyze viable options for the project, including the option to abandon the project. The scale of the project, the technology used, technical solutions and the site of the investment project are most often referenced as examples of alternative solutions.

In the case of the implementation of this Project, the subject of optioneering is primarily the technical solution for the cooling system. An additional option under consideration is also the scale of the investment project.

The subject of the optioneering is not technology due to the fact that the investor has selected the technology. The Project is for the construction and operation of the GE-Hitachi BWRX-300 reactor. The optioneering of sites is also not considered. This is connected with the new international approach to location of SMRs – potential sites for modular reactors are located in currently operating fossil fuel-fired power plants (Coal2Nuclear) or near existing industrial plants. The purpose of construction and then operation of SMRs is to replace high-carbon sources of energy and heat with a zero-carbon energy source, in this particular case using the BWRX-300 technology. Given the aforementioned information, the Investor has selected the technology, whereas the potential site is based on existing industrial plants, and thus there is no justification for including the optioneering of technologies and sites.

In accordance with the EIA Act, the so-called "zero option"" will also be analyzed at the environmental impact assessment stage. This will allow to determine environment impacts if the Project is not undertaken.

7.1 TECHNICAL OPTIONS OF THE COOLING SYSTEM

As part of the preliminary site analyses, the Investor indicated the Vistula River as the primary cooling source for the power plant. An assessment of the potential cooling systems that could be implemented at the Site was made. At the current stage of the Investment Project preparation, the Investor does not exclude the possibility of implementing any of the cooling system options described in Chapter 5.3 Power Plant Cooling Circuit. In-depth analyses of water availability, as well as technical analyses of the possible implementation of different types of cooling system will be conducted.

According to the data provided by the technology provider, the water demand for the once-through cooling system is estimated at approx. 50,000 to 90,000 m^3/h, while the water demand for one nuclear unit with a closed-circuit system averages approx. at 800 m^3/h, and in extreme situations (summer period) can reach approx. 1,200 m^3/h (water demand for the operation of one BWRX-300 reactor).

The amount of water drawn is the main difference between once-through and closed-circuit cooling systems. In a closed-circuit system, the amount of water taken to make up the cooling circuit is considerably less than in a once-through system, but this water is lost irretrievably through evaporation and drift in the cooling towers. In the once-through system, the entire volume of drawn water, after passing through the NPP cooling systems, is then discharged into the water tank, but the temperature of the discharged water is higher than the temperature of the water in the tank. Due to the large volumes of pumped water, the once-through system will need pipelines with larger cross-sectional diameters, and a pumping station equipped with higher capacity pumps.

In terms of the closed-circuit cooling system, 2 basic technical solutions are considered:

- natural draft cooling towers
- mechanical draft cooling towers

As a rule, traditional cooling towers are taller and bulkier structures compared to mechanical draft cooling towers. They are therefore characterized by higher material consumption at the construction stage, and will generate more waste at the decommissioning stage. Cooling towers also cause a greater impact on the landscape. Mechanical draft cooling towers, on the other hand, are characterized by higher electricity consumption during their operation. As part of the preparation of the EIAR, the investor will analyze and compare the environmental impact of the above-mentioned options and identify the preferred solution.

7.2 OPTION FOR THE NUMBER OF NUCLEAR POWER UNITS

As part of the Investment project, the Investor intends to build and operate a nuclear power plant with a capacity of up to 2000 MWe. As potential options, the Investor is considering:

- construction and operation of 4 BWRX-300 nuclear power units, or
- construction and operation of 5 BWRX-300 nuclear power units, or
- construction and operation of 6 BWRX-300 nuclear power units.

Thus, the number of power units with immediate environmental impact of the Project will be optioneered with regard to:

- quantities of materials, raw materials and energy used during construction,
- the amount of water needed to make up the cooling system of the nuclear power plant (in a closed-circuit system) or the amount of water needed for cooling (in the case of a closed-circuit system),
- acoustic impact of the power plant,
- quantity of waste generated, including radioactive waste,
- quantity of spent nuclear fuel generated,
- size of the paved areas,
- quantity of waste generated during the decommissioning stage of the Project,
- the amount of electricity produced (avoiding the CO_2 production).

DESCRIPTION OF THE ENVIRONMENT 8

As part of the preliminary siting analyses commissioned by OSGE, the planned NPP Site (excluding technical infrastructure) was evaluated to determine the presence of phenomena and hazards in the fields of geology, mining activity, seismology or human activity. A preliminary analysis of the tectonic structure and seismicity was performed by the Institute of Geophysics of the Polish Academy of Sciences (IGF PAN). An analysis of geological phenomena, hazards posed by human activity, including mining, was conducted by the Central Mining Institute (GIG).

As reported by the GIG, given the geological, mining, social and economic conditions, there are no contraindications to the construction and operation of nuclear facilities at the Site considered. Also, the preliminary analysis of tectonic structure and seismicity performed by experts from IGF PAN, did not reveal factors excluding the considered Site from the possibility of constructing a nuclear power plant.

The investigations conducted as part of the preliminary analyses refer to the Site Area and the Site Region.

This chapter includes descriptions and conclusions of the aforementioned analyses[11] [12].

11 Preliminary analysis and site evaluation report for the nuclear facility (Włocławek, Włocławek district), Central Mining Institute, Katowice 2023

12 Report on preliminary seismicity assessment for the nuclear facility (Włocławek, Włocławek district) Institute of Geophysics of the Polish Academy of Sciences, Warsaw 2023

SITE TOPOGRAPHY 8.1

According to the physical and geographical division of Poland (Regionalna geografia fizyczna Polski (Regional Physical Geography of Poland), collective work edited by: Andrzej Richling, Jerzy Solon, Andrzej Macias, Jarosław Balon, Jan Borzyszkowski and Mariusz Kistowski, Poznań 2021) the Site, including the area intended for the construction of cooling water channels and connection lines (power output) infrastructure, lies within the region of the North European Plain (31), subregion of the South Baltic Lakeland (314-315), macroregion of the Toruń-Eberswalde Ice-Marginal Valley (315.3), mesoregion of the Nieszawa Vistula Gorge (315.37).

The original valley filled with sediments succumbed to the erosive force of the Vistula, which led to the formation of a series of valley terraces. The most complete picture of the terrace level arrangement has been preserved in the northern part of the Włocławek Valley below city of Włocławek. The city of Włocławek lies on the "islands" of the sixth and seventh terrace at an altitude of 50–65 m a.s.l. The Włocławek Valley, which separates the Kuyavian Upland from the Dobrzyń Lakeland, is characterized by a relief primarily related to the activity of flowing water[13].

The Site Area is located within the Toruń Valley stretching along the Vistula valley, and then the Bydgoszcz Canal, to the vicinity of Nakło nad Notecią. The flood plain covering the part of Włocławek below the barrage is the lowest part of the Basin. The most characteristic part of the environment and landscape is the Vistula valley.

The topography of the Włocławek Site Region is presented in Figure 17.

13 Low-carbon economy plan for the Włocławek Municipality, 2015

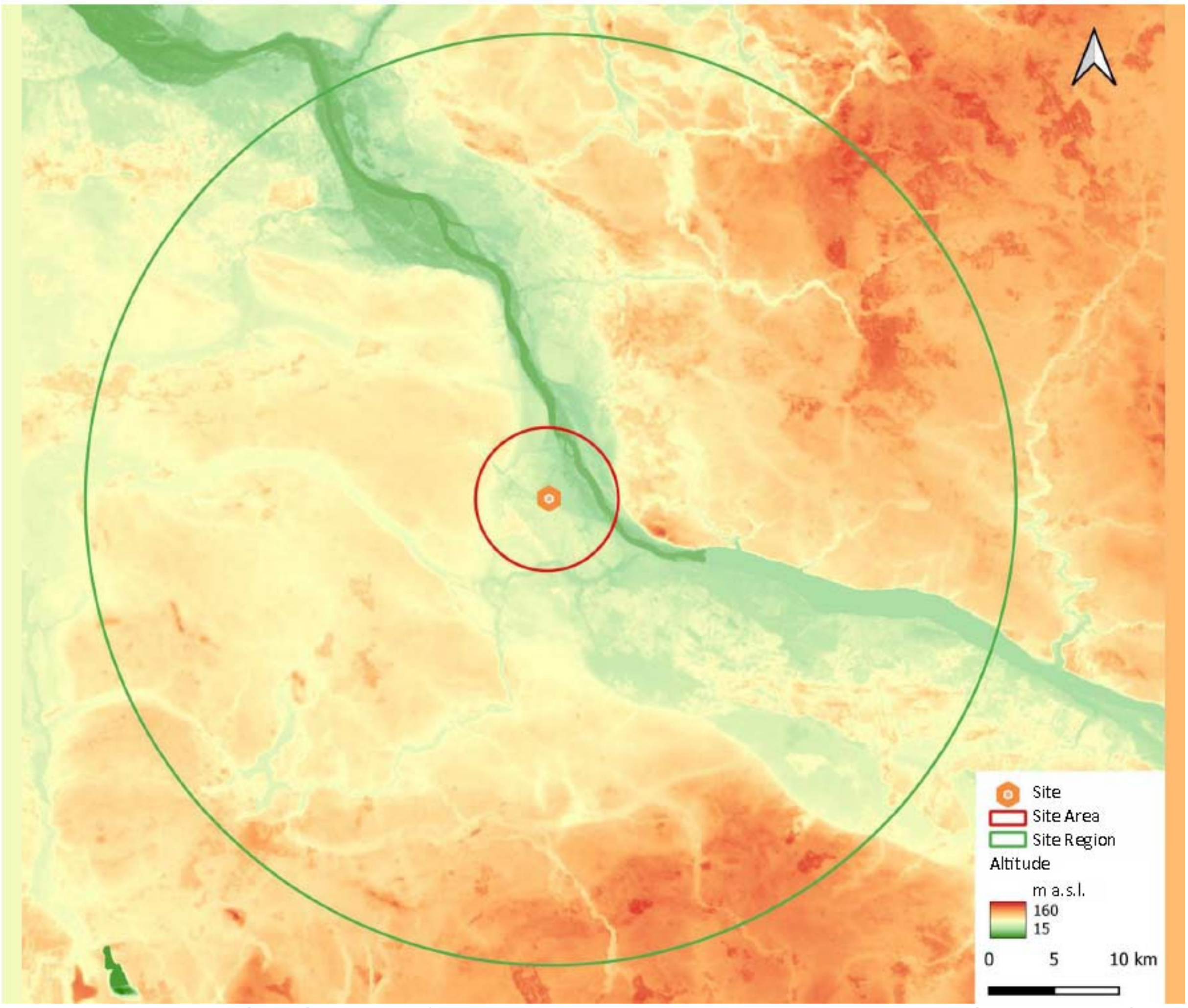

Figure 17. Topography of the Site Region (source: Preliminary analysis and site evaluation report for the nuclear facility (Włocławek, Włocławek district), Central Mining Institute, Katowice 2023)

GEOLOGICAL STRUCTURE 8.2

The oldest formations drilled in the Site Region are Jurassic deposits formed as limestones and marls, representing a basis for chalk or tertiary formations. Quaternary deposits reach a thickness of about 90 m and are deposited on eroded tertiary formations and on the Lower Cretaceous or Late Jurassic formations – a minimum depth of 75 m BGL. Quaternary cover consists of Pleistocene and Holocene formations. In Pleistocene formations, incoherent river sediments formed as fine, medium and coarse sands are dominant. The top of non-cohesive formations is located at a depth of 0.4-0.7 m below ground level. On the other hand, locally in Holocene formations there are peats with a thickness of 0.6–0.7 m.

According to the information contained in the Detailed Geological Map of Poland (sheet 402 – Bobrowniki), the area of the Site, as well as the area within which it is planned to locate technical infrastructure, i.e., cooling water channels and power connection lines, mainly consists of sands and river sands and gravels of river of meadow terrace.

In the central part of the area designated for the location of power units, peats with a thickness of about 0.6–0.7 m are found in Holocene formations.

Karst phenomena 8.2.1

Karst processes involve the chemical dissolution of rocks by surface and groundwater leading to the formation of rock voids and caves. Limestones, as well as dolomites, marls, gypsum, anhydrite, and halite are mainly subject to the Karst phenomenon.

No Karst formations were found in the Site Area. This is due to the fact that the geological structure excludes the occurrence of Karst processes in the area (there is no bedrock susceptible to Karst processes), and databases and literature do not identify Karst forms such as caves in the Site Area.

Suffosion phenomenon 8.2.2

Suffosion is the outwashing and leaching of mineral particles from detached rocks or rocks which are poorly bound by water perlocating into the permeable subsoil, which occurs most often in loesses, saprolite covers, and glacial deposits. The phenomenon may lead to the formation of free spaces (voids) in rocks and therefore to the settlement of overlying rock layers, occurring on the land surface by the formation of characteristic land forms – holes, potholes, and basins. The condition necessary for the occurrence of the phenomenon is to increase the hydraulic gradient to the level of the critical gradient, which is practically impossible in the subsurface and groundwater conditions of the Site. Therefore, it should be concluded that the phenomenon of suffosion in the Site premises and Site Area will not occur.

Landslides 8.2.3

A landslide is a geological form occurring in the terrain relief, created as a result of gravitational displacement along the slip plane, flow or detachment of rock material, in particular, rocks, saprolites, soils, and fills. Landslides may cause damage to infrastructure, crops, forest stands, and general degradation of land subject to mass soil movements.

An analysis of data provided by the Polish Geological Institute – National Research Institute (PIG-BIP) shows that there are no large landslides in Site vicinity, but only landslips of up to a few tens of square meters located on the banks of the Vistula River.

The topography analysis conducted showed the absence of slopes near the Site, which excludes the risk of landslides that may threaten the safety of the planned Investment Project.

TECTONIC STRUCTURE 8.3

For the preliminary evaluation of the Włocławek Site in terms of factors that would preclude the site from being considered suitable for the location of a nuclear facility, preliminary analyses were carried out by IGF PAN on the fault activity and seismicity of the Site Region and its immediate vicinity.

The Włocławek area is characterized by a small number of faults; all of them in the NW-SE direction. As a rule, they do not connect to each other. The oldest faults (northeast of Włocławek) occur on the sub-Permian area, i.e., they are older than approx. 295 million years. Most of the faults are related to the inversion of the Mid-Polish Trough at the turn of the Cretaceous and Paleogene period (60–70 million years). These faults may partially reactivate older structures in the deep substrate that are associated with the Teisseyre-Tornquist Zone. The youngest signs of tectonics in Neogene are related to Damasławek depression located 90 km northwest of the Site. All tectonic activity ceased there in Serravallian, that is to say, it was not younger than 12 million years.

In the Site Region, there are geological formations in the form of salt pillows and there are no traces of their activity in the last 12 million years. Salt tectonics can trigger tectonic deformations or significant overburden growth. There are no grounds for these in the case of the Włocławek Site. The Neogene and Quaternary sediments do not have any deformations other than glacitectonic ones, and the increase of the sedimentary overburden is small (tens of meters) and slow. Therefore, there are no factors that could lead to the activation of salt tectonics.

The tectonic features of the Site Region and its surroundings are shown in Table 7.

Feature	Site Region and its surroundings
Faults entombment	200-300 m under Paleogene, Miocene and Quaternary formations
Age of activity	Before Serravallian (late middle Miocene) > 12 million years After Carboniferous < 300 million years (north-eastern part of the analyzed area) or after the Turonian (late Cretaceous) < 90 million years

Table 7. Tectonic features of the Site Region and its surroundings (source: Report on preliminary seismicity assessment for the nuclear facility (Włocławek, Włocławek district) Institute of Geophysics of the Polish Academy of Sciences, Warsaw 2023).

Poland, including the Włocławek area and, in particular, the Site Region and Area, and the Site itself, are classified as very low seismic areas (aseismic area). Therefore, from the point of view of the nuclear facility safety, an important period of fault activity analysis in the Site Area and Region refers to the period from Pliocene to Holocene, i.e., approximately the last 5.3 million years[14] . The faults in the Site Region are much older. The analysis showed that the last fault activity took place more than 12 million years ago, in Sarmatian in Miocene. Therefore, the faults in the Site Region can be considered as not having the potential to generate natural seismic shocks.

SEISMIC CONDITIONS 8.4

Poland, including the Włocławek area and, in particular, the Włocławek Site Region, are classified as very low seismic areas. According to the current state of knowledge, the macroseismic intensity for the strongest earthquake recorded historically in Poland in the last millennium and using instruments since the 1960s never reached 8 in the EMS-98 scale (Guterch, 2009).

In order to assess the seismic conditions of the Site, the identification of Poland's seismogenic zones was performed and the seismogenic potential of these zones was assessed based on the reconnaissance of Poland's seismic activity, analysis of historical earthquakes, and analysis of data acquired with instruments carried out by B. Guterch (2009, 2015), and on the basis of literature information.

Subsequently, the maximum potential magnitudes of shocks that can be generated by these zones and the possible surface effects of these shocks in the Site were determined.

The highest accelerations of ground vibrations, assuming the worst-case scenario, that may occur at the Site were provisionally estimated at the level of PGA = 0.071 g.

MINING ACTIVITIES 8.5

The analysis performed by the Central Mining Institute assessing the effects of current and historical mining activities in the Site Region indicates that there is no potential impact of such economic activities on the safe operation of the nuclear power plant at the Site. The analysis covered:

- range of natural resources deposits,
- effects of historical mining activities,
- range of mining lands,

14 Seismic Hazards in Site Evaluation for Nuclear Installations, Specific Safety Guide 9 Rev. 9, IAEA, 2022

Location of deposits 8.5.1

The analysis of natural deposit distribution allows the determination of potential locations of future mining operations areas and mining lands that may affect the environment and facilities on the ground surface. As defined in the Geological and Mining Law Act (Journal of Laws of 2023, item 633), the term mineral deposit should be understood as the natural accumulation of minerals, rocks, and other substances whose extraction may bring an economic benefit. Mining of the deposit can be done through underground and open pit mining plants or boreholes.

In total, more than 160 deposits are documented in the Site Region. The vast majority are deposits of sands, gravels, and lignite occupying small areas. In addition, there are documented and exploited deposits of chalk, clay raw materials, building ceramics, medicinal water deposits, and peat deposits in the Site Region.

There are 5 mineral deposits in the Site Area, including 1 lignite deposit and 4 sand and gravel deposits. A documented deposit not far from the boundaries of the planned NPP site is the Brzezie lignite deposit. The deposit boundary runs at a distance of less than 100 m from the Site boundary in the western direction.

The likelihood of deposit exploitation in the future is very low due to the high negative environmental impacts of the mining and combustion of lignite as well as the tendency of the energy sector to move away from fossil fuels.

The Site Area in view of mineral deposits are shown in Figure 18.

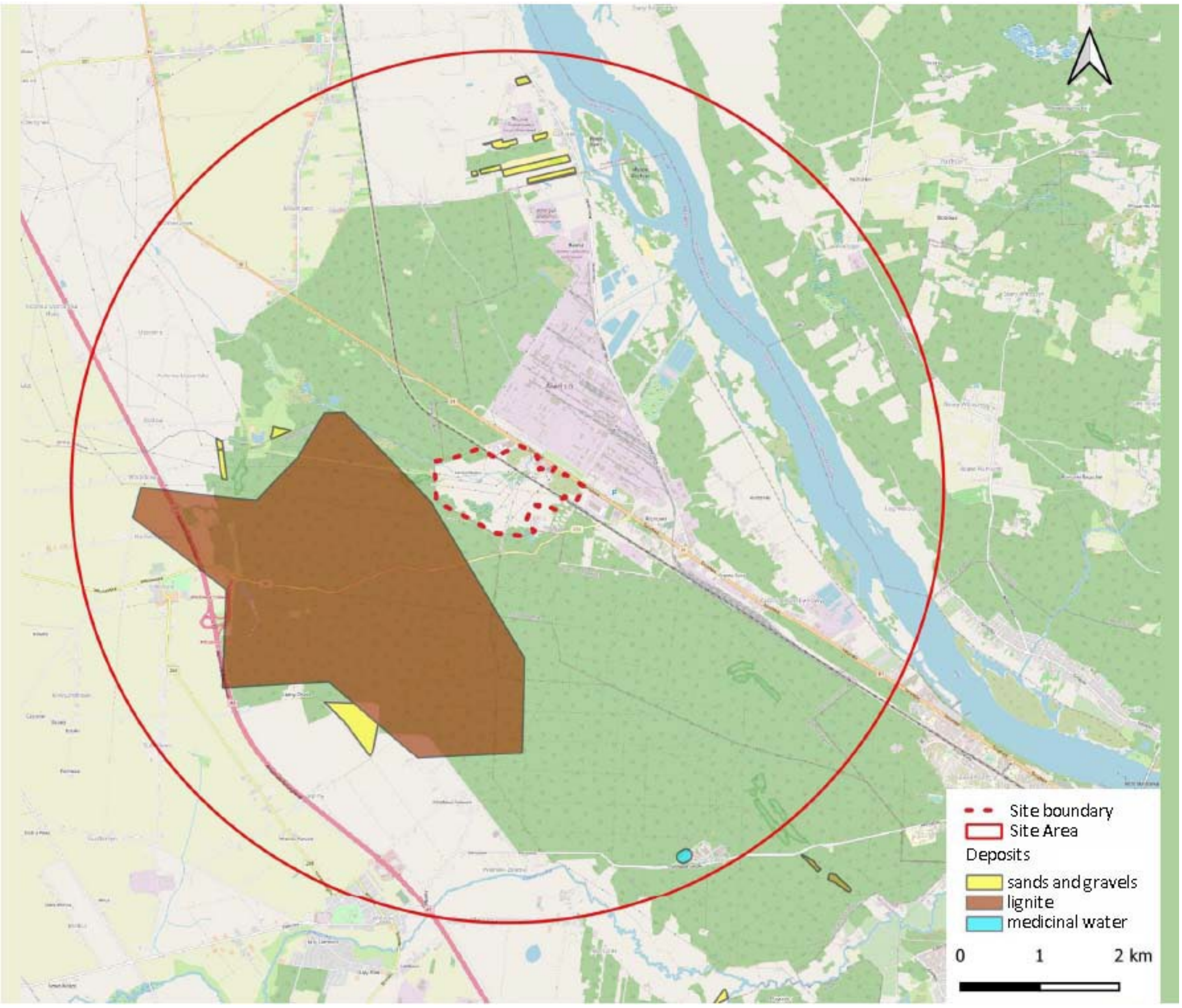

Figure 18. Location of deposits in the Site Area (Source: Preliminary analysis and site evaluation report for the nuclear facility (Włocławek, Włocławek district), Central Mining Institute, Katowice 2023)

In the case of the construction of a nuclear facility, the potential issue of a license for the extraction of deposits in the Site Area and the designation of a mining land will have to meet, in accordance with the Geological and Mining Law, the safety conditions for the facility. Under Article 104, mining operations areas and mining lands should be included in the land use plan and spatial development plan of the commune and in the local development plan. In accordance with point 5 of Article 104, the Plan may in particular specify the facilities or areas for which a protecting pillar is determined, within the boundaries of which mining plant operation may be prohibited or allowed only in a manner ensuring proper protection of these facilities.

Mining lands 8.5.2

As defined in the Geological and Mining Law Act (Journal of Laws of 2023, item 633), the term “mining land” should be understood as the area covered by the expected harmful impact of mining works of the mining plant. Conducting underground extraction of deposits, regardless of geological and mining conditions, may cause the formation of continuous deformations observed, among others, in the form of subsidence basins. The analysis of the location of mining lands allows the determination of the risk of revealing of the extraction effect within the Site and the impact on a nuclear facility.

In the Site Area, there are mining areas of medicinal water deposits as well as sands and gravels. The Site is approx. 1.0 km away from the border of the nearest mining area (Wieniec medicinal water reservoir). None of the listed mining lands covers the Site area (Fig. 19).

In addition, mining lands established for deposits of the following minerals: sands and gravels, clay raw materials, building ceramics, lignite, medicinal water, and peats are located in the Site Region.

The lack of mining lands covering the Site area indicates that there are no expected outcomes of the current mining activities, including subsidence, collapses, and overflow land.

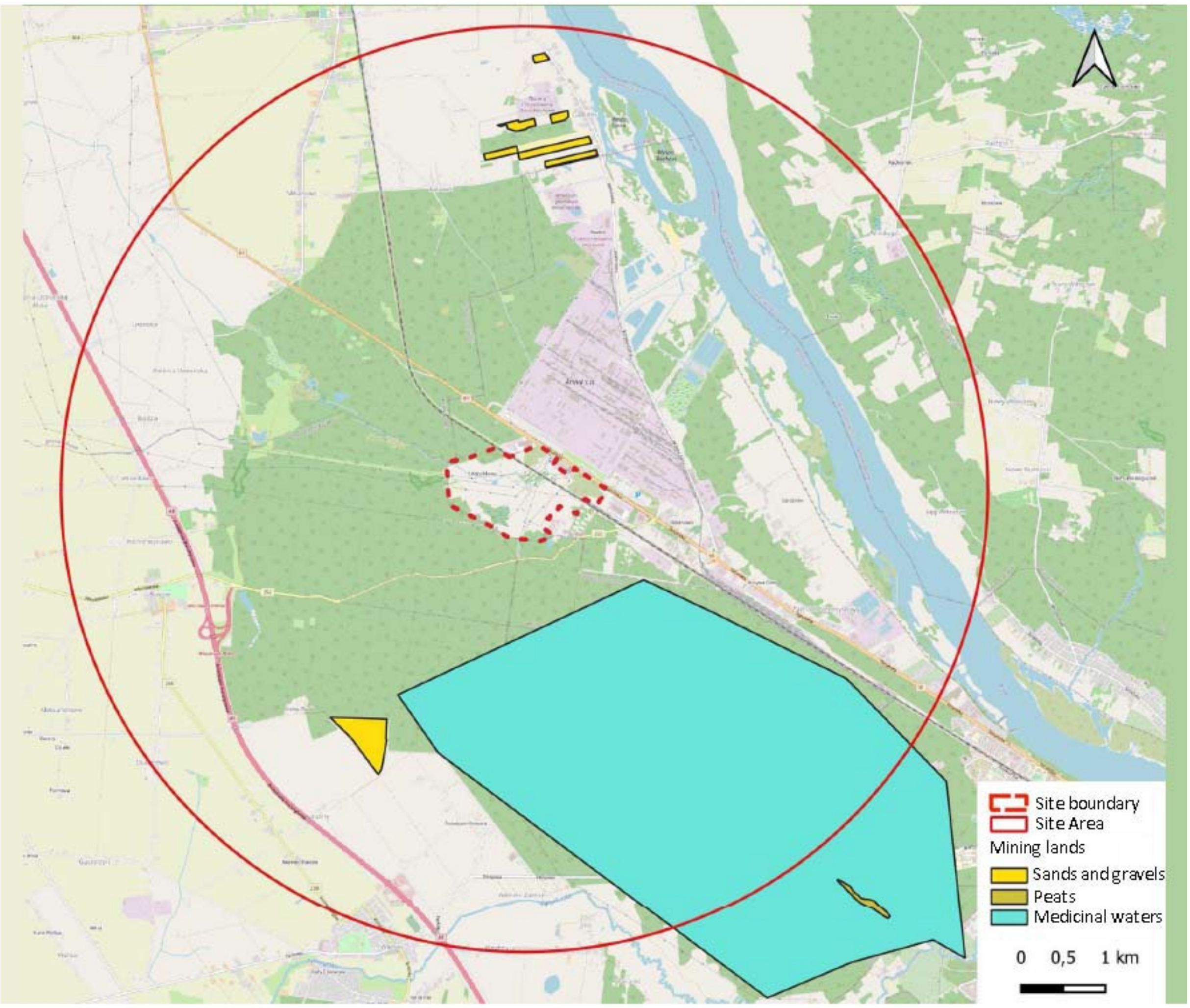

Figure 19. Mining lands in the Site Area (source: Preliminary analysis and site evaluation report for the nuclear facility (Włocławek, Włocławek district), Central Mining Institute, Katowice 2023)

Effects of current mining activity 8.5.3

Mining areas of medicinal waters (Wieniec deposit) and sands and gravels were established in the Site Region. The exploitation of these deposits does not cause negative environmental effects, such as in the case of the exploitation of hard coal deposits. Both the Wieniec deposit mining area and the sand and gravel deposits are located at a significant distance from Site boundaries. Therefore, it is necessary to exclude the possibility of the impact of ongoing exploitation in the Site Region, which could affect safety at the Site.

Effects of historical mining activities 8.5.4

In the Site Region, there were no mining operations in deep mines, thus the effects of historical mining activities related to such operations (soil discontinuities or collapses) are impossible.

The exploitation of aggregates and medicinal waters takes place on a small scale at a significant distance from the Site boundaries (the nearest aggregate mine is at a distance of 2.6 km and the mining land of medicinal water mine is at a distance of 1.0 km), hence the conclusion that their presence does not pose any threat to the Project located in the planned Site. In the analyzed area, there were also no abolished mining areas. Therefore, the occurrence, also in the future, of negative effects of historical mining operations should not be assumed.

The lack of historical mining activity in the Site Area, consisting in the exploitation of raw materials, which may cause negative effects after the cessation of mineral extraction, allows to conclude that there are no risks to the safety of to the planned Project.

Summary of the analysis of mining activities 8.5.5

Analyses conducted by GIG experts as part of the preliminary assessment of the location of the planned Nuclear Power Plant in the field of mining activities carried out in the Site Region lead to the following conclusions:

- The absence of historical mining activities in the Site Area, involving the exploitation of raw materials, which could cause negative impacts on civil structures even after the deposit has ceased to be exploited, allows us to conclude that there is no risk of negative impacts from these activities in the Site.

- The lack of mining lands covering the Site area indicates that there are no possibility of occurrence of expected outcomes of the current mining activities, including subsidence, collapses, and overflow land.
- The current prospecting licenses cover an area well away from the Site. Even if a mining license is granted and mining begins, the significant distance of the potential mine from the Włocławek Site will not generate a threat to the nuclear facility.

The mining activities conducted in the past do not pose any risk of subsidence and other negative effects in the Site Region. Effects of the historical mining activities that would create a risk for a nuclear facility at the Site should not be assumed to occur.

In conclusion, the current and historical mining activity does not pose a risk to the nuclear safety for the foundation of the nuclear facility in the Włocławek Site.

HYDROGEOLOGICAL CONDITIONS 8.6

The Włocławek Site is located in the southeastern part of the Hydrogeological Map of Poland at a scale of 1:50 000 (sheet 402 – Bobrowniki). According to the explanatory notes to the aforementioned map, the Site belongs to the hydrogeological unit of Wielkopolska region (VI), Gniezno-Kuyavian subregion (VI_3), Gniezno-Kuyavian region, a part of the Wielkopolska mining valley (VI_{3A}).

The exploitable aquifers on the sheet are: the Quaternary aquifer (the main exploitable aquifer), the Tertiary aquifer (found on a large part of the sheet).

The Włocławek Site is located within the 12aQII hydrogeological unit.

In 2013, on behalf of Polskie Sieci Elektroenergetyczne S.A., a number of geoengineering boreholes were drilled in the area of the current "Włocławek Azoty 220/110 kV" substation bordering the site of the planned Project from the northeast for geological investigation of the surveyed area. The boreholes drilled revealed the presence of one aquifer in the documented substrate. The aquifer is associated with Quaternary coarse sands of fluvial origin. The water surface of the first aquifer is of a free nature stabilized at a depth of 4.3-4.5 m BGL[15], and the flow of water of this zone is in the northeastern direction, i.e., in the direction of the Vistula River.

According to the content of the Hydrogeological Map of Poland, the capacity of a potential drilled well at the Site is more than 70 m^3/h, and in the corridors of technical infrastructure (power output by direct line and cooling water channels) is 30–50 m^3/h, and for the industrial water intake of the Anwil plants exceeds the capacity of 42 m^3/h. Water quality within the hydrogeological unit covering the Site was determined as good but requiring simple treatment. The degree of risk of the aquifer contamination was

15 Based on geological borehole sheets (source: CBDG, online access: 04.2023)

determined to be medium within the boundaries of the Site, and in the area of industrial development the degree was determined to be high and very high due to the spot contamination centers found (the presence of the Anwil plants).

Areas without a usable water bearing zones have been allocated within the sheet: within unit No. 12, in the area located between the Anwil plants and the Vistula River, where a number of waste tanks and landfills have been located. Water quality in this place is systematically tested in the local monitoring network. Due to the tests heavy water contamination was documented. Therefore, the area was separated as an area without exploitable aquifers.

MAJOR GROUNDWATER RESERVOIR 8.7

The planned area intended for the power units is located within the documented Major Groundwater Reservoir (GZWP) No. 220 – Middle Vistula Ice-Marginal Valley. The entire reservoir has an approved major groundwater reservoir disposable resource of 200,000 m^3/d and the average depth of groundwater intakes is 60 m. The major groundwater reservoir is located in a pore medium in Quaternary formations.

In addition to the aforementioned major groundwater reservoir No. 220 – Middle Vistula Ice-Marginal Valley, Reservoir No. 144 Wielkopolska Mine Valley (at a distance of about 4.3 km) and Reservoir No. 215 Warsaw Subbasin (at a distance of about 8.1 km) are located in the Region of the planned Project Site.

Both the power output infrastructure and the cooling water pipelines, including the water intake and pumping station, are outside the range of the major groundwater reservoir (Fig. 20).

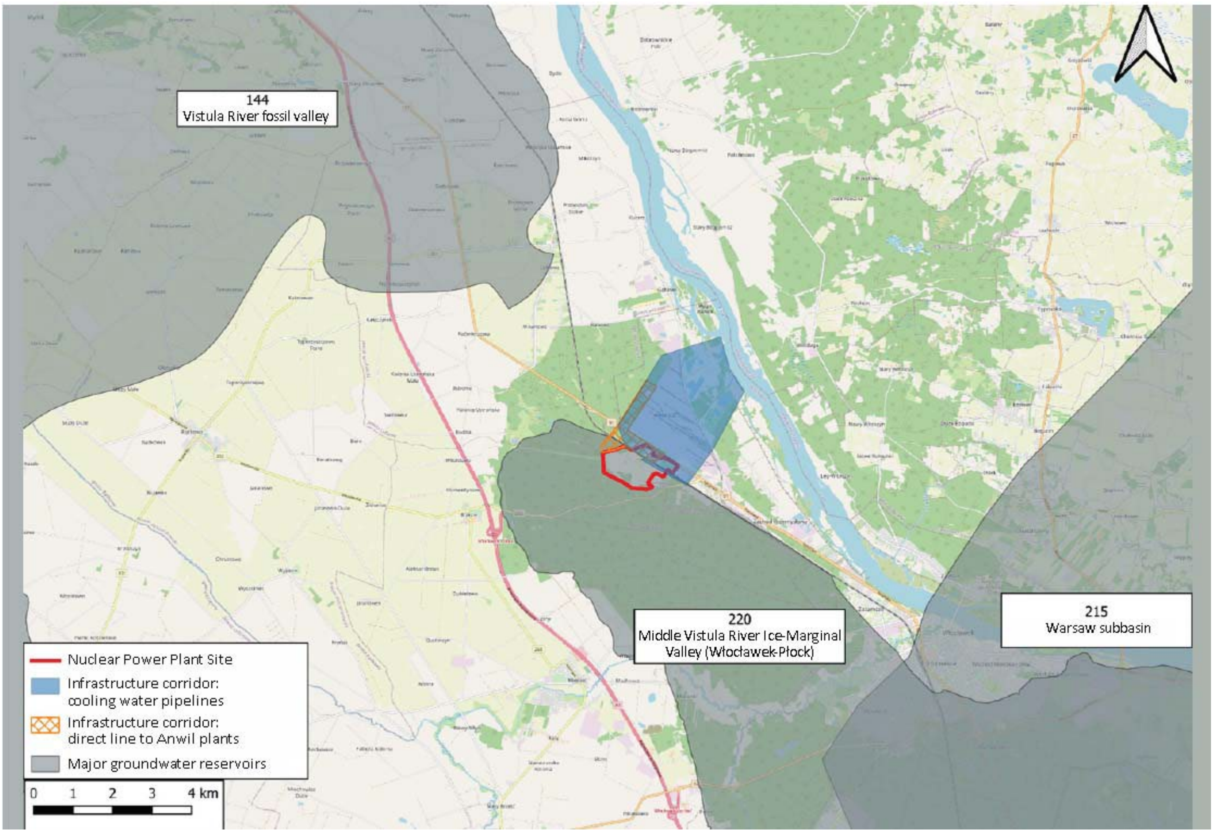

Figure 20. Włocławek Site in view of the major groundwater reservoir (source: study using data from the Public Information Bulletin of the Central Geological Database of the Polish Geological Institute, OpenStreetMap)

GROUNDWATER BODIES 8.8

According to the definition given in the Water Framework Directive (WFD), groundwater bodies include groundwater that occurs in aquifers with porosity and permeability that allow abstraction that is significant in the supply of water to the population or flow at a rate that is significant in shaping the desired condition of surface water and terrestrial ecosystems.

The planned location of the Investment Project is within the range of the following groundwater bodies (Table 8, Fig. 21).

	Groundwater body code	Basin area	Chemical status	Quantity status	General condition	Assessment of risk of failing to meet the environmental objectives
Project Site	PLGW200045	Vistula	Good	Good	Good	Not at risk
Groundwater bodies in the vicinity of the planned project	PLGW200046		Good	Good	Poor	Not at risk
	PLGW200047		Good	Good	Good	At risk
	PLGW200048		Good	Good	Good	Not at risk

Table 8. Groundwater bodies within and adjacent to the area of the planned Project (source: characteristics of groundwater bodies, ISOK).

According to the Vistula River Basin Management Plan (in the vicinity of the Site of the planned Project), the overall assessment of the condition of the groundwater bodies with codes PLGW200045, PLGW200047, and PLGW200048 has been determined as good and is the good assessment result of both chemical and quantitative status. Only for the groundwater body with code PLGW200046, despite its good chemical and quantitative condition, the overall condition have been determined as poor.

Among listed groundwater bodies, only the groundwater body with code PLGW200047 is at risk of failing to meet the environmental objective due to anthropogenic pressure/impact and threat (Table 8).

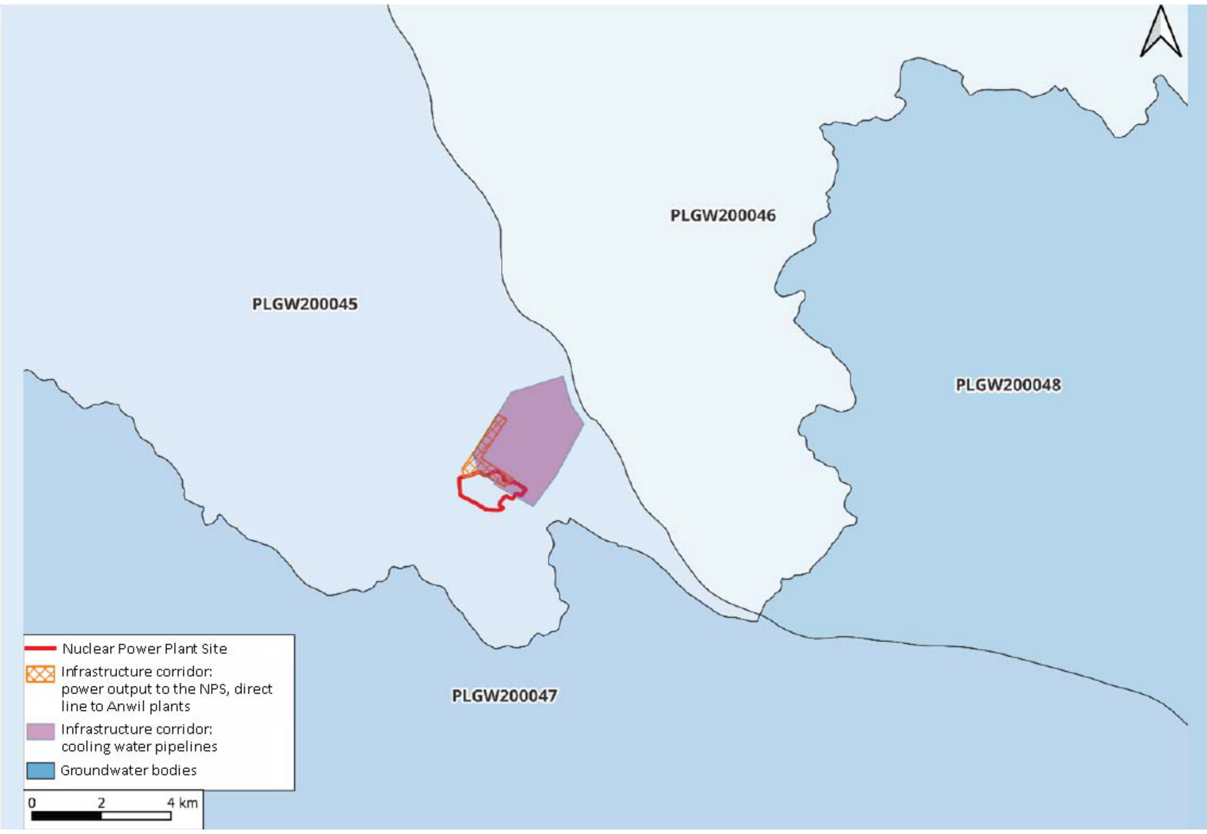

Figure 21. Groundwater bodies (Source: own study using materials from the Public Information Bulletin of the Central Geological Database of the Polish Geological Institute)

The results of the studies carried out in connection with the implementation of the Investment Project will be considered in terms of assessing the risk of failing to achieve the environmental objectives set for these groundwater bodies in the Vistula River Basin Management Plan and taking into account the findings and actions contained in the National Water and Environment Program.

HYDROLOGICAL CONDITIONS 8.9

According to the explanatory notes to the Hydrogeological Map of Poland at a scale of 1:50 000 (Sheet 402 – Bobrowniki), Warsaw 2002, the Site is located in the Vistula River basin. In this section, the Vistula is a braided river – it flows in a series of river beds separated by numerous old river beds and islands.

The Ośla River belonging to the surface water body No. RW20001727929 runs through the Site Area. During the site visits, the flow in the upstream river bed was found and its disappearance was observed in the Site Area. Reconstruction of the riverbed will be necessary in connection with the Project implementation. At this stage, no final decision has been made on the river transformation. Among the possible solutions the following are considered:

- regulation of the riverbed and redirection of water away from the Site area
- constructing a canal for a section of the river at the Site area.

Within a radius of up to 15 km from the Site, there are also watercourses of the third order and smaller ones, e.g., Zofijka, Lubieńka, Kanał Bachorze, Kanał Zuzanka, Rakutówka, all of which are located in the Vistula basin.

Streamgage points were identified at the Vistula and Zgłowiączka river for measuring the status of waters, and they can be used to determine the flow rate in the river. The "Włocławek" streamgage is located at the Vistula at km 262 + 12 of its course. The "Włocławek-Ruda" streamage is located at the Zgłowiączka river at km 1491 + 83 of its course.

Table 9 and Table 10 below summarize the characteristic flows from the multi-year period for the "Włocławek" streamgage at the Vistula and for the "Włocławek-Ruda" streamgage at the Zgłowiączka river (in accordance with the National Water Management Authority (KZGW) data – Report on the preparation of flood hazard maps and flood risk maps for the calculation period from 1951 to 2010) and the Institute of Meteorology and Water Management (IMGW) data. In the case of the "Włocławek" streamgage at the Vistula, the Table 9 also comparatively presents data for 2010-2021. No significant differences have been identified between the data submitted.

Characteristic flows [m^3/s]	Measuring line		Difference [%]
	1961-2010	2010-2021	
	Włocławek streamgage	Vistula)	
WWQ	6950	6560	- 5.6
SWQ	3443	3051	- 11.4
SNQ	291	252	- 13.4
SSQ	916	998	+ 9.0
NNQ	160	138	- 13.8

WWQ – the highest flow over a multi-year period, SWQ – average of the highest annual flows (WQ) over a multi-year period, SSQ – average flow from annual averages, SNQ – average of the lowest annual flows (NQ) over a multi-year period, NNQ – the smallest flow over a multi-year period

Source: KZGW – Report on the preparation of flood hazard maps and flood risk maps; IMGW (https://danepubliczne.imgw.pl)

Table 9. Characteristic flows from the multi-year period – the Włocławek streamgage (Vistula) (source: Preliminary analysis and site evaluation report for the nuclear facility (Włocławek, Włocławek district), Central Mining Institute, Katowice)

Characteristic flows [m^3/s]	Measuring line 2010–2021 Włocławek-Ruda (Zgłowiączka)
WWQ	327
SWQ	146
SNQ	66
SSQ	91
NNQ	61

Source: KZGW – Report on the preparation of flood hazard maps and flood risk maps; IMGW (https://danepubliczne.imgw.pl)

Table 10. Characteristic flows from the multi-year period – the Włocławek-Ruda streamgage (Zgłowiączka) (Source: Preliminary analysis and site evaluation report for the nuclear facility (Włocławek, Włocławek district), Central Mining Institute, Katowice 2023)

SURFACE WATER BODIES 8.10

A surface water body means a separate and significant element of surface water, such as:

a. lake or other natural water reservoir,

b. artificial water reservoir,

c. small stream, brook, stream, river, channel or parts thereof,

d. internal marine waters, transitional waters or coastal waters.

A SWB with code RW20001727929 was identified within the Site (Fig. 22). During the site inspections conducted by the Central Mining Institute (GIG) specialists at the Site (February 2023), the flow in the river bed, along the section of the planned Project, was unnoticeable, and traces indicate a permanently dry river bed. A site inspection conducted in April 2023, however, revealed that water flows in the upper part of the Ośla River. In addition, SWB have been identified in the vicinity of the planned Project, a list of which, along with their characteristics, can be found in Table 11.

Code of the surface water body	Name of the surface water body	River basin	Type of the surface water body	Assessment of the status of the surface water body (general condition)	Chemical status (assessment of the status for 2010–2012)	Status of the surface water body	Evaluation of ecological status/potential according to 2010–2012 assessment	Assessment of risk of failing to meet the environmental objectives
RW20001727929	Ośla	Vistula River basin area	Surface flowing water, 17	Bad	BGS_av	NWB	Moderate	At risk
RW200017279329	Mołtawa		Surface flowing water, 17	Good	Good	NWB	Good	At risk
RW20002027879	Zgłowiączka from Chodeczka to Lubieńka excluding Lubieńka		Surface flowing water, 20	Bad	Good	NWB	Moderate	At risk
RW20002127935	Vistula from the border of the Lower Vistula Water Region to the tributary from Sierzchów		Surface flowing water, 21	Good	Good	HMWB	Good and above good	Not at risk
RW20001727914	Tributary from the Wilczeniec region		Surface flowing water, 17	Good	Good	NWB	At least good	Not at risk
RW20001727912	Tributary from the Bogucin region		Surface flowing water, 17	Bad	BGS	NWB	Below good	Not at risk
RW20002127911	Vistula from the outflow from the Włocławek Lake to the border of the Middle Vistula Water Region		Surface flowing water, 21	Bad	Good	HMWB	Moderate	At risk
RW20001727934	Tributary from Gnojna		Surface flowing water, 17	Bad	Good	NWB	Below good	At risk
RW200017275899	Chełmiczka		Surface flowing water, 17	Bad	Good	NWB	Poor	At risk
RW200017275989	Tributary from the Tupadelskie Lake excluding Chełmiczka		Surface flowing water, 17	Bad	Good	NWB	Moderate	At risk
RW20002427729	Zuzanka from Struga to the river mouth		Surface flowing water, 24	Bad	Good	HMWB	Moderate	At risk
LW20023	Ostrowite		Lake	Bad	-	NWB	Bad	At risk
LW2025	Chełmica		Lake	Bad	-	NWB	Moderate	At risk
RW20000275999	Włocławek Lake		Surface flowing water, 0	Bad	BGS	HMWB	Moderate	At risk

Table 11. Characteristics of surface water bodies in the vicinity of the planned Project (Source: characteristics of SWB, ISOK)

Among the identified SWB in the area and in the vicinity of the planned Project site, only the SWBs with codes RW20001727912, RW20001727914, RW20002127935 were assessed as not at risk of failing to achieve the environmental objective of water status. The remaining surface water bodies, due to anthropogenic pressure on water status caused by municipal management and industry, were assessed as at risk of failing to achieve the environmental objective of water status.

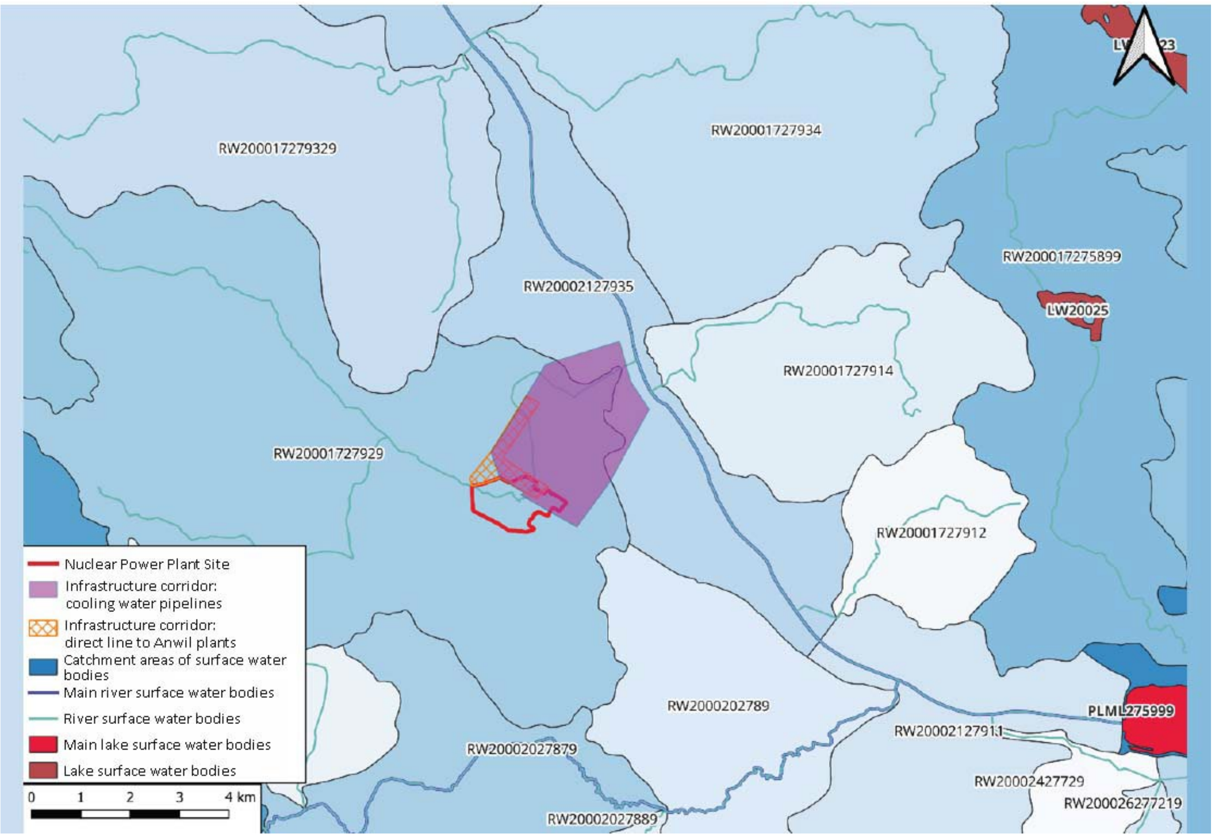

Figure 22. Planned site in view of SWBs (Source: own study using materials from the Public Information Bulletin of the Central Geological Database of the Polish Geological Institute)

The results of the studies carried out in connection with the implementation of the Project will be considered in terms of assessing the risk of failing to achieve the environmental objectives set for these groundwater bodies in the Vistula River Basin Management Plan and taking into account the findings and actions contained in the National Water and Environment Program.

FLOOD RISK 8.11

According to the Flood Risk Map (data as of April 2023), the Nuclear Power Plant Site is not at risk of natural flooding, i.e., resulting from unfavorable weather conditions with a probability of occurrence of 0.2%, 1%, 10% (once in 500, once in 100, and once in 10 years, respectively). Only the water intake with the pumping station and a small part of the infrastructure corridor (cooling water channels), depending on their final location, may be within an area at risk of flooding with the probability of 0.2% (once in 500 years). At a distance of approx. 12 km southeast of the Site, the Włocławek Hydropower Plant – the largest run-of-river power plant in Poland – is located on the Vistula River (Fig. 23).

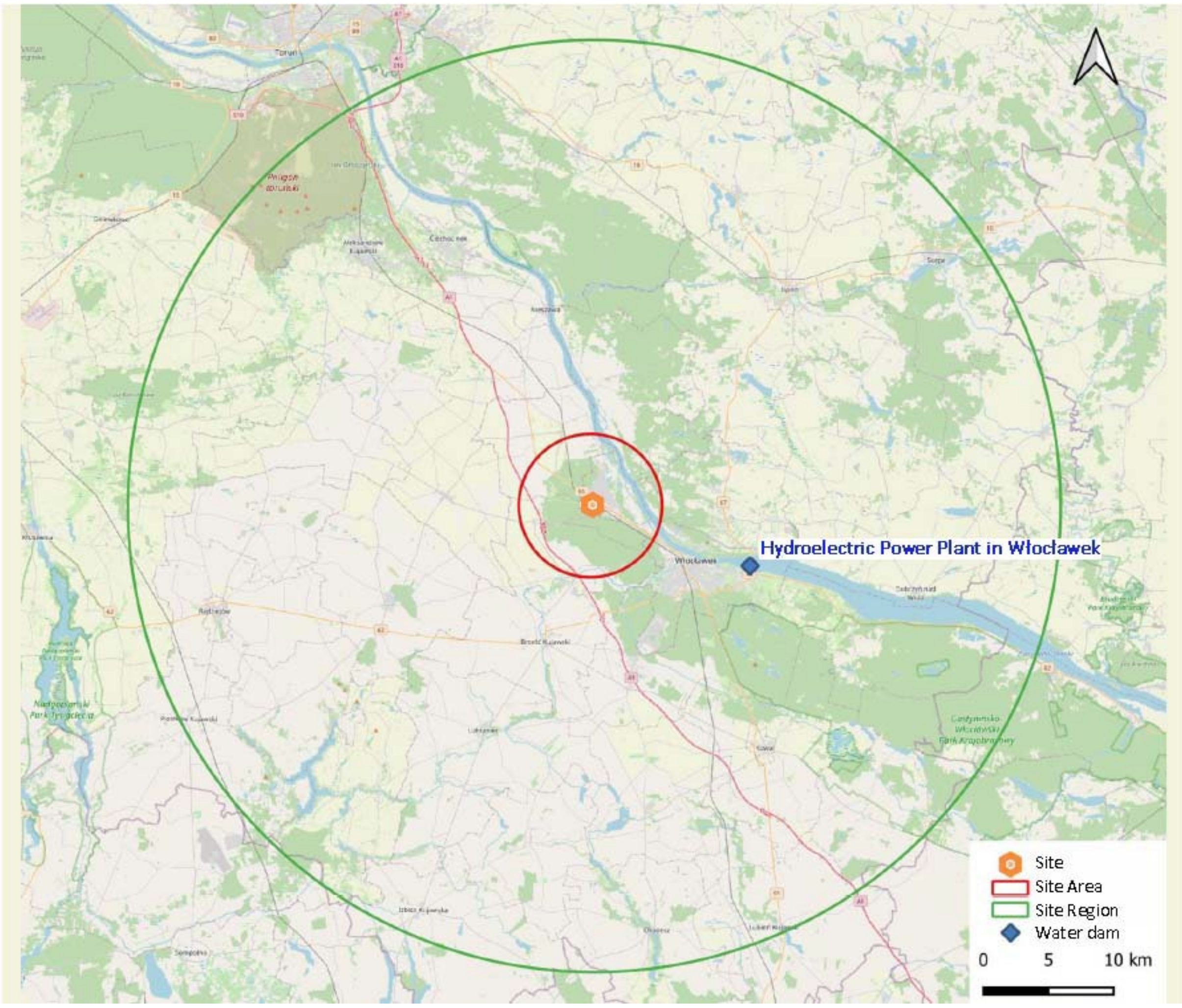

Figure 23. Location of the Hydroelectric Power Plant in Włocławek (Source: Report on preliminary analysis and assessment of site conditions for a nuclear facility (Włocławek, Włocławek district), Central Mining Institute, Katowice 2023)

Despite the relatively short distance of the dam, the Site is located outside the flood risk zone resulting from the damage to the dam. Analyses performed as part of the IT System of National Protection (ISOK) project have shown that in the event of a failure involving damage to the dam of the Włocławek lake as a result of water overflowing through the dam body under conditions of the passage of a control wave with a probability of occurrence of 0.3% with simultaneous failure of discharge facilities, the Site is not at risk of flooding. The flood risk does not apply to the Site also in the case of complete destruction of the flood embankment on the Vistula River, and its range is identical to the range of the flood risk resulting from the damage to the dam in Włocławek (Fig. 24). Only the water intake and a small part of the infrastructure corridor (cooling water pipeline), depending on their final location, may be within the flood risk area.

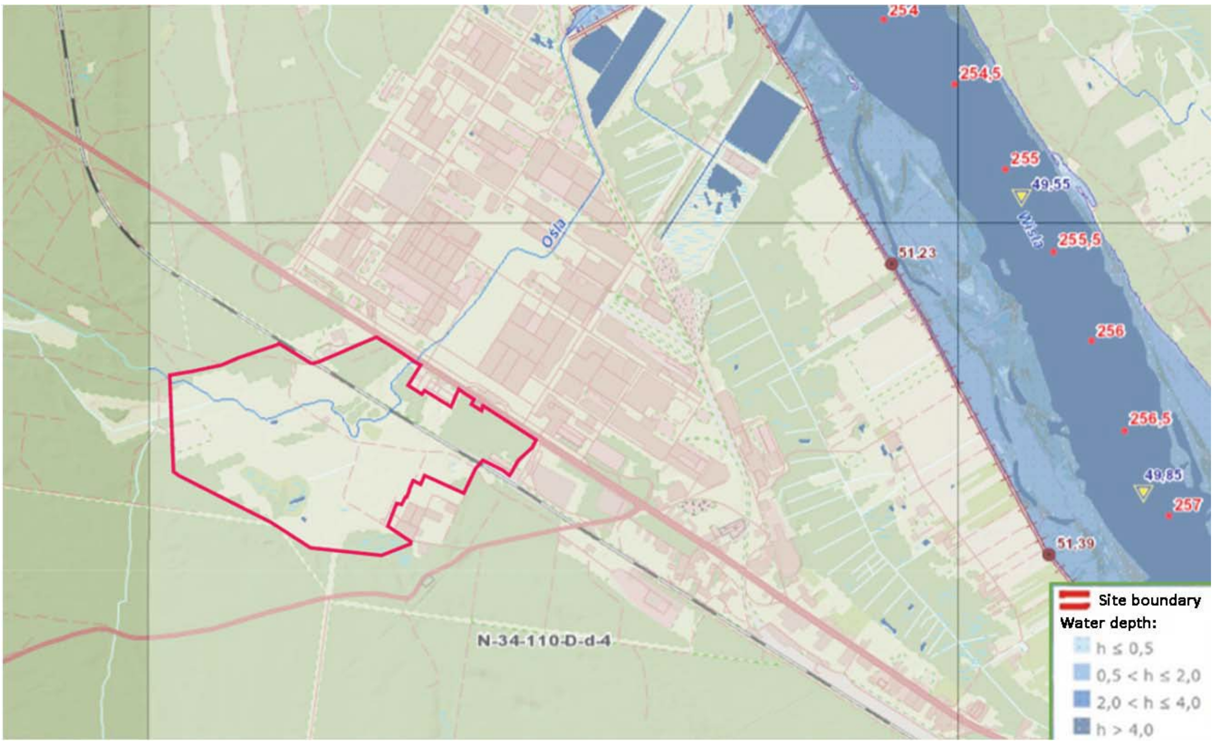

Figure 24. Flood risk as a result of dam damage in Włocławek (Source: Preliminary analysis and site evaluation report for the nuclear facility (Włocławek, Włocławek district), Central Mining Institute, Katowice 2023, based on https://wody.isok.gov.pl/ (access on March 20, 2023))

The above threat will be analyzed at the stage of detailed environmental and location studies, and if the threat is confirmed at the design stage, the threat will be taken into account in the development of the architectural and construction design.

RISK OF FLOODING 8.12

Flooding most often occurs in the vicinity of river valleys as a result of the rise of the groundwater table. The range of this phenomenon should not be identified with the flooding zone of surface waters and floods. Flooding results directly from the groundwater level and not from an increase of water levels in river beds.

According to the Flooding Risk Map prepared by the Polish Geological Institute – National Research Institute, the planned Nuclear Power Plant Site is not located in an area at risk of flooding due to its geological structure and location in the flood plain of the Vistula River (Fig. 25). Only the water intake with the pumping station and a small part of the infrastructure corridor (cooling water channels), will be in an area at risk of flooding, however, due to the nature of this part of the Project, this will not pose a threat.

The above issue will be analyzed at the stage of detailed site surveys and will be taken into account in the development of the architectural and construction design.

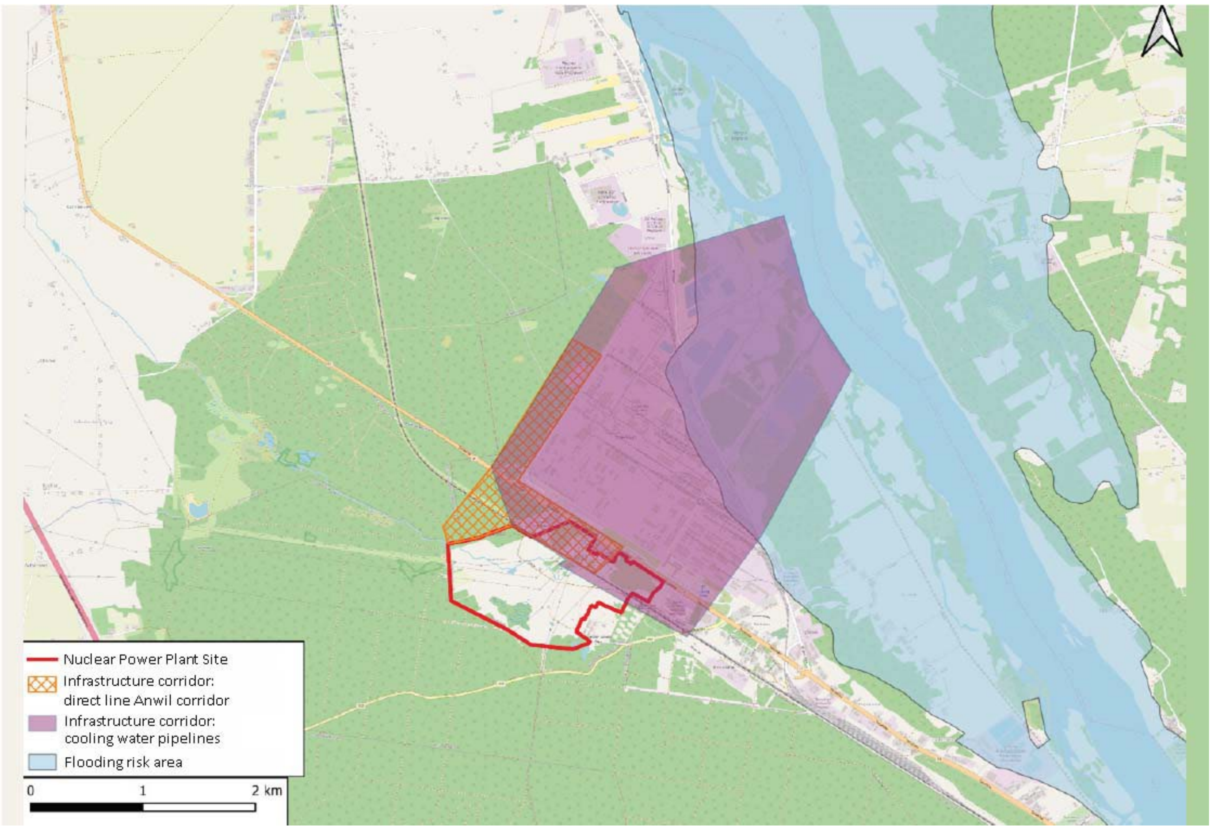

Figure 25. Risk of flooding in the Site area (Source: own study using OpenStreetMap and the MIDAS database, November 2022)

CLIMATE 8.13

The Włocławek Site Region is located in a warm temperate climate zone, transitional from the oceanic climate of Western Europe to the continental climate of Eastern Europe and Asia. It is within the range of atmospheric masses of diverse origin and character: maritime and continental, polar, subtropical, and arctic.

According to the explanatory notes to the Hydrogeological Map of Poland at a scale of 1:50 000 Bobrowniki Sheet (402), Warsaw 2002, in terms of climate, the region in question is located in the middle climate district, covering the basins of the middle Vistula and middle Warta.

The coldest month is January, and the warmest month is July. In a year perspective, February is the least rainy month and the most rainy month is July.

In the Site area winds are mainly from western and southwestern directions. Wind speeds are highest in winter, and lowest in August and September.

Below are the characteristic climatological indicators of the described region for the Płock station – climatic norms representing the averaged climatic conditions in Poland during the 30-year normal period 1991–2020:

- average daily air temperature (year) – 8.8°C

- average daily air temperature in January – 1.4°C
- average daily air temperature in July – 19.0°C
- number of days with maximum temperature < 0°C (year) – 31.4
- number of days with maximum temperature ≥ 25°C (year) – 43.9
- number of rainy days ≥ 1 mm (year) – 92.92
- total precipitation (year) – 511.5 mm
- number of days with snow cover > 10 cm (year) – 10.50
- average number of cloudy days (year) – 110.8
- average number of good weather days (year) – 100.1
- average amount of sunshine (h) per year – 1831.7

VEGETATION COVER 8.14

Location of the Włocławek Site in relation to the physical and geographical regionalization[16]:

Province Central European lowlands (31)

Subregion South Baltic Lakeland (314-315)

Macroregion Toruń-Eberswalde Ice-Marginal Valley (315.3)

Mesoregion Nieszawa Vistula Gorge (315.37)

Location of the Włocławek Site in relation to the geobotanical regionalization[17]

Division Mazovia-Polesie

Subdivision Mazovian (E)

Geographical region Chełm-Dobrzyń (E.1)

District Vistula Włocławek-Bydgoszcz (A.1.6)

Subdistrict Włocławek (E.1.6.f)

The area of the Site (energy part) has not been used for industrial purposes in the past. Currently, three extra high voltage power lines with 220 kV working voltage and three power lines with 110 kV working voltage run through the Site. These lines run through

16 Regionalna geografia Polski (Regional Geography of Poland), Collective work edited by: Andrzej Richling, Jerzy Solon, Andrzej Macias, Jarosław Balon, Jan Borzyszkowski and Mariusz Kistowski, Poznań 2021

17 Matuszkiewicz J. M., 2008, Regionalizacja geobotaniczna Polski (Geobotanical regionalization of Poland), IGiPZ PAN (Institute of Geography and Spatial Organization Polish Academy of Sciences), Warsaw

the central part of the area designated for the construction and operation of the nuclear power plant. The presence of the lines determines the limitations of tall vegetation in the form of trees in the analyzed area. In the line's right-of-way vegetation is periodically mowed to ensure the safe operation of the power lines.

The infrastructure corridor for the implementation of cooling water channels was planned within the area used for industry purposes by the Anwil plants. This area, due to its industrial use, is not covered with vegetation (Fig. 26).

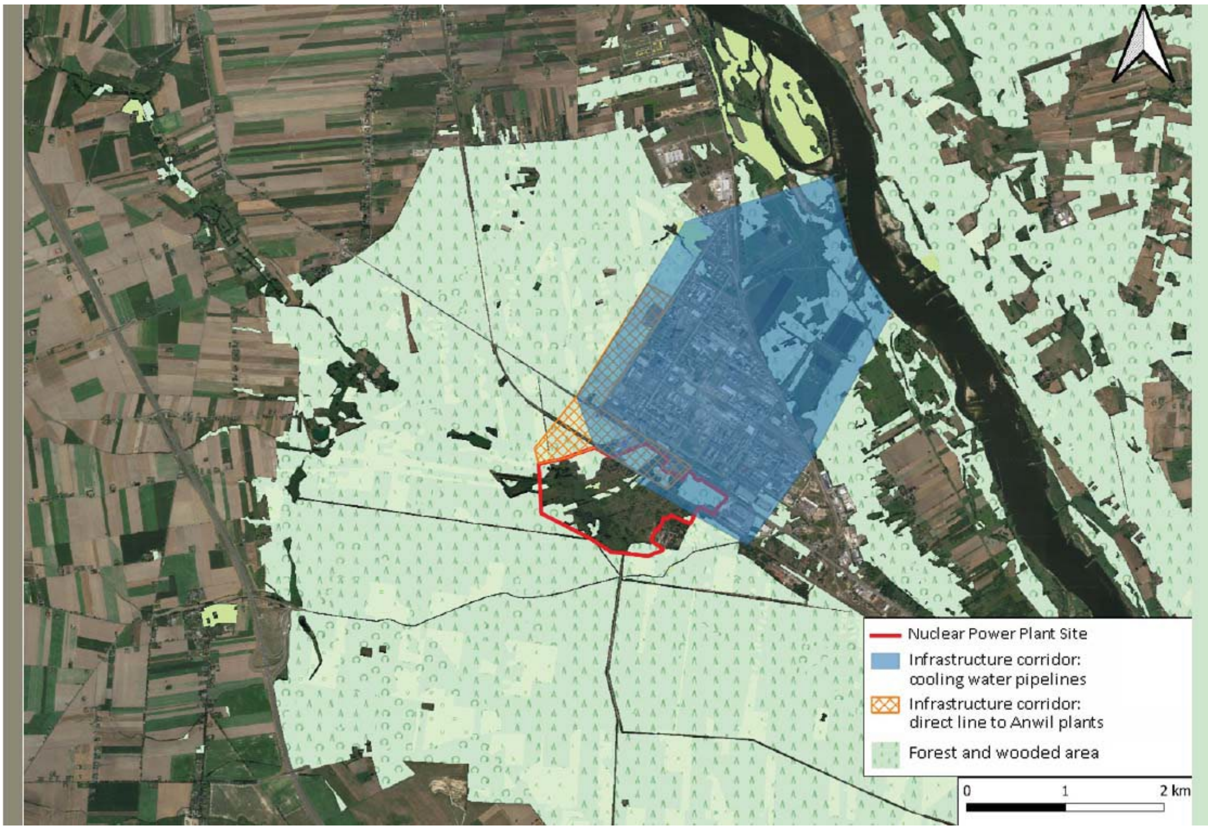

Figure 26. Forest and wooded areas within the planned Project (Source: own study using BDOT10k data, OpenStreetMap)

The infrastructure corridor designated for the implementation of the power line that constitutes the power output (connection line) from the power plant is designed in the immediate vicinity of the Anwil plants in forest areas, whose habitat type has been defined mainly as fresh mixed coniferous forest (BMśw). The Site Area in view of the results of the State Forest habitats inventory is shown in Fig. 27.

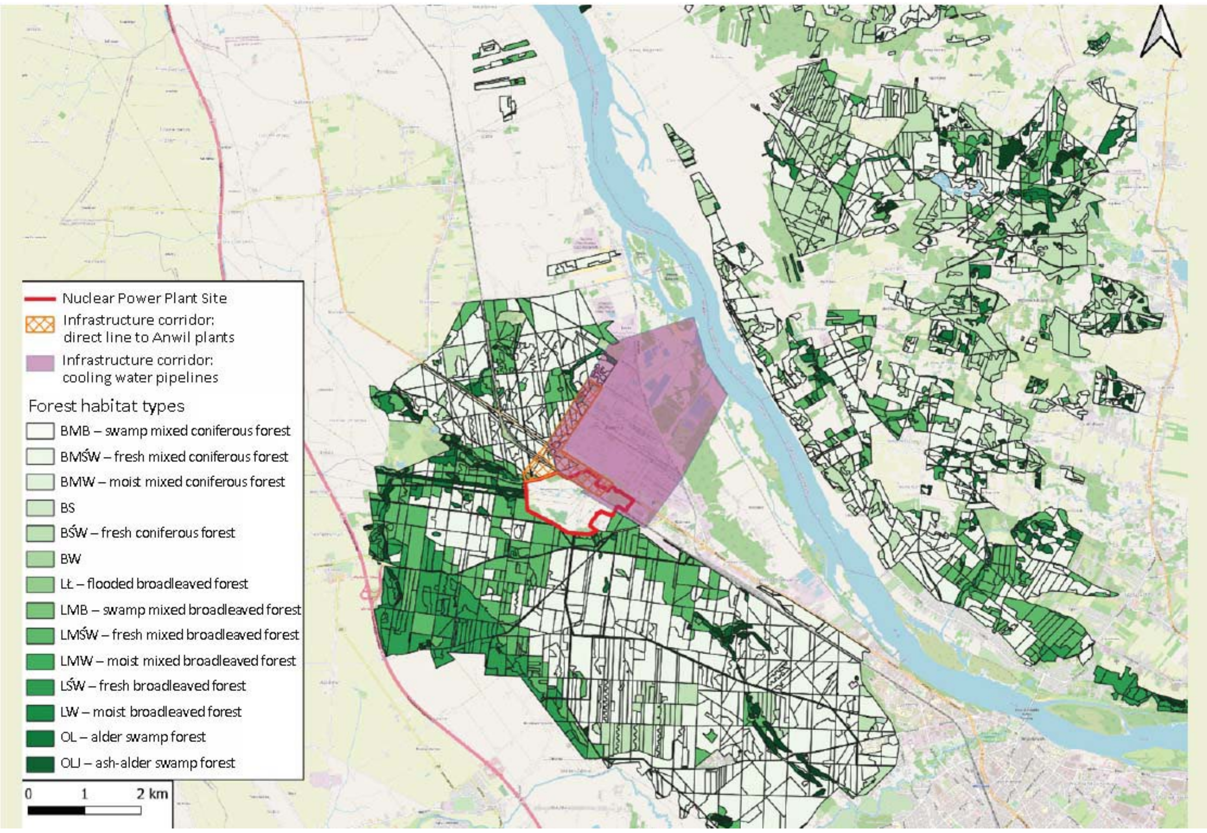

Figure 27. Site Area in view of the results of the State Forests habitats inventory (Source: own study using data from the Directorate of State Forests – results of the 2022 State Forests habitats inventory, OpenStreetMap background map)

The surroundings of the Site are mainly the following forest habitat types: fresh mixed coniferous forest (BMśw), fresh mixed forest (LMśw), mixed humid forest (LMw), and mixed bog woodland (LMb).

9 EXPECTED AMOUNT OF THE CONSUMED WATER AND OTHER USED RAW MATERIALS, MATERIALS, FUELS AND ENERGY

Depending on the life cycle stage of a planned Nuclear Power Plant, the level of use of water and other raw materials, materials, fuels and energy will fundamentally change. The greatest consumption of materials and fuels is expected to occur at the construction stage. Increased use of water, on the other hand, will take place during the operation stage (water making-up the cooling circuit).

The following subchapters provide approximate information on the estimated amounts of water, materials, fuels and energy used at various stages of the Investment Project life cycle. The quantities quoted are for the construction and operation of a Nuclear Power Plant consisting of one power unit with the BWRX-300 reactor.

CONSTRUCTION STAGE 9.1

The construction stage includes both preparatory works and actual construction works.

Use of materials and raw materials at the construction stage 9.1.1

Preparatory works comprise construction site preparation (i.a. demolition works, land leveling, construction of water supply, sewerage, telecommunications, and electricity networks, construction of 110/15 kV transformer stations, preparation of construction site back-up facilities, and relocation of current infrastructure). High-intensity construction works include earthworks (excavation for the reactor) as well as civil and erection works for the power plant and accompanying infrastructure.

The construction stage is characterized by high use of materials and raw materials. The main building materials will be steel, concrete mix, and steel components. The estimated quantities of main building materials are included in Table 12.

Reactor type	Capacity	number of units	Type of material	Quantity
BWRX-300	300 MWe	1	Steel pipes	27,500 m
			Electric cables	282,000 m
			Cable ducts	50,000 m
			Steel elements	6,000 tons
			Modular steel components	8,000 tons
			Concrete mix	50,000 m^3

Table 12. Estimated quantities of materials and raw materials that are the basic materials used to build the 300 MW nuclear power plant with the BWRX-300 reactor (source: technology provider: GE-Hitachi)

Approx. 900,000 m^3 of excavated earth will be produced during the earthworks. If possible, some of the material will be managed on the Site.

Use of water during the construction stage 9.1.2

Water at the construction stage will be used mainly for process purposes, including concrete blending. The second main area of water demand comprises water for domestic uses of construction site workers. The estimated quantities of water used during the construction stage are shown in Table 13.

Reactor type	Capacity	number of units	Type of material	Quantity
BWRX-300	300 MWe	1	Potable water	7.6 l/day per person (0.0076 m^3/day per person)
			Process water	113–150 m^3/day
			Water for concrete blending	19–38 m^3/day

Table 13. Estimated quantity of water used for the construction of the 300 MW nuclear power plant with the BWRX-300 reactor (source: technology provider: GE-Hitachi).

Use of fuels at the construction stage 9.1.3

The construction stage is characterized by increased use of diesel oil to power building equipment and machinery used during civil and erection works. The quantity of fuel used will vary and will depend on the phase of works. Any fluctuations in consumption will be mainly due to the quantity of building machinery used during a given construction stage. It is estimated that the highest consumption of diesel oil will occur during earthworks and execution of concrete structures.

The estimated average quantity of diesel oil used during construction works will be up to 10 m^3 per day.

Use of electricity at the construction stage 9.1.4

Electricity will be used on the construction site mainly to power machinery and electrical equipment and, if necessary, to illuminate the construction site. A transformer station with a capacity of approx. 5 MWe (preliminary estimates) powered from the local power system is planned to be constructed on the construction site. The construction site will also be equipped with a diesel generator with a capacity of approx. 3 MWe. This generator will be used as a back-up source of electricity and to supplement the necessary power if the power supplied from the power system proves insufficient at any given time. It is estimated that the peak electrical power needed during construction works will be approx. 4.5 MWe.

OPERATION STAGE 9.2

The operation stage will consist in the generation of electricity or electricity and heat. As part of operation, ongoing repairs and retrofit of systems and equipment necessary for proper and safe operation of the NPP will be performed. This stage is also characterized by activities relating to radioactive waste management and spent nuclear fuel storage.

Use of materials and raw materials at the operation stage 9.2.1

The operation of the nuclear power plant will be primarily associated with the use of nuclear fuel and chemicals necessary for proper operation of the power plant and its systems, and to a lesser extent, building materials in the event that overhauls are required. Examples of raw materials and materials along with the estimated quantities used during power plant operation are presented in Table 14.

Material/Raw material	Estimated quantity stored on the NPP site	Intended use
Nitrogen	approx. 50 m^3 stored in a cryogenic tank	Reactor containment inerting
Hydrogen	Tank with a capacity of approx. 360 m^3	Anticorrosive protection (Hydrogen Water Chemistry)
Diesel oil	Tank with a capacity of approx. 120 m^3	Power supply of diesel generators
Turbine oil	Tank with a capacity of approx. 20,000 m^3	Control, protection, bearing lubrication, jacking oil systems
Petrol	Tank with a capacity of approx. 0.1 m^3	Vehicle maintenance
Propylene glycol	Tank with a capacity of approx. 40 m^3	Additive in the Chilled Water System, antifreeze protection
Tetrafluoroethane (coolant)	Tank with a capacity of approx. 250 kg	Additive in the Chilled Water System, antifreeze protection

Table 14. Estimated quantity of materials and raw materials used during normal operation of the 300 MW nuclear power plant with the BWRX-300 reactor (source: technology provider GE-Hitachi).

The chemicals will be used primarily in the process of treating the water used to remove heat from the condenser. Depending on the selected cooling system technology, and the quality of raw water taken for condenser cooling, the quality and type of chemicals used for water treatment will vary (Table 15).

Material/Raw material	Estimated quantity stored on the NPP site
Sodium hypochlorite	Tank with a capacity of approx. 4 m^3
Sodium bisulfite	Tank with a capacity of approx. 11.4 m^3

Table 15. Estimated type and quantity of chemicals used in the raw water treatment process during normal operation of the 300 MW nuclear power plant with the BWRX-300 reactor. Data for an open cooling system (Source: technology provider GE-Hitachi).

Use of water at the operation stage 9.2.2

At the operation stage of the NPP, water will be used in the following areas:

- Cooling water
- demineralized water (for feeding the power plant primary circuit)
- water for domestic uses
- water for fire protection purposes.

The quantity of water used during operation in each area will depend on the final power output of the power plant and the selected cooling system. The following estimates apply for the construction of one 300 MWe BWRX-300 power unit.

It is estimated that the demand for raw water to make up the cooling system using wet mechanical draft cooling towers is about 1,200 m^3/h in the peak, while the water demand for the once-through system is estimated at about 50,000–90,000 m^3/h – this water is fully returned to the river after use. The amount of water needed for cooling depends on the quality of the water, meteorological conditions, or the power at which the power plant operates.

A detailed analysis of water consumption at the operation stage will be determined at the stage of preparation of the EIA Report.

The demand for demineralized water necessary to make up the coolant in the reactor vessel is approx. 0.18 m^3/day on average, with the maximum value of 15.2 m^3/day.

Potable water demand is estimated at approx. 0.8 m^3/day.

Use of fuels at the operation stage 9.2.3

Nuclear fuel will be the source of energy for generation of electricity or electricity and heat. The BWRX-300 reactor will use GNF2-type nuclear fuel, which is uranium oxide (UO_2) with a low enrichment level of up to 4.95%, that has been proven in service at other BWR power units. According to information made available by the technology provider, nuclear fuel reloading will take place once a year. 32 fuel assemblies will be replaced. Fuel consumption for one 300 MWe reactor will be approx. 6.6 tons of uranium per year.

During the operation of the NPP, regular tests will be performed as regards the efficiency and operational readiness of diesel generators. The estimated annual consumption of diesel fuel used to power them will be approx. 200 m^3.

Use of electricity at the operation stage 9.2.4

The NPP’s own consumption during operation will be about 10–30 MWe.

DECOMMISSIONING STAGE 9.3

The anticipated decommissioning stage will take place after the end of the NPP operation and will consist in dismantling the power plant and proper management of the resulting conventional and radioactive waste. The planned operation will be carried out for at least 60 years. Taking the above into account, and the fact of rapidly advancing technological changes concerning, i.a., changes in the method of driving vehicles or the method of radioactive waste management, at the current stage of Investment Project preparation it is extremely difficult to estimate even in general terms the quantities of raw materials and fuels used during the decommissioning stage of the nuclear power plant.

The decommissioning of the nuclear facility will be preceded by obtaining by the Investor of a nuclear facility decommissioning license issued under the Nuclear Law Act [Poland] and a demolition license issued under the Construction Law. In accordance with the EIA Act, the demolition license will be preceded by obtaining of the decision on environmental conditions by the Investor. Decommissioning of the nuclear facility will therefore be covered by a separate procedure for the decision on environmental conditions.

ENVIRONMENTAL PROTECTION SOLUTIONS 10

At each stage of the Project implementation, i.e., at the construction, operation, and decommissioning stages, appropriate measures as well as organizational and process solutions will be taken to protect the environment.

The main areas of measures aimed at mitigation of the environmental impact of the Project can be divided into two main groups:

- Radiation protection solutions
- Non-nuclear solutions

The detailed scope of applied solutions will be developed at the stage of preparation of the EIA Report after detailed determination of environmental components and recognition of the types and scale of impacts of the Project on the identified and described environmental components.

RADIATION PROTECTION SOLUTIONS 10.1

Radiation protection solutions include all process and organizational solutions aimed at ensuring stable and safe operation of the nuclear power plant, whose operation does not adversely affect the radiation safety of the environment. Radiation protection measures should include the implementation of safe and proven reactor technology that meets the safety requirements of national law and complies with international standards, the design solutions of which mitigate or practically eliminate the possibility of a major accident, with effects that may significantly and on a long-lasting basis adversely affect the environment or threaten human health or life.

Selection of appropriate process and organizational solutions 10.1.1

In addition to environmental issues, the most important factor influencing the choice of technology is to ensure nuclear safety during the nuclear power plant operation. The nuclear power sector is among the industries with the most stringent safety regulations. The approach to safety management has evolved along with the growing nuclear power sector. Nuclear power sector pioneers had limited safety regulations, knowledge and experience. Over time, the increasing number of nuclear reactors in operation has resulted in an increase in operating experience, which, combined with continuously improving reactor technology, has contributed to a significant increase in the safety of reactor operation.

Despite the passage of years, safety aspects still remain a priority for any power unit in operation. In 1957, a specialized agency of the United Nations – the International Atomic Energy Agency (IAEA), was established, one of whose goals is to develop and implement international safety standards for newly designed and operated nuclear power plants. The IAEA guidelines are multi-level proposals for both organizational and process solutions with the aim of continually improving the safety of nuclear power sector used for peaceful purposes.

The primary source of the required organizational and process solutions in the field of nuclear power implementation comprises national regulations in the form of the Nuclear Law Act [Poland] and secondary legislation.

At each stage of BWRX-300 technology implementation and operation, the Investor will follow both national regulations and IAEA guidelines that are the result of decades of work by experts from various countries with extensive experience in the operation of nuclear power plants.

This chapter presents only a general characteristics of the main concepts of the strategy for ensuring nuclear safety and radiation protection (NSRP).

Fundamental safety functions 10.1.2

The basic requirement for nuclear power plant designs is to ensure, through design solutions, the fulfillment of the so-called fundamental safety functions in all possible states of the facility (concerning normal operation and adverse events). The fundamental safety functions of a nuclear power plant cover key areas relating to the operation of nuclear reactors, the fulfillment of which guarantees the provision of NSRP:

a. reactivity control;

b. heat removal from the reactor, spent nuclear fuel storage facility, and nuclear fuel storage;

c. shielding against ionizing radiation, confinement of radioactive substances, limiting and controlling their release to the environment, as well as limiting accidental releases.

The structures of the reactor, control room, turbine building and radioactive waste building are designed to prevent construction disasters that could:

- deteriorate the operation of systems, structural elements, and equipment located in the reactor building and classified as the first safety class (i.e., of the highest importance for ensuring safety) in a manner that leads to an unacceptable reduction in the defense line;
- result in such injuries to occupants of the control room in the control room building that would deprive them of the ability to function;
- compromise the safety functions of systems, structures and components whose efficiency is required after seismic events.

Defense-in-depth 10.1.3

The fundamental concept for ensuring safety of nuclear power plants is the defense-in-depth, i.e., a sequence of defense lines. According to it, safety is ensured through a wide variety of technical measures and organizational projects focused in three main areas:

1. Prevention (prevention of defects) through technical and organizational solutions of facility operation;
2. Events control (detection and prediction of accidents);
3. Mitigation of effects (use of physical barriers to contain potential radiation releases).

The defense-in-depth concept involves planning several lines of defense against specific undesirable effects instead of a single strong protection layer. In the case of the NPP, an undesirable effect comprises the exposure of workers or the public to radiation in excess of safe levels.

The term defense-in-depth is reserved for defense lines composed of features, functions and practices that protect the continuity of barriers. The defense-in-depth concept is even largely aimed at identifying and organizing solutions, functions and activities in defense lines without referring directly to physical barriers. However, it should be understood that the fundamental purpose of multi-level defense is to ensure that the continuity of layered physical barriers is maintained.

The defense-in-depth concept implies that each successive layer of defense is designed to prevent accidents progress with the greatest possible efficiency. However, when an emergency event nevertheless occurs and exceeds the defense capabilities of a given line, then the next defense line acting with greater efficiency will be able to inhibit the developing emergency situation. The layers of defense are independent of each other, and their potential damage cannot affect the effectiveness of next layers of defense. The defense-in-depth concept is the best expression of a certain "mentality" and the absolute placement of safety of the nuclear facility in the first place. Also characteristic of the nuclear power sector is the use of significant safety margins for systems and equipment relating to the safety of power plant operation, as well as the use of redundant safety measures meaning the use of, for example, several independent devices with the same purpose in such a manner that in the event of a failure of the "first" device, the "second" device is immediately ready for operation, and in the event of its failure, the "third" device is activated. The applied measures from consecutive defense lines are considered for event scenarios with lower and lower probability of occurrence, so that most solutions will never be used, but they are present.

The implementation of the defense-in-depth concept in the nuclear power plant design is required by Polish regulations (consistent with international recommendations) in both areas, where the first area is called a sequence of defense lines, and the second is called a system of additional protective barriers:

1. Sequence of defense lines:
   a. first defense line – consists in preventing deviations from normal operation and failure of the nuclear facility's systems, in particular through its solid and

conservative design, using redundancy, functional independence, and diversity of systems and equipment components of nuclear facility important in terms of nuclear safety and radiation protection, as well as high quality of construction and operation of the nuclear facility;

b. second defense line – consists in detecting and controlling deviations from normal operation in order to prevent anticipated operational occurrences from escalating to accident conditions, in particular, through the use of systems specified in safety analyses and operating procedures appropriate to prevent the occurrence or to limit failure as a result of anticipated initiating events;

c. third defense line – consists in controlling design basis accidents, in the event that certain anticipated operational occurrences or postulated initiating events are not controlled at the second defense line, developing into a more serious event; this is accomplished by using the inherent safety features of the nuclear facility and the safety systems and procedures provided for in its design, aimed at bringing the facility first to the controlled state, and then to the safe shutdown state, as well as by ensuring that at least one protective barrier remains intact;

d. fourth defense line – consists in mitigating the consequences of severe accidents in order to maintain the radiation releases at the lowest practicable level, in particular, by maintaining the highest possible efficiency of the reactor containment in limiting the radiation releases into the environment;

e. fifth defense line – consists in mitigating the radiation effects of potential radiation releases to the environment, which may occur as a result of an accident, in particular, by providing a properly equipped emergency management center and by applying emergency plans in the event of radiation events on and off the premises of the facility;

2. a system of additional protective barriers ensuring the maintenance of radioactive substances in specific places of the nuclear facility and preventing their uncontrolled release into the environment, such as: nuclear fuel material (fuel matrix), fuel element cladding, reactor coolant pressure boundary, and reactor containment.

The functional and design requirements of the BWRX-300 reactor are determined on the basis of deterministic safety analyses and from the defense-in-depth concept itself to ensure that the functions of defense lines are included in the design in accordance with their role within the defense-in-depth concept and duly included in the safety analyses.

The safety strategy for the BWRX-300 design is based on the foundation of implementation of the defense-in-depth concept.

Safety features of the BWRX-300 technology 10.1.4

The BWRX-300 reactor design has been developed for use in a number of countries, and recommendations published by the IAEA were taken into account during its development. The IAEA safety standards represent an international consensus on measures that ensure a high defense line and use defense-in-depth as the primary measure for preventing accidents at NPPs and mitigating the consequences of accidents if they occur.

The safety system features of the BWRX-300 design are briefly listed in chapter 6 Description of the technology selected for implementation – BWRX-300. Detailed characteristics of individual solutions, along with safety analyses confirming compliance with nuclear safety criteria, will be presented in the documentation required at further stages of project preparation and assessed by the relevant authorities.

The solutions used in the BWRX-300 project make it possible to ensure that the probability of severe accidents resulting in radiation release into the environment is much lower than national and international requirements. Polish regulations require that the probability of hypothetical accidents that could result in large releases be less than 10^{-6}/year (once in a million years), which is consistent with the INSAG-12 recommendations of the International Atomic Energy Agency. In comparison, the estimated probability of hypothetical accidents resulting in large releases for the BWRX-300 project is approx. 10^{-8}/year (once every hundred million years).

10.1.5 Practical elimination of the possibility of severe accidents

The international approach introduces the practical elimination concept, providing a basis for the practical elimination of potential nuclear reactor accident scenarios leading to the release of radionuclides in quantities that cause harmful effects on humans and the environment.

The practical elimination concept was introduced as a result of accidents in Three Mile Island (U.S.) and Chernobyl (Ukraine) power plants to explicitly incorporate the “defense-in-depth” concept (chapter 10.1.3. Defense-in-depth) for severe accidents. The use of the “defense-in-depth” strategy ensures the prevention and control of incidents and potential accidents at several levels of an engineering and procedural nature. This ensures that additional physical barriers protecting radioactive substances from release are effectively protected. The “defense-in-depth” strategy is supported by strengthening the inherent safety features of the BWRX-300 reactor (resulting from physical phenomena naturally associated with the reactor's design, such as a strong negative reactivity coefficient) and lessons learned from deterministic and probabilistic safety analyses conducted to assess and optimize the overall design of the power plant.

BWRX-300 technology SMRs are designed to provide a controlled state and maintain the "containment" function of radioactive substances, so as any consequences of an accident that could potentially result in early or large releases of such substances, requiring protective measures and intervention, are virtually eliminated.

Therefore, the design scope of the facility states[18] should be expanded to include not only the ability to defend against various emergency states, but also the practical means of stopping the development of severe accidents and practically eliminating their potential consequences. Consequences are considered practically eliminated if radioactive releases are either physically impossible to occur or can be considered improbable with a high degree of certainty.

Compared to reactors currently in operation in the world, the BWRX-300 reactor is structurally simpler, and the entire safety concept is based primarily on passive safety systems and inherent safety features (such as lower thermal power, and thus less residual heat for cooling). These safety features increase the so-called safety margins ensuring the effectiveness of physical safety barriers for radioactive substance containment and virtually eliminate the possibility of reactor core degradation conditions and the possibility of large radiation releases. Consequently, dependence on the containment vessel and emergency response measures is reduced. For the postulated scenarios that could result in the containment vessel function failure or its bypassing, the avoidance of early or large releases is appropriately achieved by demonstrating practical elimination for each individual case, by showing that the scenario is either physically impossible or extremely unlikely to occur with a high degree of certainty.

Given that the probability of hypothetical accidents that could result in large releases is less than 10^{-8}/year for the BWRX-300 project, it is reasonable to treat this value as an argument for practical elimination. In addition, probability assessments are supplemented by deterministic analyses of physical phenomena and functionality of design provisions. By including additional beyond-design-basis safety measures in the design, it is demonstrated that radioactive releases that could pose a hazard to the public and the environment are physically impossible to occur.

NON-NUCLEAR SOLUTIONS 10.2

In addition to solutions for ensuring nuclear safety, it is also extremely important to provide appropriate measures and solutions to protect individual environmental components from the "conventional" negative impacts of a nuclear power facility. To minimize potential environmental impacts, all possible types and scales of impacts of the Project on individual environmental components and the public will be identified at

18 In terms of all potential operating and emergency states that must be considered in the design of the facility (more in Journal of Laws of 2012, item 1043, Appendix No. 1)

the stage of preparation of the EIA Report. This action will then enable the development and implementation of an Environmental Management Plan (EMP), as well as proper organization of works and management of the Investment Project construction, operation and decommissioning processes.

Development and implementation of an environmental management plan 10.2.1

An Environmental Management Plan will be prepared to address all potential adverse environmental and social impacts associated with the Project. The EMP will be developed as a result of the EIA process.

The main objective of preparation of the EMP is to identify the full spectrum of environmental and social impacts that may occur in connection with the Investment Project. The EMP also presents a general analysis of environmental impacts with environmental and social criteria, as well as a general assessment of methods for mitigating and monitoring possible environmental and social impacts associated with the Investment Project. The document will propose measures to minimize negative impacts, as well as set guidelines and scope for environmental monitoring.

The main elements of the EMP, in accordance with international practice, will comprise:

- Project characteristics;
- Legal considerations including a description of the EIA process, compliance of the Investment Project with the law and industry standards;
- Description of potential environmental impacts;
- Plan for the implementation of minimization and compensation measures;
- Monitoring plan;
- Schedule for implementation of the EMP and reporting procedures.

Management of construction, operation and decommissioning stages 10.2.2

Each stage of the Project will be implemented in accordance with, i.a.:

- applicable legal acts,
- IAEA guidelines,
- integrated management system,

- environmental management plan,
- relevant industry standards.

Documents confirming correct implementation of the integrated management system will be part of the application for the construction license to be issued by the President of the PAA.

TYPES AND ESTIMATED QUANTITY OF SUBSTANCES OR ENERGY RELEASED INTO THE ENVIRONMENT BY USING THE SOLUTIONS AIMED TO PROTECT THE ENVIRONMENT 11

The life cycle of the Project consists of three consecutive stages: **construction**, **operation**, and **decommissioning**. Due to its specific nature, each of the mentioned stages is characterized by different activities, which consequently translates into differences in the type and quantity of substances released into the environment.

At the current stage of the Investment Project preparation, it is not possible to precisely determine the quantity of substances or energy that will be released into the environment at each stage of the Project operation. However, it is possible to approximate the types of these substances and their sources.

Detailed information on the types and quantities of emissions into the environment, along with their environmental impacts, at various stages of the power plant life cycle will be characterized and described in detail during the preparation of the EIA Report.

CONSTRUCTION STAGE 11.1

The construction stage will be characterized by increased earthworks as well as civil and erection works. It should be noted that the Project will be implemented in stages. The works schedule will be developed at a later stage of the Investment Project preparation. Both the method of staging and the approximate schedule for implementation of the Investment Project will be described in more detail in the EIA Report. The main emissions associated with the construction stage will involve the substances indicated in the following chapters.

Noise emission 11.1.1

Noise will be emitted during construction works, and the main emitting device will be the construction machinery. It should be emphasized that construction works will be performed in stages, so the accumulation of emissions from all construction machinery used for works on the Site in one period is unlikely. The works schedule will be developed at the stage of preparation of the building permit design. The magnitude and extent of noise emission will depend on the type of machinery used, the number of simultaneously operating equipment and the duration of their operation. It cannot be ruled out that the impact may also affect the area outside the boundaries of the Site.

In principle, the construction works will be carried out in 2 phases:

- execution of necessary earthworks related to leveling of the area and preparation of the area for foundation works;
- execution of foundations, erection of enclosed structures (buildings) and erection of systems and equipment.

Conventional construction machinery such as excavators, loaders, “tub” trucks, cranes, etc. will be used during the aforementioned works. The sound power level of most construction machinery is within LWA = 50-101 dB measured at a distance of 15 m from the source. Depending on the stage of works, the number of actively working machinery and the intensity of their use will vary.

Taking into account the typical nature of noise impact during civil and erection works and the distance of the nearest residential development subject to protection, no significant impact of noise emission on these areas is to be expected. An analysis of the number and types of construction equipment and machinery, along with the determination of their impact on the acoustic environment during construction works, will be determined as part of the EIA Report.

Gas and dust emissions into the air 11.1.2

The construction stage does not involve organized gas and dust emission. However, construction works will be accompanied by unorganized gas and dust emission into the air, which will be associated with the circulation of transport vehicles and the operation of construction machinery and equipment.

Working machinery as well as earthworks and construction works will be accompanied by flue gas emission and temporary dust emission. All of the above-mentioned factors will occur only locally within no more than a dozen of meters from the machinery operation site.

To reduce the emission of dust and gas pollutants into the air, proper organization of the works will be ensured, only operational equipment (with up-to-date technical tests) will be used, which will be operated as intended, and construction machinery will not be left idle. If there is a high level of dust load, countermeasures in the form of sprinkling and water curtains will be used. Taking into account the fact that the designed Investment Project is located in an industrial area, away from larger groups of residential buildings, it should be assumed that air emissions will not adversely affect the health of people living in the areas adjacent to the Project.

An analysis of the number and types of construction equipment and machinery, along with the determination of their impact on atmospheric air quality during construction works, will be determined as part of the EIA Report.

Emissions into the groundwater environment 11.1.3

During the construction stage, the only impact on the Groundwater Bodies and Surface Water Bodies that could occur could be associated with the leakage of pollutants as a result of interference with the mechanical equipment used during the Project (e.g. leakage of oil derivative substances). The quantity and type of the substance that will be released into the water may determine the magnitude of this impact. Appropriate minimization measures will be taken to avoid the aforementioned hazard.

During construction, to prevent oil or gasoline from vehicles operating on the construction site from entering the groundwater environment in case of an accident, construction machinery and equipment and means of transport whose technical condition is not objectionable should be used, which will reduce the risk of a possible oil or gasoline leakage. As a standard, the Investment Project site will be provided with sorbent, which will be used if there is a possible leakage of a harmful substance, and the soil will then be collected and disposed of by a qualified company. Refueling of equipment will take place in a specially designated area equipped with absorbent mats to prevent possible leakage of harmful substances (i.e. oil derivative substances, operating fluids). Absorbent mats will also be part of the equipment in the area designated as a construction equipment service and repair area.

During construction, the following countermeasures will be implemented to provide adequate protection of the groundwater environment:

- ensuring proper organization of the works to maintain order: storage of materials in places designated for this purpose and protected from the penetration of pollutants into the ground, proper organization of amenity facilities, including the provision of the construction site with portable sanitary facilities with watertight tanks;
- protecting the parking, servicing, and refueling areas of the means of transport and construction machinery from potential spills of fuel, oil, and other technical substances used on the construction site;

- use of efficient technical equipment with valid technical tests, meeting the relevant standards;
- equipping the construction site with sorbents and other means to collect any oil leakage;
- excavations will be protected from the possibility of entry of pollutants associated with construction works; it is unacceptable to leave any waste in the excavations;
- waste management will be carried out in accordance with the Waste Act of December 14, 2012 (Journal of Laws of 2022, item 699, as amended). This will enable, i.a., the reduction and minimization of the volume of generated waste, proper collection of generated waste, including its selective collection, management of waste for repeated use on the construction site, recovery of waste that has the characteristics of recyclable raw materials, temporary storage of waste in places designated for this purpose, as well as proper and timely removal of waste from the sites of its generation and storage.

The analysis of the necessary construction works along with the determination of their impact on the quality of the groundwater environment during the construction works will be determined as part of the EIA Report.

Electromagnetic emissions 11.1.4

At the construction stage no electromagnetic impact is assumed. At this stage, no equipment will be used, the operation of which could generate hazard to the environment through long-term, above-normal emissions in terms of field emission or electromagnetic radiation. Any electrical equipment will be powered by a low voltage or medium voltage line connection, or portable power generator set and will operate at 220 V or 400 V, i.e., at low voltage, similarly as all household appliances. Only the power transformer may be a source of electromagnetic impact; however, given its small capacity (up to 5 MWe), it should be concluded that it will not cause an above-normal environmental impact. Considering the above, it should be concluded that electromagnetic fields generated by electrical equipment used during construction will be negligible in relation to the prevailing electromagnetic background.

Heat emissions 11.1.5

At the construction stage, no heat sources are identified that may negatively affect the environment.

Radiation emissions 11.1.6

At the construction stage, the use of materials and equipment that may cause radiation emissions into the environment is not expected.

Defectoscopic techniques which may use ionizing radiation (gamma or X-rays), may be used in the course of engineering and construction works. The observance of basic OH&S and radiation protection rules by the authorized defectoscope operator will guarantee the exclusion of exposure to bystanders and construction site workers. Radioactive emission from a defectoscope using a radioisotope as a source are virtually eliminated.

OPERATION STAGE 11.2

The operation stage of the Project is characterized by limited gas and dust emission into the environment compared to conventional thermal power plants. The main pollution emitted by the operating nuclear power plant will comprise the noise emitted by the cooling system, locally, in the vicinity of the electrical switchyard and generator, as well as the power output lines; increased electromagnetic field (PEM) emission will be possible. Heat and steam emission is also possible, depending on the cooling option chosen for the power plant. However, it should be emphasized that this emission will be no different from that generated by conventional thermal power plants and will remain within the legally permitted standard.

Noise emission 11.2.1

At the operation stage, noise emissions will be mainly associated with the operation of turbines and generators located in the turbine hall building, and, depending on the chosen cooling option, also with the operation of mechanical draft cooling towers or natural draft cooling towers that are part of the power plant cooling system. The equipment will operate continuously. In addition, periodic noise from diesel generators may occur. The equipment will be operated once a month for approx. 4 hours to test its efficiency. It will operate continuously only in the event of the nuclear power plant blackout. The estimated noise sources along with emission levels are presented in Table 16.

Noise source	Measurement distance [m]	Sound emission [dB]
Mechanical forced-draft cooling towers	305	55

Diesel generator	8	80

Table 16. Expected noise sources and estimated noise emission during normal operation of the 300 MW nuclear power plant using the BWRX-300 reactor. Data for the cooling system with a mechanical draft cooling tower (Source: technology provider GE-Hitachi).

A detailed characteristics of the emitting devices along with the analysis of their acoustic impact at the power plant operation stage will be developed as part of the EIA Report.

Gas and dust emissions into the air 11.2.2

Gas and dust emissions into the air during operation will be mainly associated with the circulation of cars and other vehicles, relating to periodic inspections, overhauls, transport of fresh and spent nuclear fuel, and transport of waste generated during the power plant operation. Another emission source will comprise diesel generators that provide backup power supply to the power plant. The diesel generators will mainly operate during periodic inspections, during which their readiness for emergency operation will be checked. The estimated emissions from diesel generators are presented in Table 17.

Type of equipment	Pollutant	Emission rate (mg/Nm^3)
Diesel generator	Solids	60
	Sulfur oxide	20
	Carbon monoxide	400
	Hydrocarbons	60
	Nitrogen oxides	6250

Table 17. Expected annual emission from diesel generators (source: technology provider GE-Hitachi).

A detailed characteristic of the emitting devices along with the analysis of their acoustic impact during their operation will be developed as part of the EIA Report.

Emissions into the groundwater environment 11.2.3

The operation of the nuclear power plant will involve the generation of liquid waste. Rainwater potentially contaminated with chemicals (lubricants, oils) from the workshop buildings will be collected by a drainage system and evacuated to separators, where it will be treated before discharge.

The operation of the power plant also involves the generation of wastewater from technological processes accompanying electricity generation. The wastewater will be treated before discharge.

Wastewater from systems directly associated with electricity generation, i.e. the reactor and its auxiliary systems, may be potentially radioactive and for this reason will be subject to special collection, storage (until signs of radioactivity cease) and possible discharge procedures.

The discharge of wastewater into the selected watercourse will be carried out on the basis of the water permit obtained. The physical and chemical parameters of the discharged wastewater will not exceed the relevant standards. The Investor considers the possibility of building infrastructure for wastewater discharge within the designated infrastructure corridor in which cooling water pipelines are planned.

Electromagnetic field emissions 11.2.4

Non-ionizing electromagnetic radiation (PEM) occurs in natural form (sources are the Earth, the Sun, atmospheric phenomena) and artificial form (relating to the widespread use of electricity and new radio techniques). Electromagnetic fields occur around all electrical devices.

The primary sources of electromagnetic fields are:

- cell phone base stations,
- radio and television stations,
- radiolocation stations,
- high voltage power lines,
- common appliances, including microwave ovens and mobile phones.

Permissible levels of electromagnetic fields in the environment are specified in Table 18 and Table 19, respectively (based on the Ordinance of the Minister of Health of December 17, 2019 on permissible electromagnetic field levels in the environment (Journal of Laws of 2019, item 2448).

Physical parameter Electromagnetic field frequency	Electrical component E (V/m)	Magnetic component H (A/m)	Power density S (W/m^2)
50 Hz	1,000	60	N.A.

Table 18. Frequency range of electromagnetic fields, for which physical parameters characterizing electromagnetic field impact on the environment are determined, for areas intended for residential development, and permissible electromagnetic field levels, characterized by permissible values of physical parameters, for areas intended for residential development (source: Ordinance of the Minister of Health of December 17, 2019 on permissible electromagnetic field levels in the environment).

Physical parameter Electromagnetic field frequency	Electrical component E (V/m)	Magnetic component H (A/m)	Power density S (W/m^2)
0 Hz	10,000	2,500	N.A.
0 Hz to 0.5 Hz	N.A.	2,500	N.A.
0.5 Hz to 50 Hz	10,000	60	N.A.
0.05 kHz to 1 kHz	N.A.	3/f	N.A.
1 kHz to 3 kHz	250/f	5	N.A.
3 kHz to 150 kHz	87	5	N.A.
0.15 MHz to 1 MHz	87	0.73/f	N.A.
1 MHz do 10 MHz	87/f0.5	0.73/f	N.A.
10 MHz do 400 MHz	28	0.073	2
400 MHz do 2000 MHz	1.375 x f0.5	0.0037 x f0.5	f/200
2 GHz do 300 GHz	61	0.16	10

f – frequency value of the electromagnetic field from the same row of the column "Electromagnetic field frequency range" | N.A. – not applicable

Table 19. Electromagnetic field frequency range, for which physical parameters characterizing electromagnetic field impact on the environment are determined, for areas accessible to the public, and permissible electromagnetic field levels, characterized by permissible values of physical parameters, for areas accessible to the public (Source: Ordinance of the Minister of Health of December 17, 2019 on permissible electromagnetic field levels in the environment).

The power system in Poland operates at a frequency of 50 Hz, for this reason the values of EMF generated by high voltage lines should be compared to the limits of the components of electric and electromagnetic field intensity specified in the aforementioned Ordinance in the electromagnetic field frequency range from 0.5 Hz to 50 Hz.

The 1 kV/m electric field is a permissible intensity value in areas intended for residential development and is a value that is completely safe for human health; this value cannot be exceeded in the area outside the buffer zone of extra high voltage lines. In areas accessible to the public, but not intended for residential development, the permissible value of electric field strength is 10 kV/m.

The value of the EMF permissible magnetic component in places accessible to the public has been set at 60 A/m; this value cannot be exceeded outside the designated buffer zone. Normally, the buffer zone for 400 kV rated lines is 70 m (35 m from the axis of the line in both directions), for 110 kV lines the width of the buffer zone is 60 m (30 m from the axis of the line in both directions).

A place accessible to the public is to be understood as any place, except for places to which access by the public is prohibited or impossible without the use of technical equipment, determined according to the existing real property development.

The source of the 50 Hz electromagnetic field associated with the operation of the nuclear power plant may be low voltage and medium voltage lines capable of generating electromagnetic field, the level of which is low enough not to threaten the environment in any way. Only high voltage lines with rated voltage of no less than 110 kV are capable of generating electromagnetic fields with levels that may violate electromagnetic climate quality standards. Sources of electromagnetic fields will include the generator, transformer, substation as well as high and extra high voltage cable lines that constitute the connection lines from the power plant to the point of connection to the grid. It should be noted that equipment such as the generator, transformer and substation (switchyard and transformer) will be located in the protected area of the nuclear power plant, where the presence of the public will be prohibited, including the presence of such persons in the immediate vicinity of electrical equipment that is part of the power plant.

At the current stage of the Investment Project preparation, no final decision has been made regarding the rated voltage of the direct line, through which some of the power will be evacuated from the power plant to industrial plants of the ORLEN Group's Anwil. The most likely solution is the construction of an extra high voltage overhead line (110 kV, 220 kV, or 400 kV). The Investor does not exclude that in certain sections it will be necessary to build a cable line, i.e. placed in a specially prepared excavation. The construction of a cable line along its entire length is also under consideration. The line will be the only component of the power plant located in the public space that can generate electromagnetic fields with increased values relative to background values.

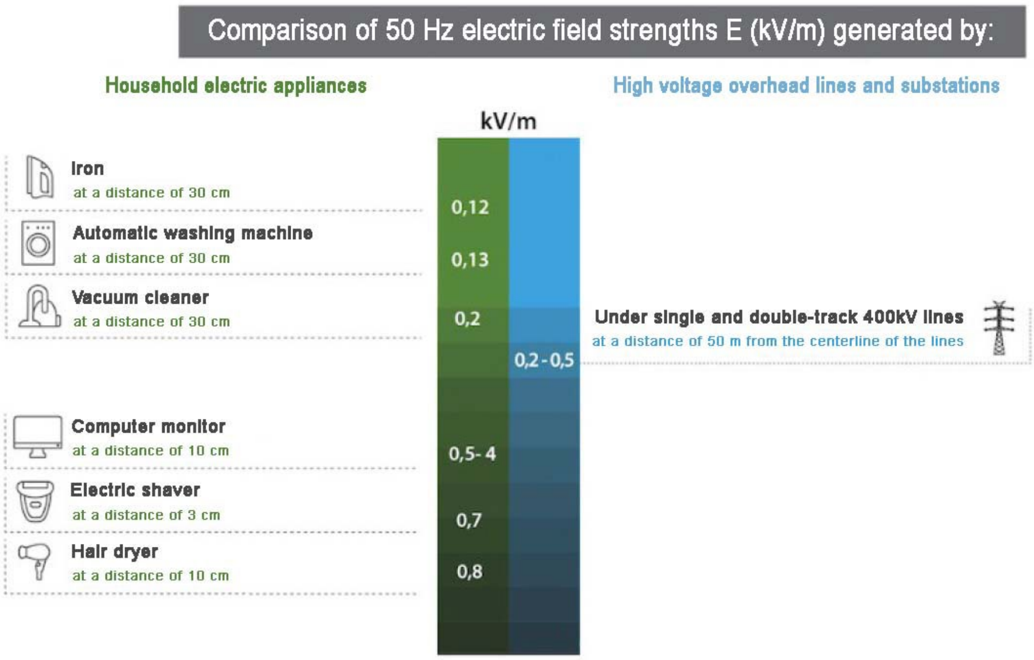

Figure 28. Comparison of 50 Hz electric field strengths (kV/m) generated by household electric appliances and extra high voltage overhead lines (Source: http://budowalinii400kv.pl/).

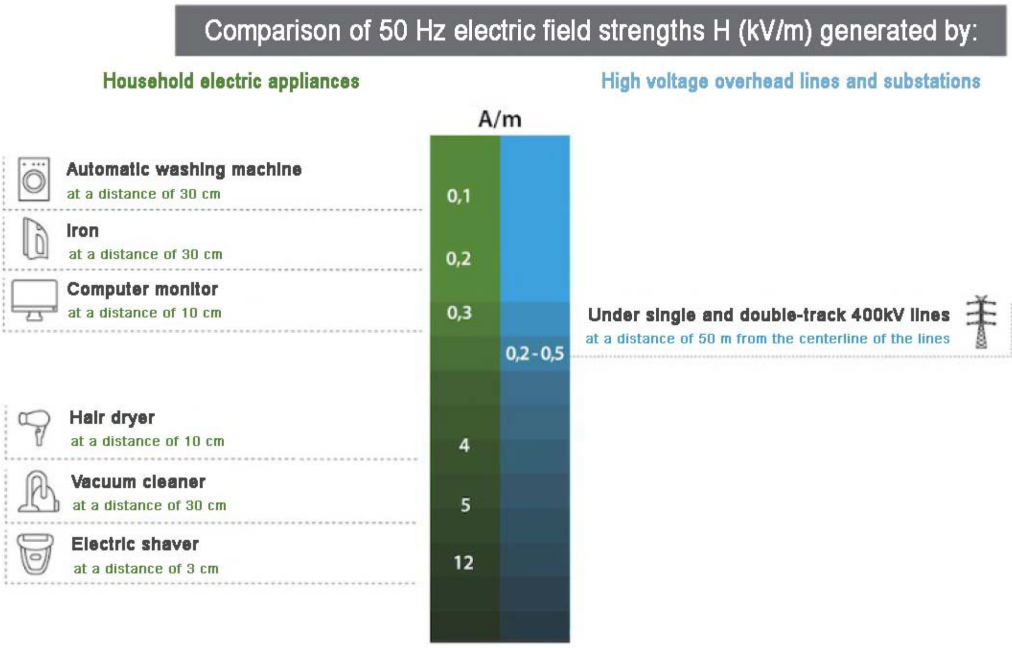

Figure 29. Comparison of 50 Hz electric field strengths (A/m) generated by household electric appliances and extra high voltage overhead lines (Source: http://budowalinii400kv.pl/).

The power equipment included in the power generation and output facilities will be certified to meet PEM generation standards. Excessive impacts of electromagnetic fields on humans are not expected. It should be emphasized that the power equipment used for power generation and power output will be the equipment commonly used in power systems around the world for the generation and transmission of electricity.

A detailed characteristics of electromagnetic field emitting devices along with the analysis of their impact during operation will be developed as part of the EIA Report.

Heat emissions 11.2.5

During normal operation of the power plant, a byproduct of electricity generation is waste heat in the form of steam, which has already completed operation in the turbine, but its parameters do not allow further process use. The heat is collected from the cooling system water on the condenser and then dissipated in the external cooling system (once-through or closed cooling system). According to the information submitted by the technology provider, GE-Hitachi, the waste heat remaining from one BWRX-300 reactor will be approx. 570 MW. A detailed characteristics of heat emitting devices along with the analysis of their impact during operation will be developed as part of the EIA Report.

Radiation emissions 11.2.6

During normal operation, emission of radioactive substances at levels that comply with the applicable law will be possible. The volume of permissible emissions will ultimately be specified in the construction license, and detailed in the power plant operating license issued by the President of the National Atomic Energy Agency [Poland].

According to the Environmental Impact Forecast of the Polish Nuclear Power Program and the European Utility Requirements for LWR Nuclear Power Plants, Rev. D, during normal operation of the ESBWR, the effective annual dose (at a distance of 800 m from the reactor) is 0.002 mSv of exposure by water and 0.01 mSv by air. The total effective annual dose at a distance of 800 meters from the ESBWR (with a capacity of 1520 MWe) is therefore 0.012 mSv. In accordance with the Nuclear Law Act, for people in the general population, the limit dose, expressed as an effective dose, is 1 mSv. Comparing these values, it should be noted that the effective doses received as a result of normal operation of the ESBWR are approx. 20 times lower than allowed by national regulations[19].

Due to the fact that the BWRX-300 reactor is an evolutionary development of the design of the large 1520 MWe ESBWR reactor, and assuming that the Project is implemented at the full capacity specified in the application, i.e., 2,000 MWe, it should be assumed that during the operation of the BWRX-300 reactor the permissible effective dose specified in the Nuclear Law Act will not be exceeded even if the distance from the reactor is significantly reduced.

The experience of operating nuclear power plants proves that the actual radiation doses associated with emissions of radioactive substances into the environment are much lower (usually by two orders of magnitude), i.e. they are at the level of a few µSv.

A detailed list of the types of radioactive isotopes along with emission quantities will be analyzed as part of the EIA Report.

DECOMMISSIONING STAGE 11.3

The operation period of the Nuclear Power Plant is estimated to be approx. 60 years, only then will measures be taken to decommission the nuclear facility. At the current stage of preparation of the Investment Project, it is only possible to present conceptual assumptions for decommissioning activities. For this reason, the assessment of the potential impact of decommissioning activities on the environment is general in nature. Decommissioning works will mainly consist in dismantling various types of equipment and systems, followed by demolition works. As at the construction stage, the decommissioning stage will be characterized by increased construction works whose

19 Environmental Impact Assessment Forecast of the Polish Nuclear Power Program taking into account the conclusions and comments of the public and environmental protection authorities

task will be to dismantle the infrastructure. These works will be accompanied by noise emissions caused by the equipment used. The dismantling of infrastructure will cause increased vehicle traffic. It is possible that periodic dust load will occur. If there is more dust load, use sprinkling. During the decommissioning stage of the project, however, it is inevitable that a significant amount of waste will be generated. Before demolition works begin, the power plant area will be checked for radiation to identify areas of special risk. Waste generated during decommissioning of power plants:

- conventional waste will be properly secured and transferred to be disposed of to a company with the legally required licenses;
- radioactive waste will be properly collected, processed, stored and transferred for storage to a qualified and licensed enterprise.

Decommissioning of the nuclear facility will be preceded by the Investor obtaining a demolition permit for the nuclear facility – issued under the Construction Law. In accordance with the EIA Act, the demolition license will be preceded by obtaining of the decision on environmental conditions by the Investor. Decommissioning of the nuclear facility will therefore be covered by a separate procedure for the decision on environmental conditions.

Noise emission 11.3.1

Decommissioning works will generate noise of a similar nature and intensity to construction works. The main emitting devices will be machinery used for demolition and transportation works. Noise intensity will depend on the degree of intensification of the works. Preventive measures will be applied to reduce negative impacts, similar to those used at the construction stage of the Investment Project. Machinery will be in good working order and will not be left idle, and the works will be properly organized. A detailed schedule of decommissioning works along with the necessary assessment of the impact on environmental components will be analyzed at a later stage of the Investment Project. Updating the power plant decommissioning schedule and method will also be done during the operation of the power plant.

Gas and dust emissions into the air 11.3.2

During decommissioning works involving the crushing of concrete structures, a certain amount of dust and particulate matter will be released. To avoid excessive dust emission during the most adverse weather conditions and the most intensive works, water curtains will be used to minimize the effects of demolition activities.

Both heavy construction equipment and vehicles used to transport waste and other materials will release exhaust fumes into the atmosphere. The nature and extent of these releases will depend on the type of equipment used and the intensity and duration of its operation, and will be similar to those generated during the construction stage of the Project.

Emissions into the groundwater environment 11.3.3

The power plant decommissioning activities are not expected to cause significant topography changes. They are also not expected to have any additional impact on the deterioration of the quality of the groundwater environment compared to that observed during the construction and operation stage of the power plant. Potential threats to groundwater quality could be unanticipated equipment failures resulting in uncontrolled leaks of operating fluids directly into the ground. However, appropriate mitigation measures will be taken to reduce the risk of failures or accidents that could result in spills. The mitigation measures will include the use of operational equipment that meets appropriate standards, only properly qualified and trained operators will operate the equipment, the construction site will be equipped with special means to absorb potential spills, refueling and any repairs to construction equipment and machinery will be carried out only in a specially marked and secured area.

A detailed description and analysis of the possible types and quantities of substances that could potentially be emitted into the groundwater environment will be presented as part of the EIA Report.

Electromagnetic emissions 11.3.4

At the end of operation, power generation equipment will be disconnected and removed from the power plant. Electromagnetic fields generated by generating equipment will disappear with the termination of their operation. The power lines that constitute the connection lines to the NPS and the direct line to the Anwil plants will be removed. No electromagnetic impact is expected during decommissioning of the Project. This stage will not use any equipment whose operation could cause an above-normal impact of electromagnetic fields. Any electrical equipment used during demolition works will be powered by low-voltage lines or portable power generator sets and will operate at 220 V or 400 V supply voltage, i.e. at low voltage, like all household appliances, hence the electromagnetic fields they generate will be negligible compared to the prevailing electromagnetic background.

At the stage of decommissioning, appropriate technical and organizational measures will be applied to the relevant emissions to reduce the harmful environmental impact, so that there will be no above-normative impact of the factor on people and the environment.

Radiation emissions 11.3.5

Prior to the commencement of the decommissioning stage, both radioactive waste and spent nuclear fuel previously stored at the Nuclear Power Plant site will be removed and moved to the National Radioactive Waste Repository and spent nuclear fuel storage or spent fuel repository, respectively, if available. All equipment will be inventoried for potential radioactive contamination, removed from the power plant and properly managed so that it does not pose an emission risk during demolition works.

As already mentioned in Chapter 9.3 Decommissioning Stage, decommissioning of the nuclear facility will be preceded by obtaining of a demolition permit for the nuclear facility by the Investor – issued under the Construction Law. In accordance with the EIA Act, the demolition license will be preceded by obtaining of the decision on environmental conditions by the Investor. The decommissioning of the nuclear facility will therefore be covered by a separate procedure for the decision on environmental conditions, which will describe in detail the quantities of radioactive waste generated and potential radiological emissions, which will be determined on the basis of the power plant's operating experience.

POSSIBLE TRANSBOUNDARY ENVIRONMENTAL IMPACT 12

Procedure for transboundary environmental impact shall be carried out in the case of projects implemented within the borders of Poland, which could affect the environment on the territory of the neighboring countries of the parties to the Espoo Convention. If the possibility of a transboundary environmental impact of a planned project is identified during the environmental impact assessment procedure, it is necessary to initiate interstate procedures related to transboundary impacts. According to the Convention on environmental impact assessment in a transboundary context (Journal of Laws of 1999, No. 96, item 1110), with regard to the planned project, due to the scale of the project and preventive measures, there are no prerequisites for conducting an environmental impact assessment procedure in a transboundary context.

To date, the international approach to the implementation of Nuclear Power Plant projects has been characterized by the fact that these projects, even despite the demonstration of their lack of impact on people and the environment (including in the event of an accident), are treated as projects with transboundary environmental impacts. There is currently no developed approach in this regard for small modular nuclear reactors (SMRs), characterized by a number of favorable safety features compared to large reactors and posing less potential risk to the environment, including, in particular:

- lower power output level (up to 1000 MWth),
- smaller quantities of nuclear fuel,
- less accumulated radioactive material in the reactor core.

It should also be noted that the design solutions of SMRs use passive safety systems (which do not require continuous power supply to perform their safety function) and inherent safety features which increases the intrinsic safety of such reactors, limits the size of the emergency planning zone.

SAFETY FEATURES OF THE BWRX-300 TECHNOLOGY 12.1

The BWRX-300 modular reactor features unique design solutions that guarantee a high level of safety. Among the most important design solutions to ensure the practical elimination of the possibility of severe accidents are:

a. use of reactor vessel isolation valves: the BWRX-300 reactor pressure vessel is equipped with isolation valves that provide rapid isolation of the broken pipeline, helping to mitigate the consequences of the LOCA. All large piping systems, of such size that their rupture could result in the LOCA, are provided with double isolating valves that are an integral part of the reactor pressure vessel;

b. no safety relief valves: pressure relief valves have been eliminated from the BWRX-300 design. A high-capacity Isolation Condenser System provides protection against excessive overpressure in the reactor. Historically, safety valves were the most likely cause of the LOCA, so they were eliminated from the BWRX-300 design, and the fulfillment of their function was provided by another solution (ICS);

c. the passive nature of the above-mentioned reactor core Isolation Condenser System (ICS): performing its function without the need for power, using the law of gravity and natural convection, which determines its high reliability;

d. the use of a dry containment: the BWRX-300 reactor has a dry-type containment, which provides effective containment of steam, water and fission product emissions following a hypothetical LOCA;

e. passive containment cooling system (PCCS) to ensure that the temperature and pressure inside the containment are maintained within design limits. The system performs its function when required without the need for power supply and using the law of gravity and natural convection, which determines its high reliability.

The aforementioned solutions make it possible to ensure that the probability of a severe accident resulting in releases of radioactive substances into the environment is much lower than national and international requirements. Polish regulations require that the frequency of hypothetical accidents that could result in large releases be less than 10^{-6}/year (once in a million years), which is consistent with the International Atomic Energy Agency's (IAEA) INSAG-12 recommendations. In comparison, the probability of hypothetical accidents resulting in large releases for the BWRX-300 project is estimated at 10^{-8}/year (once every hundred million years).

PRACTICAL ELIMINATION OF THE CONSEQUENCES OF THE ACCIDENT 12.2

The international approach introduces the practical elimination concept, providing a basis for the practical elimination of the consequences of a nuclear reactor accident and, in particular, the release of radionuclides leading to harmful impact on people and the environment.

The practical elimination concept was introduced as a result of accidents in Three Mile Island and Chernobyl to explicitly incorporate the "defense-in-depth" concept for severe accidents. The use of the "defense-in-depth" strategy ensures the prevention and control of incidents and potential accidents at several levels of an engineering and procedural nature. This ensures that additional physical barriers protecting radioactive substances from release are effectively protected. The "defense-in-depth" strategy is supported by strengthening the inherent safety features of the reactor (resulting from physical phenomena naturally associated with the reactor's design, such as a strong negative reactivity coefficient) and lessons learned from deterministic and probabilistic safety analyses conducted to assess and optimize the overall design of the power plant.

BWRX-300 SMRs are designed to provide a controlled state and maintain the "confinement" function of radioactive substances, in such a way that any consequences of an accident that could potentially result in early or large releases of such substances, requiring protective measures and intervention, are virtually eliminated.

As a result thereof, the design scope of the facility's states should be extended to include not only the ability to defend against various emergency states, but also practical measures aimed at stopping the development of severe accidents and virtual elimination of their potential consequences. Consequences are considered practically eliminated if releases of radioactive isotopes are either physically impossible to occur or can be considered improbable with a high degree of certainty.

Compared to reactors currently in operation in the world, the BWRX-300 reactor is structurally simpler, and the entire safety concept is based primarily on passive safety systems and inherent safety features (such as lower capacity, and thus less residual heat for cooling). These safety features increase the so-called safety margins ensuring the effectiveness of physical safety barriers for radioactive substance containment and virtually eliminate the possibility of reactor core degradation conditions and the possibility of large radiation releases. Consequently, dependence on the containment and emergency response measures is reduced. For the postulated scenarios that could result in the containment vessel function failure or its bypassing, the avoidance of early or large releases is appropriately achieved by demonstrating practical elimination for each individual case, by showing that the scenario is either physically impossible or extremely unlikely to occur with a high degree of certainty.

Considering that the frequency of hypothetical failures that could lead to large releases is approx. 10^{-8}/year for the BWRX-300 project, it is reasonable to treat this value as an argument for practical elimination. In addition, probability assessments are supplemented by deterministic analyses of physical phenomena and functionality of design provisions. By including additional beyond-design-basis safety measures in the design, it is demonstrated that radioactive releases that could pose a hazard to the public and the environment are physically impossible to occur.

In addition, the Investor will present in the EIA Report an analysis of the effects of the release of radionuclides for the adopted hypothetical accident scenario, proving the absence of harmful impact on people and the environment.

Due to the implementation of the Project at a considerable distance from the borders of the Republic of Poland, the Investor does not expect that the planned Project may have a transboundary impact on neighboring countries when taking into account other types of impacts.

13 AREAS SUBJECT TO PROTECTION UNDER THE ACT OF APRIL 16, 2004 ON NATURE CONSERVATION, LOCATED WITHIN THE RANGE OF SIGNIFICANT IMPACT OF THE PROJECT

Pursuant to Article 6 point 1 of the Act of April 16, 2004 on nature conservation (Journal of Laws of 2022, item 916, as amended), the forms of nature conservation are: national parks, nature reserves, landscape parks, protected landscape areas, Natura 2000 sites, monuments of nature, documentation sites, ecological arables, landscape-nature complexes, plant, animal and fungi species protection.

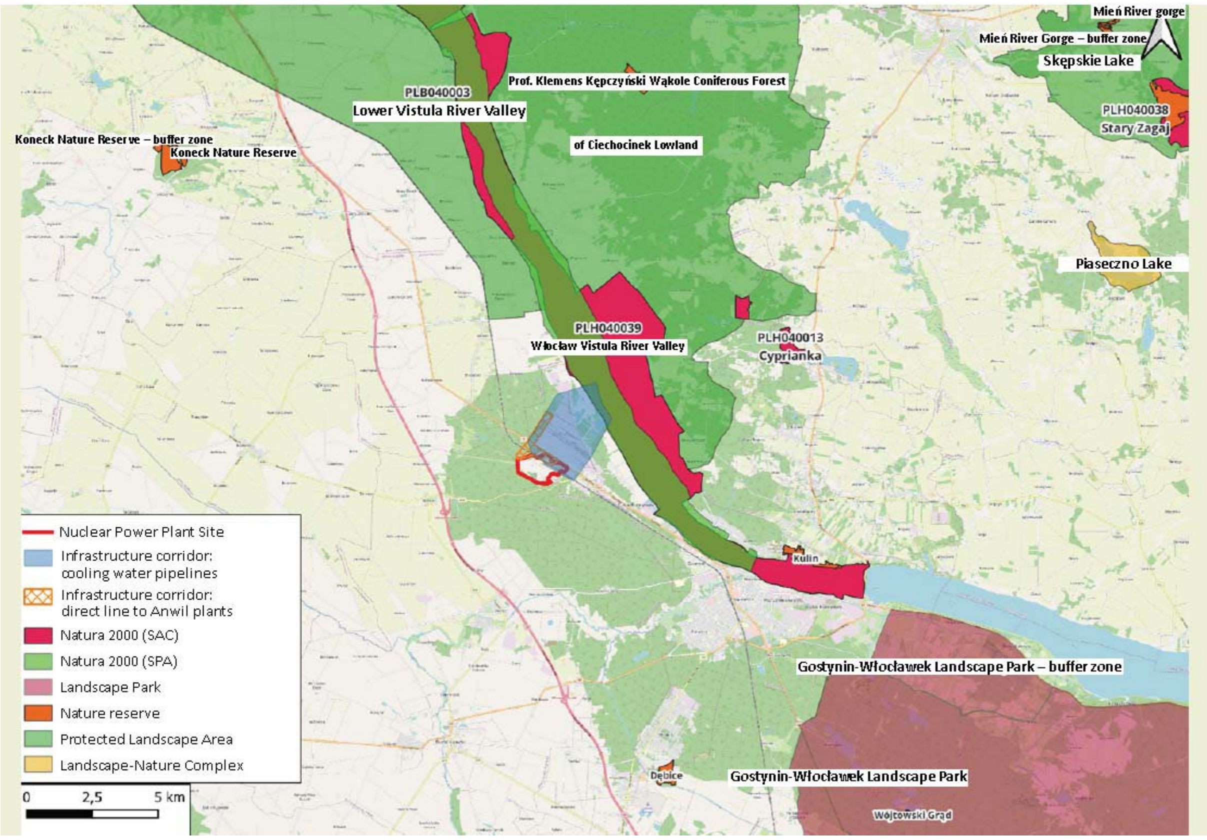

Figure 30. The Site against protected areas (source: own study based on OpenStreetMap materials and https://geoserwis.gdos.gov.pl/mapy/)

CLOSEST PROTECTED AREAS (Figure 30):

- Włocławska Dolina Wisły PLH040039 Natura 2000 site (SAC) – at a distance of approx. 3 km east of the Site, borders with the area of the cooling water channel infrastructure corridor.
- Cyprianka PLH040013 Natura 2000 site – at a distance of approx. 10 km in the western direction
- Dolina Dolnej Wisły PLB04003 Natura 2000 site (SAC) – at a distance of approx. 3 km east of the Site, borders with the area of the cooling water channel infrastructure corridor.
- Nizina Ciechocińska Protected Landscape Area – at a distance of approx. 3 km in the eastern direction
- Jezioro Skępskie Protected Landscape Area – at a distance of approx. 23 km in the north-eastern direction
- Gostynińsko-Włocławski Landscape Park with its buffer zone – at a distance of approx. 13 km in the south-eastern direction
- Jezioro Piaseczyńskie Nature-Landscape Complex – at a distance of approx. 22 km in the north-eastern direction

- Koneck Nature Reserve with its buffer zone – at a distance of approx. 18 km in the north-western direction
- Prof. Klemens Kępczyński Bór Wąkole Nature Reserve – at a distance of approx. 14 km in the northern direction
- Dębice Nature Reserve – at a distance of approx. 12 km in the south-eastern direction
- Wójtowski Grąd Nature Reserve – at a distance of approx. 18 km in the south-eastern direction
- Kulin Nature Reserve – at a distance of approx. 10 km in the south-eastern direction from the Site

NATURA 2000 SITE – SPECIAL AREAS OF HABITAT CONSERVATION (SAC)

- The Special Area of Habitat Conservation ("Włocławska Dolina Wisły" PLH040039SAC Natura 2000 SAC), with a surface area of 4763.76 hectares, is located in the north-western part of Kotlina Płocka, which is a fragment of Pradolina Toruńsko-Eberswaldzka and is an approximately 30-kilometer section of the Vistula River Valley between the dam in Włocławek and Nieszawa. The refuge area includes the riverbed and floodplain terraces with the surrounding area, with locally occurring and steep valley slopes. Habitat conditions and the vegetation cover of the valley bottom of this section of the Vistula River are shaped by the direct contribution of the river's water. Within the accumulation area, immediately adjacent to the riverbed, initial habitats have formed, and the primary succession of vegetation is associated with the initial stages of soil development. Within old river beds, biological accumulation occurs, leading to natural terrestrialization processes. Habitat diversity in the cross-section of the valley bottom is shaped by the current state and dynamics of hydration and is associated with the mechanical composition of surface formations.

  The area is primarily important for the protection of riparian forests and natural habitats, characteristic of the valley of a large lowland river, and associated fauna, including fish species from Annex II of Council Directive 92/43/EEC. A total of 8 types of habitats from Annex I of Council Directive 92/43/EEC and 5 species of animals from this directive, and in addition, 22 species of plants and animals listed in regional and local red lists, 7 species of plants and animals protected under international conventions, 60 species of animals and plants rare in Poland, have been found in the refuge. Within the boundaries of the area there are relict sites of valuable xerothermic plant species that include psammophilous species. Another group of great importance for the protection of this area comprises species typical of riverside habitats. The area is also important in terms of bird protection. 52 species of birds from Annex I of Council Directive 79/409/EEC and 46 species of migratory birds not listed in the Annex have been found here. The area includes part of the Vistula River ecological corridor, which has been identified as a priority area for protection in the ECONET and IBA networks, important for the migration of numerous species[20].

- Special Area of Habitat Conservation (“Cyprianka” PLH040013 Natura 2000 SAC) with a surface area of 109.28 ha. The area includes a complex of post-excavation peat pits and natural dystrophic water bodies located northwest of Cyprianka. It includes two types of water bodies. The first one is a dystrophic water body about 150 m long, about 100 m wide and 1 m deep, while the second type is an extensive complex of post-peat pits located in a low peat bog measuring about 1.5 km in length, which were created as a result of machine mining of peat deposits. The aquatic vegetation of the first type of water bodies consists primarily of Potametea class species (Canadian waterweed Elodea canadensis, floating pondweed Potamogeton natans, hornwort Ceratophyllum demersum and water soldiers Stratiotes aloides) and of Phragmitetea class (common reed Phragmites communis, broadleaf cattail Typha latifolia, water horsetail Equisetum limosum). The immediate surroundings of the water bodies comprise communities of marsh Salicetum pentandro-cinereae transitioning into swampy pine forest Vaccinio uliginosi-Pinetum. The vegetation of the post-peat pits complex is dominated by plant communities of the Potametea class, among which by far the predominant communities are those of Canadian pondweed Elodeetum canadensis and floating pondweed Potametum natantis, bordering on the landward side by patches of yellow water lily, white water lily Nuphareto-Nymphaeetum albae and broadleaf cattail Typhetum latifoliae.

  Within the Cyprianka PLH040013 Natura 2000 site, the identified subject of protection is the priority species *6236 lake minnow (Eupallasella perenurus = Phoxinus percnurus)[21].

NATURA 2000 SITES – SPECIAL PROTECTION AREAS FOR BIRDS (SPA)

- Special Protection Area for Habitats (“Dolina Dolnej Wisły PLB04003 Natura 2000 SPA) with a surface area of 33559.04 hectares, extended along an over 260-kilometer section of the Vistula River. It is a national bird refuge of international rank PL028 (Wilk et al. 2010). In many places in the terrace zone there are extensive wet meadows. Old river beds and remnants of riparian forests are present on the floodplain terrace.

The area is home to 28 birds species from the list of Annex I of the Birds Directive; 9 species are included in the Polish Red Book. During the breeding season, the area is important for the following bird species listed in Annex I of the Birds Directive: western marsh-harrier, common tern, little tern, kingfisher and barred warbler, as well as for 5 species not included in Annex I of the Birds Directive: common shelduck, goosander, little ringed plover, common sandpiper, European herring gull and sand martin. During

20 Standard Data Form of the “Włocławska Dolina Wisły” PLH040039 Natura 2000 site
21 Standard Data Form of the Cyprianka PLH040013 Natura 2000 SAC

the 2011–2012 survey of non-breeding birds, 59 species of water birds and wetland birds were found, including 16 species from Annex I of the Birds Directive. The population of at least 4 species exceeded the threshold of 1% of the migratory population: common goldeneye, mallard, bean goose, common crane. In addition, during spring, autumn and winter, bird concentrations exceeded 20,000 individuals[22].

PROTECTED LANDSCAPE AREA

- Nizina Ciechocińska Protected Landscape with a surface area of 38236.34 hectares, established to protect the biodiversity of habitats, microclimatic values of the Ciechocinek health resort and the Vistula River landscape. An important element of protection covers forest areas with dominant pine forests and rivers Vistula, Tążyna and Mień with the adjacent vegetation zone, mainly broadleaved forests. Forests are a permanent and very important component of the vegetation cover. They occupy a total surface area of approx. 1150 hectares, accounting for 3% of the total surface area. These are mainly pine forests of great importance for the microclimate of Ciechocinek.

  In the area of the Nizina Ciechocińska Protected Landscape Area there is a unique "Ciechocinek" saltmarsh reserve, as well as the prof. K. Kępczyński "Bór Wąkole" forest reserve and the valuable Zielona Kępa ecological site with the European feather grass. Within the boundaries of the unit there are fragments of three Natura 2000 sites: "Dolina Dolnej Wisły", "Nieszawska Dolina Wisły" and "Włocławska Dolina Wisły". A number of protected plant and animal species have been recorded in the protected area, including the gray wolf[23].
- The Skępskie Jezioro Protected Landscape Area with a surface area of 12698.73 hectares, is located within Wysoczyzna Dobrzyńska upland, in the eastern part of the Skrwa sandur. The purpose of protection is to preserve the biodiversity of the habitats of the Skępe forest complex, to protect a fragment of the Wysoczyzna Dobrzyńska upland, including the spring areas of the meandering Mień River, as well as to protect surface water bodies (natural, flowing and standing) along with the zone of surrounding vegetation[24].

LANDSCAPE PARK

- Gostynińsko-Włocławski Landscape Park and its buffer zone with a surface area of 531 km^2. The Park landscape is characterized by the dominance of forest vegetation; forests account for 62.4% of the Park area, agricultural land for 23.4%. Forests are dominated by pine forest and mixed forest communities. Within the park boundaries, approx. 800 species of vascular plants have been found, and

22 Standard Data Form of the Dolina Dolnej Wisły PLB04003 Natura 2000 SPA
23 Resolution No. XI/257/19 of the Sejmik of the Kujawsko-Pomorskie Voivodeship of November 13, 2019, on the Ciechocińska Nizina Protected Landscape Area
24 Resolution No. XIV/287/20 of the Sejmik of the Kujawsko-Pomorskie Voivodeship of February 24, 2020, on the Jezioro Skępskie Protected Landscape Area

many of them are protected and rare. Among animals, the most valuable group is the ornithofauna, especially water and wetland birds, for which a separate form of protection has been designated – the Błota Rakutowskie Natura 2000 Special Protection Area (SPA) for birds.

There are 19 nature reserves in the park, including 5 reserves in areas administered by the Włocławek Forest District: Jazy, Olszyny Rakutowskie, Gościąż, Grodno, Wójtowski Grąd[25].

LANDSCAPE-NATURE COMPLEX

- Jezioro Piaseczyńskie Landscape-Nature Complex with a surface area of 159 hectares – the purpose of protection is to preserve the ecosystem of Jezioro Piaseczyńskie. The dominant object of protection is the Phytocenotic type (PFi), non-forest communities (zn) subtype. Due to the main type of ecosystem, Miscellaneous Ecosystems (EE) type, mosaic of various ecosystems (me) subtype will be distinguished[26].

NATURE RESERVE

- Koneck Nature Reserve with a surface area of 81.23 hectares. Phytocentric type forest reserve, forest community subtype, forest and coniferous ecosystem, lowland forest ecosystem subtype. The aim of protection in the reserve is to secure and preserve forest communities that are rare in this part of lowland Poland – the Kujawy continental broadleaved forest, and the moist thermophilous oak forests with protected species and rare plant species[27].
- Prof. Klemens Kępczyński Bór Wąkole Nature Reserve with a surface area of 46.88 hectares. Phytocentric forest reserve, forest community subtype, forest and coniferous ecosystem type, lowland forest subtype. The reserve is located in inland dune areas with numerous population of juniper[28]. The protection of the reserve is aimed at preservation of the forest area – juniper forest on inland dunes.
- Dębice Nature Reserve with a surface area of 41.92 hectares. Phytocentric type forest reserve, forest community subtype, forest and coniferous ecosystem, lowland forest ecosystem subtype. The aim of the protection of the reserve is the preservation of typically developed thermophilous oak forest and rare and protected plant species occurring in it[29].
- Wójtowski Grąd Nature Reserve with a surface area of 3.52 hectares. Located

25 https://wloclawek.torun.lasy.gov.pl/
26 Ordinance No. 279/01 of the Governor of Kujawsko-Pomorskie Voivodeship of October 2, 2001
27 Koneck Nature Reserve [in:] Central Register of Nature Conservation Forms [on-line]. General Directorate for Environmental Protection (access on: April 15, 2023)
28 Prof. Klemens Kępczyński Bór Wąkole Nature Reserve [in]: Central Register of Nature Conservation, General Directorate for Environmental Protection (access in April 2023)
29 Dębice Nature Reserve [in:] Central Register of Nature Conservation, General Directorate for Environmental Protection (access in April 2023)

within the Gostynińsko-Włocławski Landscape Park. Forest reserve, phytocentric type, forest community subtype, forest and coniferous ecosystem type, lowland coniferous forest ecosystem subtype. The aim of the protection of the reserve is to preserve the complexes of mixed deciduous and coniferous forest, which are rare in dune areas, with rusty-brown soils developed in this area[30].

14 OTHER PROJECTS UNDER CONSTRUCTION AND COMPLETED

The Project is planned in an anthropogenically transformed area with a strong industrial character. In the immediate vicinity of the planned Project site there are the Anwil chemical plants of the ORLEN group, the Włocławek CCGT, a railroad line, a logistics company, a construction plant or a national road. Each of these activities is characterized by its specificity, including also various environmental impacts – with respect to their type, range, time scope and scale.

Emission and disturbances that may occur as a result of the Project will be identified, and their impact on the environment will be analyzed and assessed during the preparation of the EIA Report. The impacts of neighboring projects, both under construction and completed, located in the area of impact of the planned Project will also be identified – to the extent that their impacts may result in impacts cumulated with the planned Project.

15 RISK OF A SERIOUS ACCIDENT OR NATURAL DISASTER AND STRUCTURAL COLLAPSE

To avoid the risk of a serious industrial accident and structural collapse resulting from, e.g., a natural disaster, prescreening analyses were carried out on behalf of the Investor to identify, i.a., potential natural and human-related hazards in the Site Region. Analyses have shown that there are no factors that absolutely exclude the possibility of setting the foundation of a nuclear power plant in the analyzed area. With proper building permit design and proper performance of works, the possibility of a structural collapse risk is minimized. Proper management and protection of chemicals, as well as adherence to safety procedures, will in turn ensure that the risk of an industrial accident hazard is minimized.

30 Wójtowski Grąd Nature Reserve [in:] Central Register of Nature Conservation, General Directorate for Environmental Protection (access in April 2023)

RISK OF A SERIOUS ACCIDENT 15.1

In accordance with Article 3 section 23 of the EIA Act, the term serious accident means an event, in particular emission, fire or explosion, occurring in the course of an industrial process, storage or transport, in which one or more hazardous substances occur, leading to the immediate hazard to life or health of people or to the environment or the delayed occurrence of such a hazard.

The project is classified as a plant associated with the possibility of a serious industrial accident – in accordance with Article 248 of the Environmental Protection Law (Journal of Laws of 2022, item 2556, as amended) and the Ordinance of the Minister of Development of January 29, 2016 on the types and quantities of hazardous substances whose presence in a plant determines its classification as a plant with an increased risk or a plant with a high risk of a serious industrial accident (Journal of Laws 2016, item 138).

It is highly probable that the Project will be classified as a plant with a high risk of a serious industrial accident, but a detailed inventory of the chemicals that will be stored in the plant will be prepared during the development of the EIA Report for the Project.

RISK OF A NATURAL DISASTER 15.2

Pursuant to Article 3 section 1 point 2 of the Act of April 18, 2002 on the state of natural disaster (Journal of Laws of 2017, item 1897), a natural disaster shall be understood as an event related to the impact of forces of nature, in particular lightning strikes, seismic shocks, strong winds, heavy atmospheric precipitation, prolonged occurrence of extreme temperatures, landslides, fire incidents, droughts, floods, icing growth on rivers and sea, lakes and reservoirs, mass occurrence of pests, diseases of plants or animals or infectious diseases of people or an impact of other elements.

The main natural hazards that can have a negative impact on the safety of nuclear power plant operation, recognized by nuclear experts worldwide, are seismic phenomena and tectonic activity in the region. Therefore, on behalf of OSGE, the Site was covered by prescreening analyses performed by the Institute of Geophysics of the Polish Academy of Sciences (IGF PAN) for seismicity and tectonic activity. The analyses conducted showed that there were no exclusionary factors from natural and induced seismicity in both the Site Region and the Site Area. The Site region is characterized by a stable tectonic structure with a low risk of fault throw activation. Preliminary analyses of the Region's seismicity have shown that the maximum possible earthquake could cause ground accelerations of 0.071 g.

In addition, as part of the prescreening analyses commissioned by OSGE, the analyzed Site was assessed by the Central Mining Institute, whose task was to identify natural phenomena and hazards in the field of geology, that could have a significant impact on the safety of NPP operation. According to the Central Mining Institute report, there is no possibility of a natural disaster in the form of landslides, liquefaction of soil, suffosion or flood risk on the Site due to geological conditions.

Other natural disaster risk is associated with extreme meteorological and hydrological phenomena, in the form of violent storms and gusty winds or prolonged periods of drought. Depending on the preparedness of the population and the structural features of civil structures, the effects of a natural disaster can vary dramatically. For example, gusty winds, depending on the building permit design of the building, can be completely imperceptible to a solid structure or cause the roof to tear off for older types of buildings. The building permit design of the planned nuclear power plant will be adapted to local conditions in such a manner as to ensure its safe operation even under a combination of adverse meteorological, seismic, hydrological, etc. conditions.

Both the structure and the safety systems used ensure safe operation of the nuclear power plant under the most demanding conditions. To confirm the correctness of the architectural and construction design of the power plant and the solutions used therein, the Site of the planned Project will be subjected to meteorological monitoring and a detailed analysis of meteorological phenomena, along with anticipated changes in their intensity and frequency in the future, taking into account progressive climate change.

When analyzing the Project resilience to climate change, the following in particular will be assessed: resistance to prolonged droughts, violent winds, heat waves, cold waves, extreme precipitation, violent storms, intensive snowfall, lightning strikes, seismic phenomena, risk of flooding, freezing and thawing. The aforementioned monitoring and analyses will be performed at the stage of site surveys, which are necessary for the detailed evaluation of the Site and for the development of the location report which is attached to the application for the construction permit. The above documents will be assessed by experts of the National Atomic Energy Agency [Poland] at the stage of issuing the construction permit.

RISK OF A STRUCTURAL COLLAPSE 15.3

Pursuant to Article 73 section 1 of the Construction Law (Journal of Laws of 2023, item 682, as amended), a structural collapse is an unintentional, violent destruction of a civil structure or part thereof, as well as structural elements of scaffolding, elements of forming devices, sheet piling and excavation support.

The idea of building Small Modular Reactors (SMRs) is based on the assumption that the volume of construction works on the Investment Project site will be reduced to the necessary minimum, and a significant part of the elements that make up the entire

Project will be delivered to the site in the form of prefabricated components. Prefabricated components will be manufactured in specialized factories to ensure the quality and durability of these components, and then the components will be transported to the construction site. This approach significantly reduces the scope of construction works performed on the construction site, thus dramatically reducing the risk of a structural collapse during construction. Construction works will be carried out in accordance with the applicable regulations, permits and standards by specialized companies with relevant experience, which will ensure the appropriate quality of the works performed.

It should be added that the building permit design will be adapted to local geological conditions, also taking into account meteorological conditions that may occur on the Site, potential hazards of explosions from nearby industrial plants, or a passenger airplane crash.

It is also not insignificant that both the power unit and the technical infrastructure and auxiliary buildings will be subjected to regular and detailed inspections and ongoing maintenance to ensure their trouble-free operation throughout the life cycle of the Project, starting from the commencement of construction until the end of its decommissioning. Regular safety inspections will be carried out by the power plant personnel, public administration authorities and expert international organizations such as the IAEA.

The planned Project involves the construction of a nuclear power plant using proven yet modern technologies. The Investor undertakes to perform all possible construction works in accordance with the applicable regulations and legal norms, in particular bearing in mind the provisions of the Construction Law, including the Ordinance of the Minister of Infrastructure of February 6, 2003 on occupational health and safety during construction works (Journal of Laws of 2003 No. 47 item 401). All civil and erection works will be carried out only by qualified workers, in accordance with OH&S rules.

It is important to emphasize the fact that the nuclear industry, compared to other types of industries, is characterized by the application of extraordinarily safety principles referred to as the “safety culture” – this approach consists primarily in promoting certain behaviors and habits among workers. They must strictly adhere to specific operating procedures in their works and pay close attention to any failure, and be sensitized to any irregularities in the operation of equipment or other workers.

In view of the above, it should be concluded that the risk of a structural collapse, as understood under the provisions of the Construction Law, should be considered marginal, and in the event of its occurrence, its impact will not go beyond the area limited by the fence of the power plant.

EXPECTED AMOUNTS AND TYPES OF WASTE GENERATED AND THEIR IMPACT ON THE ENVIRONMENT 16

During the life cycle of the nuclear power plant, waste will be generated at various stages of operation:

- **Conventional** (municipal and industrial waste)
- **Radioactive waste:**

  Low-activity

  Medium-activity

  High-activity

The largest amounts of conventional industrial waste will be generated at the construction and decommissioning stages of the power plant. Municipal waste in moderate amounts will be generated at each stage of the power plant life.

Radioactive waste will be generated only at the operation and decommissioning stages of the Project.

CONVENTIONAL WASTE 16.1

Generally, conventional waste is divided into two categories: industrial and municipal. In both groups, a subgroup of hazardous waste is distinguished. Municipal waste is mainly generated in households as a result of human existence, while industrial waste accompanies business activities.

RADIOACTIVE WASTE 16.2

Radioactive waste generated at the power plant will be handled in accordance with the requirements of the law – it is the organizational unit where radioactive waste or spent fuel is generated that is responsible for safety in the handling of this waste or spent fuel from the moment it is generated until it is transferred for storage.

In accordance with Article 47 section 1 of the Nuclear Law Act [Poland], radioactive waste, due to the concentration of radioisotopes, is classified into the following categories of waste:

- Low-activity
- Medium-activity
- High-activity

After the storage period, spent nuclear fuel destined for storage is classified as high-activity radioactive waste.

During operation of the BWRX-300 reactor mainly low- and medium-intensity waste will be generated. The waste will be processed in accordance with the license issued by the PAA President. After processing, the waste will be stored in an interim radioactive waste storage facility, and then it will be collected by the Zakład Unieszkodliwiania Odpadów Promieniotwórczych – public utility company (ZUOP). ZUOP, in accordance with the Nuclear Law Act, was established to carry out activities in the field of radioactive waste and spent nuclear fuel handling and, above all, to ensure the permanent storage of waste and spent fuel. The currently operating radioactive waste repository in Różan will not be able to accept waste from the operation of the planned nuclear power plant; however, the problem has been identified and, in accordance with the provisions of the National Plan for Handling Radioactive Waste and Spent Nuclear Fuel (KPPzOPiWPJ), works are in progress to select the location, build and operate a new surface radioactive waste repository. This task is the responsibility of the Ministry of Climate and Environment, ZUOP and the Polish Geological Institute – National Research Institute.

In terms of spent nuclear fuel handling, it will be safely stored in a basin at the reactor for about 8 years, after which it will be transferred to a spent fuel storage facility, where it will be stored until it is transferred for storage in a deep radioactive waste repository. Currently, there is no such a repository in Poland; however, in accordance with the National Plan for Handling Radioactive Waste and Spent Nuclear Fuel, works are in progress to identify the optimal location for a deep repository. The Ministry of Climate and Environment, ZUOP and the Polish Geological Institute – National Research Institute are responsible for this process.

CONSTRUCTION STAGE 16.3

The construction stage is characterized by intensive earthworks, construction, as well as civil and erection works, including the construction of nuclear power units, spent fuel storage facility building, interim radioactive waste storage facility, cooling systems, power output infrastructure, and other auxiliary buildings and technical infrastructure.

The performance of construction works will involve the generation of a significant amount of waste characteristic for construction, installation and finishing works. The waste catalog, in accordance with the classification contained in the waste catalog, which is an appendix to the Ordinance of the Minister of Climate of January 2, 2020 on waste catalog (Journal of Laws of 2020, item 10), is contained in Table 20.

Group code	Description
07	Waste from production, preparation, marketing and use of organic chemical industry products
08	Waste from production, preparation, trading and application of protective coatings (paints, veneers and ceramic enamels), putties, glues, sealing agents and printing paints
12	Waste from forming and physical and mechanical treatment of metal and plastic surfaces
13	Waste oils and liquid fuel waste (except for edible oils and groups 05, 12, and 19)
14	Waste organic solvents, refrigerants and propellents (excluding groups 07 and 08)
15	Packaging waste; sorbents, wiping cloths, filter materials and protective clothing not specified in other groups
16	Waste not included in other groups
17	Waste from construction, renovation and demolition of civil structures and road infrastructure (including soil and soil from polluted areas)
18	Medical and veterinary waste (excluding kitchen and restaurant waste not relating to health or veterinary care)
19	Waste from systems and equipment used for waste management, water treatment plants and treatment of potable water and water for industrial purposes
20	Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions

Table 20. Classification of waste likely to be generated on the investment project site at the construction stage (waste classification in accordance with the Waste Act (Journal of Laws of 2022, item 699, as amended)).

No radioactive waste is expected to be generated at the construction stage of the Investment Project.

A waste generator within the meaning of the Waste Act of December 14, 2012 (Journal of Laws 2022, item 699, as amended) will be the entity that performs the service involving the performance of construction works, which under the Waste Act will be obliged to manage the waste generated during construction.

During the performance of works, the Site will be cleaned up on an ongoing basis. The waste generated will be subject to quantitative and qualitative records. All the above-mentioned waste will be collected selectively and stored and then transferred to specialized companies with the necessary licenses for further management. Liquid waste until it is accepted, will be collected in closed containers in areas with a paved and impermeable surface.

Proper organization of the ongoing waste management system and proper organization of the construction site, and above all, compliance with the Waste Act and secondary legislation, will minimize the direct impact of waste on human health and life and the environment. Therefore, it is concluded that waste management at the construction stage will not have a negative environmental impact.

The detailed characteristics of the generated waste by subgroups and types of waste, along with their estimated amounts, will be determined during the preparation of the EIA Report.

OPERATION STAGE 16.4

The operation stage is characterized by the generation of both conventional and radioactive waste.

Conventional waste generated at the operation stage is expected to fall mainly into the groups in accordance with Table 21.

Group code	Description
06	Waste from production, preparation, marketing and use of inorganic chemical industry products
08	Waste from production, preparation, trading and application of protective coatings (paints, veneers and ceramic enamels), putties, glues, sealing agents and printing paints
12	Waste from forming and physical and mechanical treatment of metal and plastic surfaces
13	Waste oils and liquid fuel waste (except for edible oils and groups 05, 12, and 19)
14	Waste organic solvents, refrigerants and propellents (excluding groups 07 and 08)
15	Packaging waste; sorbents, wiping cloths, filter materials and protective clothing not specified in other groups
16	Waste not included in other groups
17	Waste from construction, renovation and demolition of civil structures and road infrastructure (including soil and soil from polluted areas)

18	Medical and veterinary waste (excluding kitchen and restaurant waste not relating to health or veterinary care)
19	Waste from systems and equipment used for waste management, water treatment plants and treatment of potable water and water for industrial purposes
20	Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions

Table 21. Classification of waste likely to be generated on the investment project site at the NPP operation stage (waste classification in accordance with the Waste Act (Journal of Laws of 2022, item 699, as amended)).

It is estimated that the main waste stream will be the waste generated from overhauls, municipal waste or waste generated from maintenance of equipment and systems.

In accordance with the information submitted by the technology provider GE-Hitachi, operation of one BWRX-300 reactor will generate mainly solid waste. The estimated annual amount of solid radioactive waste will be less than 224.00 m^3/year. The main stream of radioactive waste will be low-activity waste. Waste will be processed on the NPP site in accordance with the procedures approved by the PAA President.

Detailed characteristics of waste generated at the operation stage of the nuclear power plant by category and subcategory of waste, along with its estimated amount, will be determined during the development of the EIA Report.

DECOMMISSIONING STAGE 16.5

The decommissioning stage of the nuclear power plant will first consist in an inventory of facilities and components that may have been subject to radioactive contamination during the facility operation. Subsequently, uncontaminated facilities and elements will be subject to demolition works. The waste from the demolition of the power plant will be mainly conventional waste in the form of concrete, debris, earth masses, steel structural and system components, metals and other typical components generated during the demolition of infrastructural facilities. It should be noted that the vast majority of waste generated during decommissioning works will be conventional waste. The waste will be properly segregated and classified on the demolition site. It is estimated that most of the conventional waste will be recycled (mainly steel and other metals, concrete, glass, plastic) or other forms of recovery; only waste that proves impossible or economically inviable to recycle or recover will be transported and deposited in a suitable repository. Waste handling will be adapted to the regulations in effect at the time of the power plant decommissioning.

It is estimated that radioactive waste generated during decommissioning of nuclear facilities will account for only a few to 10% of the mass of all waste generated during decommissioning works. This waste, after appropriate preparation, will be transported by ZUOP to a radioactive waste repository.

DEMOLITION WORKS FOR PROJECTS LIKELY TO HAVE A SIGNIFICANT IMPACT ON THE ENVIRONMENT

17

In accordance with the Construction Law, demolition is a type of construction works involving the dismantling and removal from space of a specific civil structure or part thereof. The commencement of demolition works will be preceded by the Investor obtaining the necessary decisions and licenses including:

- Decision on environmental conditions – issued under the EIA Act,
- Nuclear facility decommissioning license – issued under the Nuclear Law Act,
- Nuclear facility demolition license – issued under the Construction Law Act.

The environmental impact of decommissioning and demolition works will be characterized as part of a separate environmental impact assessment procedure on a date close to the actual end of the power plant operation. Given the distant time (at least 60 years) when the demolition of the facilities will take place, and given the process progress relating to, i.a., the manner vehicles and equipment are powered, the description of the potential impact of the works as of today would not be precise.

Demolition works will be characterized by similar impacts as civil and erection works. All works will be carried out by appropriately qualified personnel under the supervision of persons with appropriate building licenses. All works will be performed after workers have been trained in OH&S.

At the time when it is necessary to perform demolition works, the Investor will fulfill all legally required formalities to allow demolition works to be performed, and during the works, the safety conditions for workers provided for by the relevant regulations will be observed.

REFERENCES 18

1. Atlas klimatu Polski (Climate Atlas of Poland) (1991–2020), Scientific Editor: Arkadiusz M. Tomczyk, Ewa Bednorz, Bogucki Wydawnictwo Naukowe, Poznań 2022
2. BWRX-300 Generic Plant Parameter Envelope 005N3953 Rev. D, April 2023
3. Central Geological Database [online access], Polish Geological Institute – National Research Institute
4. Central Register of Nature Protection Forms [available online] General Directorate for Environmental Protection, accessed April 2023.
5. Characteristics of surface water bodies, [online access] ISOK, access in April 2023.
6. Characteristics of groundwater bodies, [online access] ISOK, access in April 2023.
7. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (OJ L 327 of 22.12.2000, p. 1)
8. Directive 2009/147/EC of the European Parliament and of the Council of November 30, 2009 on the conservation of wild birds (Birds Directive), OJ EU L 20 of 26 January 2010, as amended
9. Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, OJ L 206/7 of 22 July 1992, as amended
10. Gospodarka energetyczna i gazownictwo w 2021 r. (Energy management and gas engineering in 2021), Statistics Poland, Warsaw, September 15, 2022
11. IAEA Nuclear Series No. NG-T-3.11, Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programs, 2014
12. IAEA SSR-2/1 (Rev. 1) Safety of Nuclear Power Plants: Design
13. IAEA-TECDOC-1915, Considerations for Environmental Impact Assessment for Small Modular Reactors, IAEA, 2020
14. Classification of forest habitats – comments on soils in terms of diagnosis principles, S. Brożek, 2007
15. Convention on environmental impact assessment in a transboundary context (Journal of Laws No. 1999, No. 96, item 1110)
16. Kryteria wyboru lokalizacji elektrowni jądrowej w Polsce, Logistyka – nauka (Selection criteria for nuclear power plant sites in Poland, Logistics – science), 5/2011, 544-551, Fabisiak J., Kupiński J., Michalak J., Nowik H., 2011
17. Mapa Geośrodowiskowa Polski (II) (Geoenvironmental Map of Poland (II)) Chart A 1:50 000, sheet Bobrowniki (402), PIB-BIP, compiled by K. Seifert, 2016
18. Mapa Geośrodowiskowa Polski (Geoenvironmental Map of Poland) Chart (II) B 1:50 000, sheet Bobrowniki (402), PIB-BIP, compiled by E. Gawlikowska, P. Różański, 2016
19. Mapa hydrogeologiczna Polski w skali 1:50 000 (Hydrogeological map of Poland at a scale of 1:50,000), sheet Bobrowniki (402), compiled by A. Narwojsz, M. Odoj, 2002.
20. MIT Energy Initiative, “The Future of Nuclear Energy in a Carbon-Constrained World”, 2018
21. Objaśnienia do mapy Geośrodowiskowej Polski (Legend to the Geoenvironmental Map of Poland)

1:50 000, sheet Bobrowniki (402), Warsaw 2007

22. Objaśnienia do mapy hydrogeologicznej Polski w skali 1: 50 000 (Explanations of the hydrogeological map of Poland at a scale of 1: 50,000), sheet Bobrowniki (0402), Przedsiębiorstwo Geologiczne Sp. z o.o., Warsaw 2002
23. Objaśnienia do mapy hydrogeologicznej Polski w skali 1: 50 000 (Explanations of the hydrogeological map of Poland at a scale of 1: 50,000), sheet Włocławek (0442), ARCADIS Ekokonrem Sp. z o. o for PIG-BIP, Warsaw 2002
24. Objaśnienia do szczegółowej mapy geologicznej Polski w skali 1:50 000 (Explanations of the detailed geological map of Poland at a scale of 1:50,000), sheet Bobrowniki (402), Warsaw 1990
25. Written summary containing results of the strategic environmental impact assessment and justification for the selection of the Polish Nuclear Power Program, Warsaw 2020
26. Low-carbon management plan for the Municipality of the City of Włocławek, Bydgoszcz, October 2015.
27. Water management plan for the Vistula river basin area, appendix to the ordinance of the Minister of Infrastructure of November 4, 2022
28. “Polish Energy Policy 2040” (PEP2040) developed by the Ministry of Climate and Environment of February 2, 2021
29. Environmental Protection Program for 2020-2023 including the perspective until 2026 for the City of Włocławek, 2020.
30. Polish Nuclear Power Program (PPEJ) of October 16, 2020 (Resolution No. 141 of the Council of Ministers)
31. Report of the National Center for Emission Management (KOBiZE) titled “CO_2, SO_2, NO_x, CO and total dust emission factors for electricity based on the information contained in the national database on greenhouse gases and other substances emissions for 2021”
32. Initial analysis and site evaluation report for nuclear facility (Włocławek, Włocławek district), Central Mining Institute, Katowice 2023
33. Report on preliminary seismicity assessment for nuclear facility (Włocławek, Włocławek District) Institute of Geophysics of the Polish Academy of Sciences, Warsaw, March 2023
34. Regionalizacja geobotaniczna Polski (Geobotanical regionalization of Poland), IGiPZ PAN, J. M. Matuszkiewicz, Warsaw 2008
35. Regionalizacja przyrodniczo-leśna Polski 2010 (Nature and forest regionalization of Poland), R. Zielony, A. Kliczkowska, Warsaw, November 2012
36. Regionalna geografia fizyczna Polski, karty informacyjne mezoregionów (Regional physical geography of Poland, information sheets of mesoregions), Collective work edited by: A. Richling, J. Solon, A. Macias, J. Balon, J. Borzyszkowski and M. Kistowski, Poznań 2021
37. Register of ecological areas in Poland
38. Ordinance of the Minister of Climate of January 2, 2020 on the waste catalog (Journal of Laws of 2020, item 10)
39. Ordinance of the Minister of Infrastructure of November 4, 2022 on the Water Management Plan in the Vistula River Basin (Journal of Laws of 2023, item 300)
40. Ordinance of the Minister of Infrastructure of February 6, 2003 on occupational health and safety during construction works (Journal of Laws of 2003, No. 47, item 401)
41. Ordinance of the Minister of Development of January 29, 2016 on types and volumes of hazardous substances present in the plant, which decide on classification of the plant as a plant of increased

or high risk of major industrial accident (Journal of Laws of 2016, item 138)

42. Ordinance of the Minister of Environment of June 14, 2007 on the permissible noise levels in the environment (Journal of Laws of 2014, item 112)
43. Ordinance of the Minister of Health of December 17, 2019 on the permissible levels of electromagnetic fields in the environment (Journal of Laws of 2019, item 2448)
44. Ordinance of the Council of Ministers on the nuclear safety and radiation protection requirements to be taken into account in the design of a nuclear facility (Journal of Laws of 2012, item 1048)
45. Ordinance of the Council of Ministers of August 10, 2012 on detailed scope of assessment of the land intended for the location of a nuclear facility, cases excluding the possibility of finding the area compliant with the requirements for the location of a nuclear facility and on requirements for the site evaluation report for a nuclear facility (Journal of Laws of 2012, item 1025)
46. Ordinance of the Council of Ministers of September 10, 2019 on projects which may have a significant impact on the environment (Journal of Laws of 2019, item 1839, as amended)
47. Ordinance of the Council of Ministers of December 14, 2015 on radioactive waste and spent nuclear fuel (Journal of Laws of 2022, item 1320)
48. Report on the activities of the President of the Energy Regulatory Office for 2022, April 2023
49. Standard Data Form for Special Protection Areas (SPA): PLB040003 Dolina Dolnej Wisły, General Directorate for Environmental Protection [Poland]
50. Standard Data Form for Special Protection Areas (SPA): PLH040013 Cyprianka, General Directorate for Environmental Protection [Poland]
51. Standard Data Form for Special Protection Areas (SPA): PLH040039 Włocławska Dolina Wisły, General Directorate for Environmental Protection [Poland]
52. Strategy for Responsible Development (SRD) until 2020 (with an outlook to 2030)
53. Websites:
54. Szczegółowa Mapa Geologiczna Polski 1:50 000 (Detailed geological map of Poland), sheet Bobrowniki (402), compiled by J. Jeziorski, 1987
55. Resolution No 15/2014 of the Council of Ministers of January 28, 2014 on the long-term program titled “Polish Nuclear Power Program”
56. Resolution No. X/243/15 of the Sejmik of the Kujawsko-Pomorskie Voivodeship of August 24, 2015 on the Jezioro Skępskie Protected Landscape Area
57. Resolution No. XIV/287/20 of the Sejmik of the Kujawsko-Pomorskie Voivodeship of February 24, 2020 on the Jezioro Skępskie Protected Landscape Area
58. Resolution No. XLII/700/13 of the Sejmik of the Kujawsko-Pomorskie Voivodeship of October 28, 2013 on the determination of the update of the air protection program for the Włocławek city zone due to exceeding the permissible level of PM10
59. Resolution No. XXXII/575/13 of the Sejmik of the Kujawsko-Pomorskie Voivodeship of March 25, 2013 on the amendment to the statute of the Gostynińsko-Włocławski Landscape Park
60. Resolution No. XXXIX/1/2014 of the Włocławek City Council of January 27, 2014 on the local development plan for the city of Włocławek for the area located between the forest border, Toruńska Street, the city border, Inowrocławska Street, railroad areas and in the area of Krzywa Góra Street
61. Construction Law Act (Journal of Laws of 2023, item 682, as amended)
62. Geological and Mining Law Act (Journal of Laws of 2023, item 633)

63. Act of April 16, 2004 on nature protection (Journal of Laws of 2022, item 916, as amended)

64. Act of July 20, 2017 – Water Law (Journal of Laws of 2022, item 2625, as amended)

65. Act of April 27, 2001 – Environment Protection Law (Journal of Laws of 2022, item 2556, as amended)

66. Act of November 29, 2000 – Nuclear Law (Journal of Laws of 2023, item 1173)

67. Act of October 3, 2008 on providing access to information on the environment and its protection, public participation in environmental protection, and on environmental impact assessments (Journal of Laws of 2023, item 1094, as amended)

68. Act of December 14, 2012 on waste (Journal of Laws of 2022, item 699, as amended)

69. Act of April 18, 2002 on the state of natural disaster (Journal of Laws of 2017, item 1897)

70. Emission factor of CO_2, SO_2, NO_x, CO and total dust for electricity based on the information contained in the national database on emissions of greenhouse gases and other substances for 2021

71. Order of the Regional Director of Environmental Protection in Bydgoszcz of December 14, 2017, on the "Jezioro Piaseczno" nature reserve

http://geologia.pgi.gov.pl

http://www.ine.eko.org.pl/index_areas.php?rek=463

http://ine.eko.org.pl/index_areas.php?rek=462

LIST OF FIGURES

LIST OF TABLES

OSGE

ORLEN SYNTHOS GREEN ENERGY