5 IDENTIFICATION AND CHARACTERISTICS OF EXPECTED ENVIRONMENTAL IMPACTS OF PROGRAMME IMPLEMENTATION

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Summary of significant identified impacts

This summary does not include "impacts on the biotic elements of the environment", since they have been described in detail in subsection 4.5. Text structure applied therein is compatible with the following layout of content.

PHASE	DESCRIPTION OF EXPECTED IMPACTS
	5.1.1 **Impact on humans**
CONSTRUCTION	**Impact of noise** It will be minimal due to required selection of a site not adjacent to a developed area. Transport will be also a source of noise. The selected transport route should minimise any nuisance factors for the local population. **Impact of dust emission** The increase in dust, intrinsically linked with the construction of large surface facilities, can be effectively minimized through preventive action. **Additional jobs** The creation of new jobs is a positive impact on people.
OPERATION	**Emission of radiation** The highest possible doses of radiation associated with normal operation of EPR, AP1000 and ESBWR reactors for adults from critical group - estimated at a conservative approach - are, respectively, 25μS/year, 121μS/year and 12μS/year, which falls within any of assumed standards (the maximum dose for a critical group according to Atomic Law is 300μS/year). These doses are incomparably smaller than the current average annual radiation dose rate of 3400 μS/year, associated mainly with the natural radiological background, medical applications, and emissions from other industries. Additional radiation dose from a nuclear power plant is also much lower than the difference between doses in individual Polish towns and cities, which means that an inhabitant of Wrocław who decides to move to a city like Kraków will be exposed to a much higher dose of radiation than they would be exposed to in Wrocław if a nuclear power plant was built right in front of their house. Detailed calculations and data on the emission of radiation are provided in chapter 3.1 - **Błąd! Nie można odnaleźć źródła odwołania.**. Chapter 0 discusses radiation effects for a reference facility, which in 20 years did not cause negative impacts on people and ecosphere related to emission of radiation.
	Impact of small radiation doses Impact of low doses of radiation which may be emitted during normal power plant operation, has been described in detail in chapter **Błąd! Nie można odnaleźć źródła odwołania.**. Based on years of research of population and selected groups of workers or patients it was concluded that low doses of radiation (comparable to the size of natural background) do not cause adverse health effects. Quite on the contrary, most studies indicate that the impact of small doses of radiation is even positive for living organisms, including humans, as they have an anti-cancer effect (radiation hormesis hypothesis).
	Noise emission Noise is emitted by plant and machinery operated on site (see chapter 4.3.5). The nuisance level depends mainly on the actual location of a nuclear power plant. It may be higher in case of a power plant with *closed-cycle cooling system*, because basic noise emission results from operation of cooling towers. The noise level in a radius of 100m from the cooling towers can reach 60-70 dB (A). However the level of noise emitted by the power plant unit (with EPR) was estimated at 45 dB(A) at a distance of 350 m. The noise will therefore not be a substantial burden on the people, especially since no one will reside in the area of limited use, whose radius is estimated at about 800 m.
	Supply of electricity and improvement of the natural environment The introduction of nuclear energy in Poland is one of the actions that will improve energy security of the country (diversification of sources, reducing fossil fuel consumption, relatively low cost - ch. **Błąd! Nie można odnaleźć źródła odwołania.**). Energy production at nuclear power plants is associated with lower emissions to the atmosphere (Chapter 4.3.4.3), so its introduction will improve the quality of the environment by reducing emissions from existing energy sector.

	Failures	In the event of a nuclear reactor breakdown, the key threat is connected with radioactive substances released to the environment through air (mainly) or water. These substances may be either inhaled or ingested by humans (see chapter **Błąd! Nie można odnaleźć źródła odwołania.**). Therefore, all reactors have an entire system of safeguards and protections – including devices and solutions that prevent the potential release of significant quantities of radioactive substances to the environment (see chapter **Błąd! Nie można odnaleźć źródła odwołania.**). But the fact is that the potential severe failure, which would result in significant release of radioactive substances into the environment, mainly into air, and (in much smaller quantities and less likely) to the water, could pose a significant threat to human health (maximum dose, in case of the most serious failure with core melt is 246mSv/2h (AP1000 reactor, estimate with conservative assumptions) - ch. **Błąd! Nie można odnaleźć źródła odwołania.**). However, the occurrence of such a failure, due to the applied security and planned use of the latest improved technologies with III and III+ generation reactors to build even first nuclear power units in Poland, in fact almost completely exclude the risk of such an accident (the frequency of such events is estimated at less than once in a million years of reactor operation). Radiological protection procedures have been defined and will be followed in any emergency situation. These intervention measures (see chapter **Błąd! Nie można odnaleźć źródła odwołania.**) will minimise any potential negative health effects. In case of third-generation reactors, constructed so as to meet the safety requirements specified in the proposed Polish regulations and generally adopted European energy requirements, the risks in the event of design failure will not require interventions outside the restricted-use zones (about 800 m), and in case of severe failure early or long-term intervention will not be needed outside this zone. Theoretically, one may need to undertake medium-term interventions (administration of stable iodine), which will not cause impairment of normal life. The probability of such a failure is less than one in a million years of reactor operation.
DECOMMISSIONING		**Emission of radiation** Dose size and power of the emitted doses during and after the decommissioning of NPP are not a threat to humans (Ch. **Błąd! Nie można odnaleźć źródła odwołania.**). Employees working on nuclear decommissioning will be exposed to doses of radiation that are comparable to normal radiation doses emitted during normal operation and maintenance of a nuclear power plant, and these doses will not cause any harm to their health – as confirmed in a study involving 500,000 people working in the nuclear power sector. **Impact of noise** It will be minimal due to required selection of a site not adjacent to a developed area. Transport will be also a source of noise. The selected transport route should minimise any nuisance factors for the local population. **Additional jobs** The creation of new jobs is a positive impact on people.

5.1.2 Impact on surface waters

CONSTRUCTION	There will be no significant negative impact on surface waters in the construction phase. We may only expect local changes in water circulation caused by the fact that ground waters will be pumped out of excavations and trenches and released to surface waters.
OPERATION	**Heat emission to surface waters** Eventually, all the waste heat discharged from power plants is transferred to the atmosphere, but using *open-cycle cooling systems*, this heat is transferred through the surface waters - inland or sea. Before the water, after discharge of the heated water is re-cooled, heat contained in it may have a negative impact on the aquatic ecosystem. Heated water mixing processes, transmission and giving up waste heat are described in detail in chapter 4.3.2.5. The acceptable heat emissions to surface waters are limited by law. The introduced heated water must not exceed 35°C for rivers and seas, and 26°C for lakes and their tributaries. An excessive rise in temperature of surface waters can lead to increased intensity of respiration, increased biological production and, consequently, eutrophication of surface waters. The temperature of water has a direct impact on all living organisms and their physiological processes, and an indirect

impact on oxygen balance in water. If water is heated up, it affects the solubility of oxygen and facilitates decomposition of organic matter, which leads to faster consumption of oxygen.
The value of the temperature increase in the reservoir water, which will receive the waste heat, can be calculated only on the basis of a detailed computational model for a particular location for the investment. Such detailed analysis will be performed after the selection of investment location, and on that basis one can determine precisely the degree of water heating near the discharge of cooling water and in the distance from the point of discharge. An example of such an analysis for the selected reference facility is presented in chapter 4.3.2.5.1. The water reservoir used for cooling purposes will be analysed in detail during the operation phase to determine the scope and type of impacts caused by the release of heat.

Pollution with chemicals

Chemical pollutants are released to water from: products used to prevent depositions on the surface of elements of the cooling water system, biocides, and products of corrosion in heat exchangers and piping.
In *nuclear power plants on river sites*, makeup water used in the cooling system or cooling water must be treated, based on: lime decarbonisation, acid grafting, application of precipitation retardant. The application of these methods depends on the design of the cooling system and the quality of water used (see chapter 4.3.3). Due to decarbonisation, sediments of $CaCO_3$ and$(OH)_2$ are created, with which some heavy metals may be precipitated. The precipitate is collected in special settlers, concentrated, dried and disposed of in landfill. Deposition of this type of waste has no negative impacts on the environment. As calcium and magnesium are removed in the form of deposits, mineralisation is lower in water released to surface water compared to water that is taken in.
In *nuclear power plants on coastal sites* chlorine (biocide) must be used to maintain the required purity of water used in water circulation systems. Chlorine reacts with organic compounds and forms organo-halogenated compounds. Concentration of those compounds is higher with chlorination in *closed-cycle cooling systems*.
Due to the value of the discharge concentrations of chemicals released into water, which do not exceed 1% of environmental quality standards, their impact can be regarded as negligible (see chapter 4.3.3.6). The only substances in excess of the standard are TRO (total residual oxidants). However, the area of potential exceedences for these compounds will be limited to the immediate surroundings of the discharge point due to dilution and degradation processes of these compounds.

Failures

A potential release of radioactive substances to surface waters may occur only as a result of a very serious accident (with reactor core melt). However, third generation reactors include additional systems and structures that protect the integrity of the safety containment and the foundation slab. As a result, the risk of an accidental release of radioactive substances is reduced practically to zero.
However, in the event of an accidental release of radioactive substances to the atmosphere, radioactive particles will slowly deposit on the surface of the ground, or will be washed away quickly by rain or snow and will finally get to surface water bodies. Depending on the existing weather conditions, potential pollution of surface waters is therefore possible.

DECOMMISSIONING

No significant negative impact on surface waters is expected in the nuclear decommissioning phase.

5.1.3 Impact on ground waters

CONSTRUCTION		**Pollution of waters** During the construction phase there is the greatest threat of groundwater pollution. This will be particularly important in the areas characterised by high and very high sensitivity to underground water pollution related to lack of rock insulation of aquiferous layer from the surface of the area. The most favourable area in terms of securing aquifers are impervious moraine deposits with slow infiltration of depth. Such a location ensures protection of groundwater also in potential emergency situations. **Change in water relations** Impact of ground works on underground water may be particularly visible in the areas of shallow deposits of aquifers. Deep excavations require intensive drainage, resulting in local depression craters, which may affect the drainage of adjacent areas. However, in the case of nuclear power plants excavation depth is not particularly large[2], since the lowest level of foundation of the most sunken buildings (containment) is -14.00 m (EPR). Sealing large areas of land through the construction of power plants and adjacent infrastructure may locally influence lowering the surface of shallow groundwater, and thus drainage of the surface.
OPERATION		**Potential pollution of groundwater** NPP structures, systems and devices will be constructed under strict quality control standards, environmental standards, supervision standards, and standards of BAT (Best Available Techniques), which will minimize potential unplanned releases of hazardous substances to the soil. Storage containers, storage areas for chemical substances, fuel unloading areas and areas of other works that could cause environmental pollution will be located on hardened surfaces or confined with leak proof barriers that will contain any possible releases of harmful substances. Retention zones will be designed to prevent contact of spills with the ground and then with groundwater. Therefore, operation of the nuclear power plant will have no impact on the quality of the ground and groundwater – unless an unforeseen accident occurs. During normal operation there is no likelihood of direct or indirect release into the groundwater of the following substances: hydrazine hydrate, bromoform, hydrocarbons, metals, phosphates, ammonia, nitrates. In order to control the quality of groundwater from piezometers network surrounding the NPP water samples will be collected, in order to monitor groundwater quality and detect any possible contamination.
		Potential changes in groundwater level The level of groundwater may be subject to slight changes due to sealing a large area surface, which prevents infiltration to approximately 43 thousand m^3 (chapter 4.3.6.1). The level of groundwater will be controlled by a network of piezometers. It will be used to determine the impact of buildings on the local hydro geological conditions (changes in groundwater flow in the surroundings of the buildings).
	Failures	**Release of radioactive substances** A potential release of radioactive substances to surface waters may occur only as a result of a very serious accident (with reactor core melt). However, third generation reactors include additional systems and structures that protect the integrity of the safety containment and the foundation slab. In the EPR reactor measures protecting containment foundation slab before melting are a central element of the reactor safety system. The AP1000 reactor foundation slab protection system is different, but also tested and reliable. Polish regulations provide that reactors cannot be built without these systems that ensure proper protection of the safety containment. As a result, the risk of an accidental release of radioactive substances is reduced practically to zero. **Release of non-radioactive substances** The real threat of groundwater pollution (other than radioactive substances) may occur due to uncontrolled leakage. Therefore, provision of emergency water collection tanks and development of emergency procedures is a key element in the design and construction phase. In the event of any accidental release of pollutants, an emergency procedure will be launched to detect and neutralise source of the leakage and the contaminated area in order to prevent the pollution of groundwater.

[2] Compared with such facilities as large scale hydro stations.

DECOMMISSIONING	Complete removal of buildings and the associated infrastructure, including all hardened surfaces, will have a positive impact on water resources by increasing the infiltration area.

5.1.4 Impact on the air

CONSTRUCTION	**Emissions during the production of materials** Quantities of materials and equipment needed for third-generation nuclear power plants are relatively small (converting into unit of energy production). As a result, emissions of sulphur dioxide, nitrogen oxides, dusts, heavy metals, and CO_2 during the construction of a power plant and production of the associated equipment are much lower for nuclear power projects than for other sources of electricity (chapter 6.1.2.4). **Dustiness** As a result of the construction works dust emissions into the atmosphere will increase. However, it can be effectively reduced by, e.g., spraying. Quantities of materials are relatively small (converting into unit of energy output), therefore values of dust emission in the area during construction are also correspondingly small (about 7 mg of dust per 1 kWh of power (Table 4.3.14)). **Exhaust emission from machines and vehicles** The construction phase will involve an increase in heavy machinery traffic and the related increase in the emissions of exhaust gases to the air. This impact will depend on the location of the construction site and the selected access route.
OPERATION	**Reduction potential of atmospheric pollution emissions** Potential reduction of air pollution resulting from the introduction of nuclear power in Poland was evaluated based on the analysis of emission volumes from various energy sources for the entire electricity production cycle (from the extraction of raw materials up to the deposition of waste). The data are presented in chapter 4.3.4.3. They show that NPP has definitely the lowest emissions of CO_2 (ca. 50 times lower compared with coal power plants), as well as the lowest emissions of dust, NO_x and SO_2. According to calculations (chapter 4.3.4.3) minimal potential for emission reductions resulting from implementation of the objectives of Polish Nuclear Power Programme, is 127 kg of CO_2/1MWh, 23 mg of dust/kWh, 58 NOx mg/kWh and 34 mg SO_2/kWh, which gives, respectively, 18%, 16%, 17% and 15% of current emissions. Given the projected demand for energy, the total emission reduction potential in Poland, associated with the implementation of the Programme would be more than 27 Tg ($27*10^{12}$ g) CO_2, and ca. 5 Gg ($5*10^9$ g) of dust, 12,6 Gg ($12,6*10^9$ g) NOx and 7,4 Gg ($7,4*10^9$ g) SO_2.
	Emissions from cooling towers With *closed-cycle cooling systems*, moisture emitted into the atmosphere from cooling towers may (in case of improper water treatment system) include chemical pollution with water treatment agents or microbes. These problems should be eliminated by an effective water treatment system, and their impact will be only marginal.
	Exhaust emissions Potential emissions, mainly sulphur and nitrogen oxides are associated with the transport and operation of emergency power generators. Their impact will be only temporary and will depend on the specific location and the transport infrastructure on site. Emissions related to the transport of fuel and waste (in small amounts) will be limited compared to the transport of employees.
	Other emissions of chemical substances There are potential ammonia emissions from steam generators and formaldehyde and carbon monoxide from the ventilation system. The significance of these emissions can be considered negligible.

	Failures	In the event of a serious accident, a potential release of radioactive substances to the atmosphere will be the most likely source of radioactive pollution. Impact of the radioactive cloud and its spread in the air will depend on the weather conditions. Calculations for dispersion coefficients of radioactive streak in the air are presented in detail in chapters **Błąd! Nie można odnaleźć źródła odwołania.-Błąd! Nie można odnaleźć źródła odwołania.**.
DECOMMISSIONING		The decommissioning phase will involve an increase in heavy machinery traffic and the related increase in the emissions of exhaust gases to the air. This impact will depend on the location of the construction site and the selected access route.

5.1.5 Impact on the climate

CONSTRUCTION		Emissions of greenhouse gases (mainly CO_2)) are related to the operation of construction equipment and transport of building materials and the workforce to the construction site. These emissions will not be burdensome to the local environment. For the global balance these are not important added variables, as they relate solely to the construction and decommissioning phase (short-term impact).
OPERATION		**Reduction potential of greenhouse gas emissions** Production of electricity in nuclear power plant does not cause emissions of CO_2, and so participation of NPP in energy production will reduce production of this greenhouse gas, which can have a positive impact on the climate. Very low emissions of CO_2 will be generated in the construction and decommissioning phase, as well as during the fuel cycle. The total carbon footprint is estimated at approximately 17kg CO_2/MWh (for comparison, in the case of coal-fired power plants, this figure is approximately 1054kg CO_2/MWh, and for gas power plant – 417kg CO_2/MWh) (chapter 4.3.4.3.1).
		Heat emission to the atmosphere Ultimately waste heat, generated as a by-product of electricity production is transferred to the atmosphere. With *open-cycle cooling systems*, heat may be transferred through water environment, and it is released to the atmosphere gradually (evaporation, radiation from water surface, and absorption in air). Given the large temperature differences, these processes may produce fog in the area where heated water is discharged. The area covered by fog will be limited. In power plants with *closed-cycle cooling systems* heat is transferred directly to the atmosphere via the cooling tower in the form of latent heat (70%) and sensible heat (30%). Cooling towers will release humid and heated air into atmosphere. This air cools down and produces a cloud of vapour. The cooler and more humid the surrounding air, the longer the cloud will remain in the air. This process, as well as the process of deposition of the cloud on the surface of the ground, will depend on the weather and design of the cooling tower (see chapter 4.3.2.6). Fogging may also be more intensive in the surrounding areas.
	Failures	No major impacts.
DECOMMISSIONING		Emissions of greenhouse gases (mainly CO_2) are related to the operation of construction equipment and transport of building materials and the workforce to/from the site. These emissions will not be burdensome to the local environment. For the global balance these are not important added variables, as they relate solely to the construction and decommissioning phase (short-term impact).

5.1.6 Impact on the Earth's surface

CONSTRUCTION

Impacts on the Earth's surface will be diverse, depending on the scale and phase of the project. The key impacts will include exclusion of the biologically active surface and changes in the ground structure (compaction, removal of a humus layer, etc.). The potential impacts also include the pollution of soil with petroleum products that mat be released into the ground due to leakage or breakdowns of mechanical vehicles.

OPERATION

Land take
The size of the surface occupied by NPP and the accompanying infrastructure depends on the adopted technological solutions (ch. 4.3.6.1) and may reach ca. 40 ha. Sealing of the area will reduce the biologically active area and the infiltration of water.

Production of solid waste
- radioactive waste – 30 Mg/year (for reactor with capacity 1000MWe) (ch. 4.3.6.1)
- chemical and inert waste – 294 Mg/year
- hazardous (non-radioactive) waste – 63 Mg/year

Failures

In the event of an accidental release of radioactive substances to the atmosphere, radioactive particles will slowly deposit on the surface of the ground as the radioactive cloud spreads out, or will be washed away quickly by rain or snow, depending on the weather conditions. As a result, contamination of soil is possible

DECOMMISSIONING

Complete removal of all facilities and infrastructure of the nuclear power plant and proper recultivation of the area that restores the former condition of land will have a positive impact on the Earth's surface.

5.1.7 Impact on the landscape

CONSTRUCTION

Impacts on the landscape will depend on the specific location and the type of land use in the neighbouring areas. In the construction phase, it is also of key importance to select the most optimum route for the transport of building materials.
Impacts on the landscape will result not only from the construction of the nuclear power plant, but also the associated infrastructure, including access roads, overground power lines, and water intake and discharge piping. The implementation phase (e.g. due to the use of large cranes) will probably be more unfavourable to the landscape than the exploitation phase of the investment.

OPERATION

Power plant buildings
Impacts on the landscape will depend on the specific location and the type of land use in the neighbouring areas.
For cycle-cooled power plants presence of the cooling tower is an additional detriment to the landscape. Wet natural draft cooling towers, whose raw (hyperboloid) form generally is not blatant, are very high and visible from afar, especially in the open. Hybrid cooling towers, whose appearance is more questionable, have the advantage that they are generally lower than other major power plant facilities and, above all, do not emit large plumes of vapour, visible from a distance. Examples of impacts of referential facilities are shown in ch. 4.3.8.
Coastal power plants and power stations on inland waters do not have a cooling tower, so that their interference in the landscape is significantly smaller.

Associated infrastructure

Power lines connected to the nuclear power plant will be a key element of the associated infrastructure. They intersect natural systems and developed anthropogenic systems, jointly forming specific landscape complexes. The scale and type of impacts caused by power lines will depend mainly on their linear layout and technical parameters (i.e. height of facilities, type of structures – tubular poles or lattice towers) that will clearly stand out in the landscape.

Failures

A potential accident will have no impact on the landscape. However, protection of the area after a breakdown may affect the environment.

DECOMMISSIONING

It is expected that nuclear decommissioning, involving the complete dismantling of all facilities and structures and restoration of the area to the condition as close to the original state as possible, will have a positive impact on the landscape.

5.1.8 Impact on natural resources

CONSTRUCTION

Construction of a nuclear power plant will involve the consumption of large amounts of water and mineral resources used to build power generating units and the associated infrastructure. At the same time, it will generate large amounts of waste: (including inert, construction, and municipal solid waste and sewage).

Analysis of maps of natural resources (chapter 4.3.6.2) shows that none of the variants of localization jeopardizes exploitation of the useful mineral deposits.

OPERATION

Securing supplies of nuclear fuel for NPP

In the foreseeable term, manufacturing nuclear fuel in Poland is not expected. Fuel - as fuel assemblies ready for loading into the reactor - will be purchased from foreign suppliers of NPP technology or from another manufacturer (as far as economic reasons make it beneficial). Production of nuclear fuel in Poland is not a feasible alternative given the relatively limited scale of the nuclear power projects and current prices of uranium ore. The balancing and availability analysis of radioactive deposits in Poland indicates that they are rather limited and economically non-viable, and the demand will rather be covered from external sources.

However, in the future with the large scale development of nuclear energy and an increase in market prices for uranium, the exploitation of domestic resources can be cost effective. Similarly, domestic execution of some fuel cycle processes may develop (e.g. the final stage of fuel production).

Reduced consumption of raw materials

We can expect that the development of nuclear power will result in a significant reduction in the demand for fossil fuels – which may decrease from 20% to 25% depending on the adopted option[279].

Failures

No major impacts.

DECOMMISSIONING	No direct impacts of the nuclear decommissioning phase on natural resources were identified. However, disposal of materials from demolition sites will have an indirect impact on the consumption of environmental resources. These materials should be re-used or recycled as much as possible (positive impact on environmental resources). If, however, they are treated as waste and disposed of, this will involve the negative impacts on environmental resources.

5.1.9 Impact on historical buildings

CONSTRUCTION	A nuclear power project will have the same impact on the country's historical heritage as any other large building covering a similar area. The most serious problem is related to the destruction of archaeological sites, but it is rather unlikely – any works performed in areas that include documented archaeological sites will be supervised and approved by the Regional Building Conservation Officer. In addition, construction works covering such a large area may actually lead to the discovery of new undocumented sites of cultural significance and their subsequent exploration.
OPERATION	At this stage, the impact on historical monuments is difficult to predict, since the actual location for the project has not been selected yet. However, given the nature of the investment it is not expected to have any impact on the movable monuments and the potential locations exclude impact on the UNESCO World Heritage sites. Therefore, focus should be on immobile monuments and archaeological sites.[280] More precise impact will be determined only in the EIA Report prepared for the specific location where the nuclear power plant will be built. Possible impacts for potential location options currently under consideration are presented in ch. 6.1.
	No negative impact on historical buildings and other cultural resources is expected in the operation phase. On the contrary, we may venture to say that the project will reduce the pollution that may have a negative impact on the structure of historical buildings and other cultural assets. By obtaining energy from the proposed power plant there will be no need for location of new coal or gas power plants in the area. Moreover, the number of conventional power plants currently operating in Poland may be reduced, which will be associated with reduction of harmful emissions into the air. When combined with water, substances emitted by coal-fired power plants cause acid rains that dissolve and change the surface of stone buildings and structures. This risk applies in particular to structures made of limestone and marble – they are composed mainly of calcite that is dissolved relatively quickly in light sulphuric acid or nitric acid.
	Failures: No major impacts.
DECOMMISSIONING	No significant negative impacts on cultural assets is expected in nuclear decommissioning phase. Impacts will be comparable to those caused by the dismantling of any other facilities covering a similar area. In the areas adjacent to places of historical and cultural significance, the site may be brought to the state that corresponds to the land use in the surrounding areas.

5.1.10 Impact on material assets

CONSTRUCTION	Construction of a nuclear power plants will require significant investments. Therefore, in a short-term perspective it will consume material assets. Only after the construction phase is completed can we expect a positive impact in the context of the economic balance.

OPERATION		Based on the analysis of reference sites (see chapter 4.3.9) positive impact of NPP operation on material goods has been shown in form of: - increased value of land in the area of the investment (the initial drop is only possible at the beginning of the construction/operation phase) - increased income of the municipality - improved infrastructure - lower unemployment rate - economic revival in the region
	Failures	Any potential accident will cause significant material losses suffered by the investor and the adjacent areas – which must be partially compensated in accordance with the current provisions regarding the liability for nuclear accidents.
DECOMMISSIONING		Nuclear decommissioning will be financed with funds deposited in a special bank account during the operation of the nuclear power plant, in accordance with draft amendment to the Atomic Energy Act. The impact on material assets will depend on how the area of the former nuclear power plant will be managed.

5.1.11 Impact on biodiversity, including biological resources protected under the Natura 2000 network

CONSTRUCTION		Like any other large investment, construction of a nuclear power plant will have an impact on the natural environment. Selection of an optimum location is the key as regards the impacts. If the selected location is not recommended for reasons related to environmental protection, the integrity and objectives of Natura 2000 sites may be affected, functions of ecological corridors undermined, habitats fragmented, and valuable species endangered (both at the domestic and international level). When selecting a less sensitive location, the impact of the investment on biodiversity resources and Natura 2000 sites will be much smaller.
OPERATION		In the operation phase, expanded overhead traction network will have crucial significance, as in some locations it may be a source of increased mortality of large numbers of migrating birds, as well as a permanent threat to the birds occurring in the Natura 2000 areas (in case of power line routing through the area). Other significant impacts will include discharges of heated water to rivers or other water bodies, which may lead to changes in ecosystems and affect biodiversity (a two-way impact involving both negative and positive aspects).
	Failures	As the risk of a radioactive leakage in nuclear power plants that are allowed in Poland is negligibly small, the release of a radioactive cloud is the key threat. Depending on the weather conditions, it may lead to contamination that will affect living organisms to a greater or lesser extent and cause increased mortality in the contaminated area.
DECOMMISSIONING		The complete decommissioning of a nuclear power facility and restoration of the environment to the state as close to natural as possible will ultimately have a positive impact on the natural environment. However, demolition work itself may have a negative impact on Natura 2000 sites (in sensitive locations), as it will generate vibrations, noise, possible contamination of surface and ground waters, and may also temporarily affect functions of the ecological corridor.

5.2 Description of impacts

The identified environmental impacts may differ in terms of their source and origin (direct and indirect, secondary, accumulated), duration (short-, medium, and long-term), and frequency (permanent and temporary), as well as the probability of their occurrence.

The nature of impacts in terms of source and mode of action is defined as:

- **direct** – impacts resulting from direct interaction between the action to be taken under the project, and the environment of the project;
- **indirect** - impacts resulting from other activities taking place in connection with the project or the impact on one element of the environment through impacts on the other one;
- **secondary** - impacts resulting from the direct or indirect impacts, resulting from subsequent interactions with the environment;
- **accumulated** – impacts occurring in conjunction with other interactions (including the related existing or planned activities of third parties), concerning the same resources or subjects of impact as the draft.

The duration of impact is shown in the following way:

- **short-term** - short duration associated with the stage of the project;
- **medium-term** - impacts at the project operation stage;
- **long-term** - impact remaining after decommissioning of the project.

The frequency of impacts, that is the nature of occurrences in time can be defined as:

- **permanent** – acting on a continuous basis;
- **temporary** – acting in intervals or limited periods of time.

The possibility of the occurrence of impacts, i.e. the probability of their occurrence can be defined as:

3 certain impact (inherent to a specific activity, and thus will certainly occur)

2 probable impact (there is a possibility of impact depending on occurrence of other external factors)

1 unlikely impact (impact occurrence is allowed, but only in certain cases)

0 impact almost impossible (considered within the worst, very unlikely eventuality)

Individual impacts have also been classified in terms of their scale, which were marked in the table with different colours:

	significant positive impacts(both improving the properties of the element and change in its characteristics are observed, which as a result of subsequent interactions can have a positive impact on other environmental components)
	moderate positive impacts (basic properties of the element are not changed significantly, although improvement of their size or quality is observed, this is without significant effect on other environmental components)
	no significant impacts or neutral impact
	moderate negative impacts (basic properties of the element are not changed significantly, although deterioration of their size or quality is observed, this is without significant effect on other environmental components)
	significant negative impacts(both deterioration of the properties of the element and change in its characteristics are observed, which as a result of subsequent interactions can have a negative impact on other environmental components)
	indeterminable impact (dependent largely on the specific location of the investment)

5.2.1 Characteristics of impacts - construction stage

Table 5.2.1 Tabular summary of the characteristics of the impacts associated with construction of NPP

TYPE OF IMPACT	SCALE OF IMPACT		NATURE			DURATION			CONTINUITY		PROBABILITY OF OCCURRENCE
	NEGATIVE	POSITIVE	DIRECT	INDIRECT	SECONDARY	SHORT-TERM	MEDIUM-TERM	LONG-TERM	PERMANENT	TEMPORARY	
IMPACT ON PEOPLE											
nuisances due to noise emission and dustiness			v			v				v	2
nuisances due to intensity of heavy machinery and transport traffic			v		v	v				v	3
additional jobs			v	v	v	v			v		3
radiation hazard (also refers to a critical group, e.g. employees)			v	v	v	v				v	0
IMPACT ON SURFACE WATERS											
local disruption of aquatic relations				v	v	v			v		2
IMPACT ON GROUND WATERS											
potential water pollution			v		v			v	v		1
changes in aquatic relations				v	v		v		v		2
IMPACT ON AIR											
dustiness			v			v				v	3
exhaust emission from machines and vehicles			v			v				v	3
IMPACT ON CLIMATE											
greenhouse gas emission				v	v	v				v	3
IMPACT ON EARTH'S SURFACE											
potential land pollution			v		v		v		v		1
exclusion of biologically active area				v	v		v		v		3
waste generation				v	v			v	v		3
IMPACT ON LANDSCAPE											
deterioration of aesthetics of adjacent areas				v	v	v			v		2
IMPACT ON NATURAL RESOURCES											
consumption of natural resources (water, construction materials, power)				v	v			v	v		3
limitation of access to natural resources			v				v		v		1

TYPE OF IMPACT	SCALE OF IMPACT		NATURE			DURATION			CONTINUITY		PROBABILITY OF OCCURRENCE
	NEGATIVE	POSITIVE	DIRECT	INDIRECT	SECONDARY	SHORT-TERM	MEDIUM-TERM	LONG-TERM	PERMANENT	TEMPORARY	
IMPACT ON HISTORICAL BUILDINGS											
potential destruction of archaeological sites within the area of nuclear power plant site	*impact substantially dependent on selection of investment site*										**1**
IMPACT ON MATERIAL GOODS											
financial investments				v	v	v			v		**2**

5.2.2 Characteristics of impacts - operation stage

Table 5.2.2 Tabular summary of the characteristics of the impacts associated with operation of NPP

TYPE OF IMPACT	SCALE OF IMPACT		NATURE			DURATION			CONTINUITY		PROBABILITY OF OCCURRENCE
	NEGATIVE	POSITIVE	DIRECT	INDIRECT	SECONDARY	SHORT-TERM	MEDIUM-TERM	LONG-TERM	PERMANENT	TEMPORARY	
IMPACT ON PEOPLE											
provision of energy supplies			v				v		v		**3**
general improvement of environment quality				v	v			v	v		**3**
radiation hazard (also refers to a critical group, e.g. employees)			v	v	v		v			v	**3**
in emergency: - potential necessity of evacuation - release of radioactive substances to environment			v				v			v	**0**
IMPACT ON SURFACE WATERS											
consumption of surface water resources			v				v		v		**3**
discharge of waste heat - increase in temperature			v		v		v		v		**2**
potential water pollution			v				v			v	**1**
in emergency: - contamination of surface waters			v				v			v	**0**

TYPE OF IMPACT	SCALE OF IMPACT		NATURE			DURATION			CONTINUITY		PROBABILITY OF OCCURRENCE
	NEGATIVE	POSITIVE	DIRECT	INDIRECT	SECONDARY	SHORT-TERM	MEDIUM-TERM	LONG-TERM	PERMANENT	TEMPORARY	
IMPACT ON GROUND WATERS											
consumption of groundwater resources			v				v		v		1
potential water pollution			v		v		v			v	0
potential radiological contamination			v	v	v			v	v		0
changes in groundwater level				v	v			v	v		2
in emergency: - contamination of groundwater			v	v	v			v	v		0
IMPACT ON AIR											
decreasing gas emission to atmosphere				v	v			v	v		3
decreasing dust emission to atmosphere				v	v			v	v		3
discharge of waste heat (cooling towers)					v		v		v		2
in emergency: - radioactive emission to atmosphere				v	v			v		v	1
IMPACT ON CLIMATE											
reduction of greenhouse gas emission				v	v			v	v		3
discharge of waste heat (cooling towers)				v	v		v		v		2
IMPACT ON EARTH'S SURFACE											
land take							v		v		3
reduction of biologically active area							v		v		3
waste generation				v	v			v	v		3
IMPACT ON LANDSCAPE											
reducing development of conventional power plants (chimneys - industrial landscape)				v	v			v	v		2
nuclear power plant as a new anthropogenic element of landscape	*impact substantially dependent on selection of investment site and manner of incorporation into surrounding area*										*3*
IMPACT ON NATURAL RESOURCES											
consumption of uranium ore resources								v	v		3
reduction of fossil fuel consumption				v	v			v	v		3

TYPE OF IMPACT	SCALE OF IMPACT		NATURE			DURATION			CONTINUITY		PROBABILITY OF OCCURRENCE
	NEGATIVE	POSITIVE	DIRECT	INDIRECT	SECONDARY	SHORT-TERM	MEDIUM-TERM	LONG-TERM	PERMANENT	TEMPORARY	
IMPACT ON HISTORICAL BUILDINGS											
reduction of harmful impact of atmospheric pollutions on buildings				v	v			v	v		**2**
IMPACT ON MATERIAL GOODS											
increase in land value and income of municipality				**v**	**v**			**v**	**v**		**2**
improved infrastructure			**v**					**v**	**v**		**3**
decreased unemployment and economic revival			**v**	**v**	**v**			**v**	**v**		**3**
improved energy security of the country.			**v**		**v**			**v**	**v**		**3**

5.2.3 Characteristics of impacts - decommissioning stage

Table 5.2.3 Tabular summary of the characteristics of the impacts associated with decommissioning of NPP

TYPE OF IMPACT	SCALE OF IMPACT		NATURE			DURATION			CONTINUITY		PROBABILITY OF OCCURRENCE
	NEGATIVE	POSITIVE	DIRECT	INDIRECT	SECONDARY	SHORT-TERM	MEDIUM-TERM	LONG-TERM	PERMANENT	TEMPORARY	
IMPACT ON PEOPLE											
nuisances due to noise emission and dustiness			**v**			**v**				**v**	**2**
nuisances due to intensity of heavy machinery and transport traffic			**v**		**v**	**v**				**v**	**3**
additional jobs			**v**	**v**	**v**	**v**			**v**		**3**
radiation hazard (also refers to a critical group, e.g. employees)			**v**	**v**	**v**	**v**				**v**	**0**
IMPACT ON SURFACE WATERS											
local disruption of aquatic relations				**v**	**v**	**v**			**v**		**0**
potential water pollution			**v**		**v**	**v**			**v**		**0**
IMPACT ON GROUND WATERS											
potential water pollution			**v**		**v**			**v**	**v**		**1**

TYPE OF IMPACT	SCALE OF IMPACT		NATURE			DURATION			CONTINUITY		PROBABILITY OF OCCURRENCE
	NEGATIVE	POSITIVE	DIRECT	INDIRECT	SECONDARY	SHORT-TERM	MEDIUM-TERM	LONG-TERM	PERMANENT	TEMPORARY	
restoration of natural water relations			v		v		v		v		2
IMPACT ON AIR											
dustiness			v			v				v	3
exhaust emission from machines and vehicles			v			v				v	3
IMPACT ON CLIMATE											
greenhouse gas emission				v	v			v	v		3
IMPACT ON EARTH'S SURFACE											
potential land pollution			v		v		v		v		1
restoration of biologically active area				v	v		v		v		3
waste generation				v	v			v	v		3
IMPACT ON LANDSCAPE											
Improving the aesthetics of the adjacent areas due to land reclamation				v	v			v	v		2
IMPACT ON NATURAL RESOURCES											
consumption of environmental resources (disposal of demolition material as waste)				v	v			v	v		2
reduction of the use of environmental resources (recovery of demolition material)				v	v			v	v		2
IMPACT ON HISTORICAL BUILDINGS											
no significant impacts	*impact substantially dependent on selection of investment site*										1
IMPACT ON MATERIAL GOODS											
financial investments				v	v	v			v		2

5.3 Characteristics and summary of impacts on the biodiversity resources, including those protected under the Natura 2000 network

Impacts on flora, fauna, biodiversity and Natura 2000 sites mentioned in the chapter below have a wide spectrum of impact and apply to all listed natural assets.

Expected significant impacts identified in the table below have been described due to their nature (direct, indirect, secondary, accumulated), duration (short, medium, long-term) and due to the frequency of impact (permanent and temporary). Information was also added about the likelihood and strength of the identified negative impacts.

Table 5.3.1 Tabular summary of the characteristics of impacts on biodiversity resources

Designed action	Possible impact	Nature of impact
• Seizure of land for permanent and temporary construction works, machinery and equipment used during construction	• Loss or reduction of populations of protected species or vegetation communities due to the seizure of land and destruction of habitats needed for feeding • Direct lethality of animal species due to collision with buildings and machinery	• Direct/indirect • Long-term and medium term • Permanent
• Expansion of the overhead traction network	• Direct lethality of birds and bats due to collisions • Possibility of influencing the change of bird migration route, due to the barrier effect	• Direct • Long-term • Permanent or temporary
• Uncontrolled waste storage from ground works and the site	• Destruction of natural habitats • Possibility of water pollution, poisoning of animals	• Direct • Long-term • Permanent or temporary
• Production of dust during construction activities.	• Deposition of dust on the leaves of plants and on the surface of aquatic organisms	• Indirect • Short-term • Temporary
• Hardening of large surface areas (roads, parking lots)	• Soil erosion and changes in water quality. Possible emissions of sediments to water and disturbance of aquatic ecosystems	• Direct • Long-term • Permanent
• Surface runoff from construction site	• Soil erosion, with possible destruction of plant communities by contaminants running off with water (e.g. machine oils)	• Direct • Long-term • Permanent and temporary
• Storage of spoil from excavations and underground workings	• Animals settling on temporarily stored soil masses (sand martins and other burrow-dwelling species) and resulting species endangerment	• Direct • Short-term • Temporary
• Use of surface water for construction work • Drainages for excavation works.	• Change in local water relations • Possibility of contamination of watercourses	• Direct • Short-term • Temporary
• Noise and vibration	• Disturbance of aquatic mammals, fish and	• Direct • Short-term, medium

Designed action	Possible impact	Nature of impact
	bottom invertebrates • Disturbance of other land animals living in proximity	term • Temporary
• Light emission during construction, demolition, and at the stage of operation (from lighting facilities, vehicles, machinery)	• Disruption of animal environment (bats, resting birds etc.)	• Direct • Short-term • Temporary
• Accidental fuel, petroleum, chemicals, concrete, cement spills etc.	• Contamination of groundwater and surface water, contamination of natural plant communities, animal poisoning	• Direct • Short to long term • Permanent or temporary
• Vehicle traffic	• Direct lethality of animals due to collision or road kills	• Direct • Long-term, medium term • Temporary
• Cooling water uptake	• Disruption of aquatic ecosystem balance • Possible aspiration of living organisms	• Direct • Long-term, medium term • Permanent
• Warm water discharge from cooling systems	• Disruption of aquatic ecosystem balance • Impact on change in bird migration habits	• Direct • Long-term, medium term • Permanent

5.4 Analysis of the likelihood of cumulative impacts

Occurrence of cumulative impacts can be understood in two ways:

1) as overlapping impacts associated with the implementation of various investments, for which the impacts zones overlap, therefore accumulation of negative impacts occurs in these places

2) as an accumulation of negative impacts associated with the operation of the investment in question for the various environmental elements (impact on the individual elements may be insignificant, while analyzing the cumulative occurrence, accumulated impacts to entirety of the environment may be significant).

Regarding the first aspect, one cannot at this stage rule out the possibility of accumulation of impacts, due to lack of choice of specific location, hence the lack of knowledge of the detailed plans for development of neighbouring areas. But certainly, each location will entail the expansion of power network and accompanying infrastructure, so one can expect the accumulation of impacts on landscape and animated nature, particularly in the context of Natura 2000 sites. However, any additional impacts, such as associated with the expansion of the grid, will be the subject of separate studies including forecasts for the development of energy infrastructure, and therefore in this paper this problem is only indicated, not specifically addressed. Industrial plants are listed in the analysis of location variants (subject to availability of relevant information). In these cases, one can consider the potential accumulation of impacts at the stage of environmental impact assessment before a decision on the environmental conditions. It should become the subject of detailed analysis during the preparation of environmental impact report for a particular investment location.

Regarding the second aspect, on the basis of table in chapter 0 and 5.3 numerous impacts on various environmental elements can be identified. In particular, for construction phase and a possible failure it is clear that there are many negative environmental impacts in various aspects. During the construction phase, negative impacts on people, air, surface, natural resources and nature accumulate. But these are mostly short-term or temporary impacts associated with construction phase only. Similar impacts, albeit in a narrower spectrum, are also associated with decommissioning stage. However, the accumulation of potentially the most serious negative impacts may occur as a result of a failure. Concomitant negative impacts on various environmental elements can have serious consequences (accumulation of radiological contamination and increase in doses of radiation by various routes of exposure on living organisms). However, the situation has been examined and detailed calculations of radiation doses in the event of possible failures were made. Calculations with the results and their interpretation are presented in chapter **Błąd! Nie można odnaleźć źródła odwołania.**. The occurrence of these impacts, however, is highly unlikely due to numerous safety systems, which aim to prevent accidents, even in the worst-case scenarios (see chapter **Błąd! Nie można odnaleźć źródła odwołania.** and **Błąd! Nie można odnaleźć źródła odwołania.**).

The likelihood of cumulative impacts includes the construction of Polish nuclear energy Programme together with the implementation of other strategic documents in the country. The reference is to the documents assuming diversification of energy sources and promoting sources other than nuclear power as it is provided in *National development strategy 2007-2015*, *National Strategic Reference Framework 2007-2013 supporting economic growth and employment. National Cohesion Strategy*, *Polish Climate Policy. Strategies for reducing greenhouse gas emissions in Poland by 2010* and other documents. As pointed out earlier in the Forecast, almost all investments related to the development power industry are associated with potential impact on the environment. Thus in the process of diversification of energy sources, which is a goal of strategic Polish documents, where development of nuclear energy, promoting the expansion and modernization of energy infrastructure (e.g. networks capable of absorbing the increased transmission of electricity) will be included, are closely related. These activities must meet the needs. At the same time as stated in all strategic documents maintenance of strict environmental protection requirements is required, including the components of animate and inanimate nature. This is a guarantee that even the accumulation of impacts will not be standing in opposition to the current assumptions of II National Ecological Policy and other environmental documents and legislation.

5.5 Information on possible cross border impact of the Programme on the environment

5.5.1 Basics of cross-border environmental impact assessment

The basic legal acts that govern cross-border environmental impact assessment are respectively:

- The Convention on Environmental Impact Assessment in a Transboundary Context, drawn in Espoo on 25 February 1991 (Journal of Laws of 3 December 1999)
- European Parliament and Council Directive 2001/42/EC of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment
- Act of 3 October 2008 on provision of information on environment and its protection, public participation in environmental protection and environmental impact assessment

The Convention on Environmental Impact Assessment in a Transboundary Context, drawn in Espoo on 25 February 1991 (Journal of Laws of 3 December 1999)

Convention requires signatory states to take all appropriate and effective measures to prevent, reduce and control significant, harmful, transboundary environmental impact resulting from planned activities.

Pursuant to art. 1 of the Convention:

"transboundary impact" means any impact, not of global nature, within an area under jurisdiction of the party, caused by a planned activity whose physical origin is situated wholly or partly within the jurisdiction of another party.

The term "impact" means any effect of the planned activities on the environment including: health and safety of people, flora, fauna, soil, air, water, climate, landscape and historical monuments or other structures or the interactions among these factors; it also includes effects on cultural heritage or socio-economic conditions due to changes in these factors;

The basic method of preventive fulfilment of obligations under the Convention is to carry out within the state, which intends to undertake the activities causing such impacts, procedures for environmental impact assessment (EIA) of the proposed action, and thus in accordance with Article 3 and 4 of the Convention:

3. *The Party of origin*[281] *shall ensure that in accordance with the provisions of this Convention performance environmental impact assessment*[282] *takes place before deciding whether to approve or undertake a proposed activity listed in Annex I, which may cause significant adverse transboundary impact*.

4. *The Party of origin shall ensure, in accordance with the provisions of this Convention, that the Parties affected will be notified of any planned activity listed in Annex I, which may cause significant adverse transboundary impact*.

According to Annex I, "Summary of activities" the facilities that require discussion include thermal power stations and other combustion installations with heat output of 300 megawatts or more and nuclear power stations and other nuclear reactors ... "

1. *For the planned activities under the Annex I, which may cause significant adverse transboundary impact, the Party of origin in order to ensure adequate and effective consultations under Article 5, shall notify any Party which it considers a possible affected Party as early as possible and no later than informing its own public opinion about the proposed activity*.

8. *Parties concerned will ensure that the public of the affected Party in the areas likely to be affected, is informed of the proposed activity and that it has the opportunity to express their comments or objections to the planned activities and an opportunity to submit these comments or objections to the competent authority*[283] *of the Party of origin, either directly or, if appropriate, through the Party of origin*.

European Parliament and Council Directive 2001/42/EC of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (SEA Directive)

The SEA Directive sets out requirements for the implementation of environmental impact assessment of plans and programs in the European Union. The main objective of the Directive is that the environmental aspects of the preparation and adoption of plans and programs are included at the earliest possible stage so as to achieve a high level of environmental protection.

Pursuant to Article 7 of the SEA Directive:

If a Member State considers that the implementation of the plan or program being prepared in relation to its territory may potentially cause a significant impact on the environment in another Member State, or when requested by a Member State, which potentially can be significantly affected, that Member State on whose territory the plan or program is prepared prior to its adoption or submission to the legislative procedure, forwards a copy of the draft plan or program and the relevant environmental report to another Member State.

Act of 3 October 2008 on provision of information on environment and its protection, public participation in environmental protection and environmental impact assessment (*EIA Act*);

EIA Act defines, inter alia, the principles and procedures in cases of transboundary environmental impact, and so in accordance with Article 104:

If there is any possibility of a significant transboundary environmental impact originating in Polish territory as a result of implementation of projects, policies, strategies, plans or programs, investigation shall be carried out investigation of transboundary environmental impact. Such proceedings shall be carried out also at the request of another Member State whose territory may be affected by execution of the draft document.

Procedure on transboundary impact originating in Polish territory in case of projects of policies, strategies, plans and programs is described in section 3 of the EIA Act.

5.5.2 Assessment of the possible transboundary impact of the Programme on environment

At this stage of a strategic document (the Polish Nuclear Programme), the assessment of environmental impacts in neighbouring countries can be only preliminary. To evaluate these impacts, an analysis was conducted to decide which countries could be affected by the potential impact in the operational phase of the planned nuclear plant in Poland.

Pursuant to art. 36F of the draft of Atomic Law, a restricted use area around the nuclear facility covers the area, outside of which:

- in operation conditions of a nuclear facility covering normal operation and anticipated operational events annual effective dose of all routes of exposure will not exceed 0.3 milisievert (mSv);
- in case of failure without melting the core annual effective dose of all routes of exposure does not exceed 10 milliSievert (mSv).

It can therefore be assumed that if land adjacent to the Polish state will be in the above specified limited use area, it will be directly exposed.

The analysis should therefore determine the extent of the areas depending on the dosage level for normal operation and after failures without melting the core. But this is not possible at the stage of detail of Polish Nuclear Energy Programme.

Reactors intended for Poland must meet the requirements of EUR. According to these requirements the boundary of the limited use area proceeds 800 m from the reactor and boundary of emergency planning zone 3000 m from of the reactor. Currently, works are in progress on the Ordinance of Council of Ministers on requirements for nuclear safety and radiological protection included in the project. The draft of the mentioned Ordinance § 6.4 provides that the design of a nuclear facility should provide for a limitation of radioactive releases outside the reactor containment in emergency situations so that:

- in the event of design failure no interventions are required at a distance greater than 800 meters from the reactor;
- In case of occurrence of extended design conditions it is not necessary:
- to make early intervention during the radioactive releases in containment at a distance greater than 800 m from the reactor,
- to make medium-term intervention at any time at a distance greater than 3 km from of the reactor.
- to make long-term interventions at a distance greater than 800 m from of the reactor.

According to analyses carried out in Chapter 7, the EPR, the AP1000 and the ESBWR reactors, which are currently planned for installation in Poland, meet these requirements.

The Espoo Convention requires that the people of neighbouring countries have the same rights as people of a country where a power plant is built:

6. *According to the provisions of this Convention, the Party of origin shall provide the public in the areas that may be exposed the opportunity to participate in the relevant procedures of environmental impact assessments for the planned activities, and ensure that the opportunity to participate in these procedures, provided for the public of the affected Party, is the same as the option provided for the public of the Party of origin*.

In light of this formulation, it is important that the zone of the planned medium-term interventions according to the provisions of current proposals of Polish regulations and according to EUR requirements the third generation reactors reaches no further than 3 km from the nuclear power plant. Outside this area there is no need to provide e.g. the necessity of evacuation routes or emergency planning for NPP areas in Poland, so even with location of nuclear power plants in a small distance from the border there will also be no need to agree on interventions with the administrative authorities of the neighbour state.

Threat assessment is often subjective. It is also indicated by the result of the CBOS report, developed at the request of the Ministry of Economy, in which the question was asked concerning acceptance of a nuclear power plant location near the place of residence. Test results indicated that the term "near" is a purely subjective because the differences in the responses ranged from approximately 1 kilometre to 500 kilometres. The average of the reported values was 92 kilometres. This would mean that for the majority of the society an acceptable distance that does not raise concerns and negative emotions is 92 kilometres. It can be assumed with likelihood that the societies in which nuclear power plants already exist, and such are most societies in the neighbouring countries, have the same if not more liberal approach to these distances. Thus, the table indicates also the locations which are closer than 92 km from the Polish border, as the distance resulting from the concerns of society.

Thus, for further analysis it was assumed that if a State is at a distance less than 3000 m from of the reactor, it is directly exposed, and if it is closer than 92 km, its society might want to participate in the cross-border procedure of environmental impact of the Polish Nuclear Programme .

5.5.3 Analysis of possible cross-border impacts of the programme

In 2009, the Ministry of Economy devised a list of 27 potential sites for nuclear power plants. Locations are shown in Fig. 5.5.1. In 2010, commissioned by the Ministry of Economy a document was prepared entitled "The study on the siting criteria for nuclear power plants and preliminary assessment of the agreed locations", which analyzes the locations in the ministerial list. The study recommended six potential sites: Żarnowiec, Nowe Miasto, Kopań, Warta-Klempicz and Choczewo

and Lubiatowo-Kopalino. Use of other locations (except for Kozienice) in foreseeable term is unlikely, especially for the construction of the first two nuclear power plants - as is clear from the information obtained from the Ministry of Economy and PGE S.A.

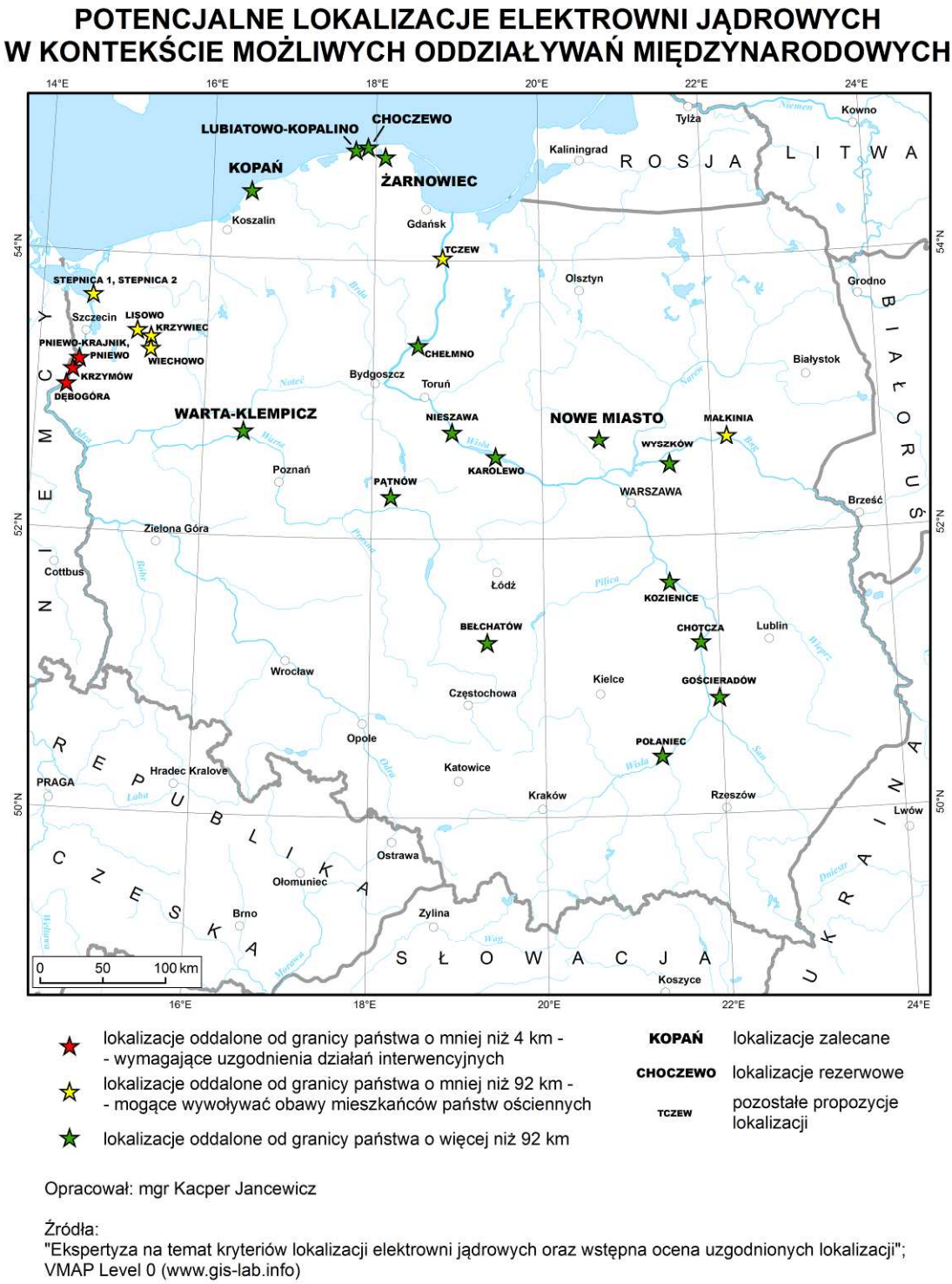

Fig. 5.5.1 Nuclear power plant sites in Poland in the context of possible international impacts

[POTENTIAL NUCLEAR POWER PLANT SITES IN THE CONTEXT OF INTERNATIONAL IMPACTS

Locations less than 4 km away from the border – requiring agreement on interventions
Locations less than 92 km away from the border – they may cause fear in residents of neighbouring countries
Locations more than 92 km away from the border
Recommended locations
Reserve locations
Other site proposals
Developed by: mgr Kacper Jancewicz
Sources:
"Expert opinion on criteria of nuclear power plant locations and preliminary assessment of established sites"
VMAP Level 0 (www.gis-lab.info)]

For all locations, a table was developed with distances to the nearest Polish borders. The table marks the locations which are closer than 92 km from the Polish border and those whose limited use area goes beyond the State boundary. In the latter case the locations were also marked which are not in the immediatelimited use area, but are very close.

Table 5.5.1 Approximate distances of potential sites of nuclear power plants in Poland from the borders of the state.

		Distance [km]							
No.	**Location**	**Baltic Sea***	**Germany**	**Czech Republic**	**Slovakia**	**Ukraine**	**Belarus**	**Lithuania**	**Russia**
1	Bełchatów	329,6	300,5	154,9	184,3	299,4	287,4	412,3	354,4
2	Chełmno	107,6	272,4	338,9	426,2	398,6	334,4	284,5	139,1
3	Choczewo	0,3	257,6	460,1	589,7	523,2	377,0	245,9	120,0
4	Chotcza	369,8	470,9	270,6	199,5	129,5	128,6	322,7	343,5
5	Dębogóra	48,9	2,3	233,3	499,4	650,3	599,2	524,2	373,2
6	Gościeradów	416,3	488,4	260,0	156,2	124,3	136,3	360,8	389,2
7	Karolewo	181,7	324,9	280,0	332,1	306,6	255,4	296,4	206,5
8	Kopań	2,7	159,8	395,4	573,1	575,5	461,4	342,5	204,6
9	Kozienice	316,1	447,7	281,3	246,9	151,8	135,2	289,0	294,4
10	Krzymów	62,0	1,2	220,9	492,3	652,3	602,5	534,0	382,5
12	Krzywiec	43,8	54,7	269,1	497,8	606,5	550,1	462,1	311,4
13	Lisowo	52,5	61,0	265,9	490,7	597,9	542,8	456,8	305,7
14	Lubatowo-Kopalino	0,0	251,6	456,5	589,7	527,0	382,6	252,1	125,4
15	Małkinia	247,0	510,3	399,6	365,5	156,9	80,6	164,3	180,5
16	Nieszawa	163,9	291,8	285,5	354,2	345,9	292,4	309,8	193,1
17	Nowe Miasto	189,3	408,5	336,0	355,5	236,2	176,3	231,5	183,2
18	Pątnów	226,9	238,6	222,9	312,2	379,8	337,5	380,2	257,7
19	Pniewo	41,2	3,1	240,7	503,5	649,0	597,1	518,3	367,6
20	Pniewo-Krajnik	42,7	3,3	239,3	502,7	649,1	597,4	519,3	368,5
21	Połaniec	442,2	450,6	197,6	108,0	134,2	201,3	419,0	433,2
22	Stepnica -1	2,5	19,6	293,4	542,3	654,3	587,9	488,8	341,8
23	Stepnica -2	4,0	21,2	293,7	541,6	652,7	586,2	487,2	340,1
24	Tczew	36,5	300,7	410,1	493,0	419,7	306,6	224,2	72,0
25	Warta-Klempicz	155,6	125,9	213,5	392,0	506,1	457,7	433,7	281,9
26	Wiechowo	55,8	60,3	259,4	484,6	595,4	541,0	459,3	307,8
27	Wyszków	236,1	462,4	354,0	341,3	177,8	117,2	209,2	200,1
28	Żarnowiec	10,3	267,1	458,1	579,1	507,7	362,4	234,8	104,9

* distances for the Baltic Sea including the Szczecin and Vistula Lagoon

Analysis of results:

Recommended and reserve (basic) sites:

- None of the primary locations is close enough to the border to make it necessary to coordinate interventions with the administrative authorities of the neighbouring state. Thus, in accordance with approved methodology, no State will be directly affected by the choice of one of the primary locations.
- None of the primary sites is located closer than 92 km from the border, therefore it can be assumed, in accordance with accepted methodology, that societies of neighbouring States will not feel fear as a result of the selection of one of the primary sites.

Other sites (for which there is little likelihood of location of the first nuclear power plants in Poland):

The following sites from this group will require arrangements on intervention, (they will be directly affected):

- Dębogóra site – 2.3 km from border with Germany
- Krzynów site – 1.2 km from border with Germany

Moreover, because of the distance close to the border, the following were qualified to this group:

- Pniewo site – 3.1 km from border with Germany
- Pniewo-Krajnik site – 3.3 km from border with Germany

The following sites are closer than 92 km from the border, therefore it can be assumed, in accordance with accepted methodology, that the societies of those States may feel fear as a result of selection.

- Krzywiec site – 54.7 km from border with Germany
- Lisowo site – 60.1 km from border with Germany
- Małkinia site – 80.6 km from border with Germany
- Tczew site – 72.0 km from border with Russia
- Stepnica 1 site – 19.6 km from border with Germany
- Stepnica 1 site – 21.2 km from border with Germany
- Wiechowo site – 60.3 km from border with Germany

Conclusions

- Considering the small likelihood that the first nuclear power plants in Poland will be built in one of the locations defined as “other” in the Programme, we can conclude than none of the neighbouring countries will be exposed to any impacts (direct or indirect).

- However, if we assume that any "other" location is selected, Germany will be exposed to direct impacts from the Polish nuclear power plant.
- Germany, Belarus and Russia are the countries whose societies may be potentially interested in the participation in social consultations (given the distance from the potential sites).

5.5.4 The experience of neighbouring States in cross-border environmental impact assessment

In the context of the analysis of transboundary impacts it should be also pointed out that Poland is not a pioneer in the nuclear power sector. Apart from Lithuania and Belarus, all other neighbouring countries operate nuclear power plants in their territory. Schematic location of nuclear power plants in the vicinity of Poland is shown in Fig. 5.5.2

Fig. 5.5.2 Distribution of nuclear power plants in the vicinity of Poland

[DISTRIBUTION OF NUCLEAR POWER PLANTS IN THE VICINITY OF POLAND
Active nuclear power plants
Developed by: mgr Kacper Jancewicz
Source: www.insc.anl.gov; VMAP Level 0 (www.gis-lab.net)]

In the countries neighbouring with Poland, namely Slovakia (case of NPP Mochovce units 3 and 4) and the Czech Republic (Temelin case units 3 and 4) before deciding to build these units, the appropriate Ministry for the Environment appointed a responsible and competent organization, which was to carry out discussion of environmental impact assessment and present the conclusions of this discussion, to the ministry for a decision. This competent organization was not Nuclear Supervision, although the Nuclear Supervision in the course of the discussion presented its assessment of the safety and radiological protection around the proposed power plant. n case of NPP Mochovce materials were prepared in Slovakian and English, but they did not cover the entire environmental impact assessment, and only a summary of that assessment. The same was true in case of Finland[284].

The public discussion first took place in Bratislava, with the participation of about 200 people from Slovakia and four activists from Austria, and later in Vienna. The whole course of the discussion was recorded and forwarded to the competent Slovakian organization which has prepared conclusions for the Ministry of Environment. Similarly, the discussion takes place on Temelin.

The case of Temelin is important due to the fact that the discussions have already been conducted before selecting a specific reactor, specifying only that it will be a reactor with water under pressure. This means that if a final decision on the construction of NPP in Poland is made, a similar discussion can also be conducted, specifying only boundary parameters of the releases of radioactivity from the reactor during normal operation and emergencies.

After receiving conclusions from the discussion, the government body of the country building a power plant declares that it became familiar with the course of discussions, questions, objections and responses, and believes that the answers were satisfactory - or not. In the first case, it decides to approve the application of the investor from point of view of nuclear power plant impact on the environment, in the second - to reject the application. Regardless of that, nuclear power plant security analysis must be performed by nuclear supervision and only if positive decisions in both of these processes are made, construction of a power plant can begin.

5.6 Analysis of potential social conflicts

5.6.1 Potential social conflicts in Poland in the light of existing data and official documents

In the discussed draft of the Polish Nuclear Energy Programme (p. 95) it is provided that “social support for nuclear power is one of the most important pre-conditions for the Polish Nuclear Programme” and that “steady and conscious support (or at least acceptance) of the majority of the society is a condition precedent to the introduction of nuclear power that will prevent the Programme being used as a subject of political debates”. The draft gives a figure for the support declared by the Polish society for the introduction of nuclear power at 40-50%. At the same time, it was emphasised that this support is unstable and to a large extent it is not based on the society’s knowledge of nuclear power, which is an outcome of 20 years of education negligence.

When actions towards the development of nuclear power in Poland were resumed, social conflicts became a fact and the public opinion was divided from day one. It is all happening despite the fact that for quite some time articles in the press have been forecasting an ever-increasing demand for electricity and potential problems with electricity production in the future[285]. Some environmental organizations provide negative opinions on potential locations and the desirability and security

related to the construction of nuclear power plants. At the same time, fierce protests of environmentalists reported in the media, combined with actions taken to disrupt the implementation of major infrastructural projects important for the country or local communities (even those that are reasonable and based on sound argumentation), trigger protests from other groups of the society. In the worst-case scenario, the significance of environmental initiatives may be undermined by the excessive and stubborn focus on single elements of the natural environment of relatively minor importance for the entire ecosystem.

Social conflicts are an inherent part of any large project. In holds true in particular in the case of investments in the energy sector. Not a long time ago, environmentalists voiced their protests against projects such as construction of Niedzica dam on the Dunajec River, the man-made Czorsztyn Lake, or Niedzica – Sromowce Wyżne Hydroelectric Power Plants. Major protests carried out in the 1980s and 1990s subsided after 1997, when the erected dam significantly contributed to the reduction of losses during the July flood (on the official opening of the barrier on 9 July 1997 the water level on the Dunajec River surpassed the record of 1934). Czorsztyn reservoir has also contributed to the construction of sewage treatment plant, to supply of drinking water to nearby towns (before construction of the dam this area had serious water shortages during droughts, and it was one of the main reasons for the construction of the reservoir), to stabilization of the level of the river (so that the traditional rafting down the Dunajec valley takes place without obstacles.)

In more recent years, wind power projects are the source of serious conflicts. Wind farms projects with wind turbines were rejected by the inhabitants and local authorities in many regions of Poland. Villages in the Kłodzko Valley or the Kaczawskie Foothills are just one example. In addition to the significant impact on the landscape and risks for birds and bats, opponents of wind power projects claim that wind turbines may have an impact on people's health and well-being. Not without significance are also issues of cost-effectiveness of investment and its efficiency in the Polish power grid (power drops during interruptions in operation due to lack of wind at the time of greatest energy demand - during heat and frost). Opponents of wind farm locations organize pickets and create websites. In many places around the country they are effective, influencing local authorities and eventually discouraging investors.

Projects of new open-pit mines and brown-coal mining projects for the purposes of electricity generation are just as controversial. The plans of relocation of villages north of Legnica encountered a backlash from the protesting local communities. An initiative called 'STOP the PIT' was set up[286]. Inhabitants of these areas reject the proposed compensatory payments and refuse to relocate. The subject of huge damage related to the functioning of the excavation is also taken up. As in few other cases, the situation in Legnica region showed the incompatibility of interests of different levels of authority.

Public opinion on nuclear power in Poland and other electricity production methods and technologies is summarised in a Report of CBOS (Public Opinion Research Centre) published in September 2009, titled: "Public Opinion on Nuclear Power. Quantitative Research Report". Respondents were requested to evaluate the efficiency of the following sources of energy: hard coal, brown coal, petroleum, natural gas, nuclear energy, biofuels, hydropower, solar power, wind power, geothermal power.

Findings presented in the CBOS Report are as follows:

- social support for the nuclear power plant project in Poland is increasing, but its supporters include usually well-educated people;

- lack of knowledge of nuclear power gives rise to fear and concerns that are expressed in the form of protests against the construction of a nuclear power plant or location of a radioactive waste depository;
- arguments of opponents always focus on irrational fears and general concerns;
- information and argumentation must be targeted mainly at social groups with a lower education level and inhabitants of rural areas, as well as young people (aged 15–17 lat) whose knowledge of nuclear power is simply a disaster;
- a radioactive waste depository raises more concerns than a nuclear power plant;
- any location for a radioactive waste depository will be accepted only on condition that it is properly protected with safety measures, but at the same time we may expect that the effectiveness of these safety measures will be questioned;
- there is a wide social support for compensatory payments for inhabitants of areas close to a nuclear power plant – they should include a number of elements, with special focus on health care and reduced electricity charges;
- the self-assessment of the respondents' knowledge of nuclear power is very low – Poles are well aware of the fact that their knowledge is poor; at the same time, data clearly indicates that the level of knowledge corresponds to the level of acceptance. The knowledge of nuclear power comes mainly from the media: the press, TV, and radio. Less than 1/5 of respondents declare that they gained this information from school, university, or work.

Findings presented in the CBOS Report are very interesting. Special attention should be given to the society's low level of knowledge of nuclear power, as well as the sources of this information – the public media rather than school curricula or specialist publications. Still, public approval for nuclear power in the period 2008–2009 increased by nearly 70%, and nuclear energy ranked second (after renewable sources) among all suggested options for the development of the energy sector. It results from the Research Report of 2009 entitled "Ecological awareness of Poles - sustainable development" made by the Institute for Sustainable Eco-Development in the framework of Active education program for sustainable development Eco-Hercules. According to the quoted report, recorded promotion of nuclear power occurred at the expense of all other solutions, with the largest decrease in the indications concerning energy saving (this can be considered as a sign of lower propensity to save). There is still extremely relatively low acceptance of coal as an energy source. Quite rationally, respondents did not consider power industry based on oil and natural gas. It should be added that in contrast to the results from 2008, not every the socio-professional group put raw materials and renewable sources in the first place. Nuclear power is preferred by members of households with incomes *per capita* exceeding 1500 PLN (45.3% indications to 36.7% for renewables) as well as those with higher education (40.4% versus 39.7%). Group of respondents which to a much lesser extent are convinced by this direction of energy policy are:

- persons with primary education - 11.9%
- unskilled workers, the unemployed and farmers - 12.1%
- persons with the lowest incomes (below 500 PLN) - 12.9%,
- women - 14.9%,
- rural residents - 18.9%,

- people aged 35-44 - 19.0%.

Results of studies conducted throughout the country echo the unofficial the results of the smaller polls, published in local media. For example, according to the portal *trzcianka.info*, based on the collected votes of Internet users, 60% of respondents said YES to a nuclear power plant in Klempicz, 33% said DEFINITELY NO to a nuclear power plant in Klempicz, (5% said YES to a nuclear power plant, but not in Wielkopolska, 2% had no opinion)[287]. Although a group of Internet users is not entirely conclusive and the vote was attended by just 43 people, the result is part of a noticeable trend in the country.

Information on the feedback to nuclear power in other countries, especially in countries where nuclear power plants are in operation, is presented in the Study no. OT-575 titled "Reaction of the local European communities to the proposed location of a nuclear power plant in their close vicinity" prepared by the Analyses and Documentation Office, Analyses and Topical Papers Unit of the Chancellery of the Polish Senate in October 2009. This study, as it is said in the introduction, attempts to answer the question: is location of a nuclear power plant in tourism-attracting region possible and acceptable and what consequences will result for the local community. The basis for the answers are the experiences of other European countries. Regions that are attractive for tourists often overlap with regions of high natural or scenic value, and therefore this study has a deeper meaning.

To perform the analysis, the Office of Analysis and Documentation turned, through the European Centre for Parliamentary Research and Documentation (ECPRD), to the parliaments of the Member States of the Council of Europe and Canada, the U.S. and Israel, with questions on this issue. A cover letter and a survey of five questions were prepared in order to obtain answers to a given topic from the experience of specific communities, rather than popular opinion. In response to the survey materials were received from 27 of 49 countries which were sent the questions. Tabular summary of information included in the study is presented below:

Table 5.6.1 The issue of location of nuclear power plants in Europe, in countries having, building or planning investments according to the survey conducted by the Office of Analysis and Documentation of the Chancellery of the Sejm. Applies to areas attractive for tourism. The table is a shortened version of the table contained in the original study.

State	Location in the attractive area (examples)	Attitude to construction of nuclear plants based on: General public opinion polls Local public opinion polls Other opinions	Loss or benefit of local government in connection with the location of a nuclear power plant
Belgium	No[288] (Huy-Tihange3)	positive a, b – no research c – opinion of local government	increased tourism, influx of people, increased employment, increase of financial assets in the region, development of education, building evacuation roads
Czech Republic	acceptable (Temelin)	positive a - yes[289] b - yes[290]	construction of two sewage treatment plants, supplying heat and hot water to local residents
Finland	no	–	no data
France	yes[291] (Tricastin, Flamanville)	positive a - yes[292] b - yes[292]	new infrastructure and development, increased employment, tax revenues,
Netherlands	no[293]	no data	no data
Lithuania	no data	no data a - no data b - yes[294]	no data

Germany	No[295] (Lumin[296])	negative[297]	tax revenues
Russia	no data	fearful14	no data
Slovakia	No[298]	no data	no data
Switzerland	no data	no data	no data
Sweden	no[299] (Ringhals, Oskarhamm, Forsmark[300])	lack of visible negative impact. Based on ranking of tourist resorts of Swedish Tourist Agency. a, b – no research20[301]	new jobs, also seasonal jobs. Tax revenues.
Turkey	yes[302] (Akkuyu)	no research	–
Great Britain	no[303]	–	no data
Italy	–	Recently published surveys on the return of nuclear energy: 45.75% - against 38.7% - for 8.2% not in my neighbourhood.	–

The study concludes that no examples were found that location of a nuclear power plant will adversely affect tourism in a given village/town. It also underlines the positive impact of nuclear power projects on the development of municipalities in the area. It was found that persons who live in an area where a nuclear power plant actually operates are in support of nuclear power. The remaining respondents, who do not benefit from nuclear power projects in their region, are usually against a nuclear power plant in the area where they live. Respondents (e.g. from the UK) agree that new nuclear power plants could be built in the same location as old nuclear facilities that are dismantled, and respondents who work for the nuclear sector, either directly or indirectly, actually expect that a new nuclear power plant will be built after the old one is decommissioned. The same applies to radioactive waste depositories. On the other hand, the study also indicates that there are signs of clear opposition against the development of nuclear power in Germany.

5.6.2 Organisations opposing the development of nuclear power in Poland and their initiatives

The draft Polish Nuclear Power Programme and its assumptions are clearly in opposition to the assumptions and objectives of a number of environmental organisations that do not accept the development of nuclear power in Poland or anywhere in the world. The one organisation that stands out in particular is a group called Anti-Nuclear Initiative (Inicjatywa Antynuklearna) – it identifies very strongly with anti-nuclear protests in Germany where the police regularly fight with the opponents of nuclear power on the streets or with groups of protesters who block transport routes leading to nuclear power plants. A group of scientists also voice their protests against nuclear power, including a number of scientists who are published in the press. Among those familiar to public service media due to their anti-nuclear convictions is Mrs. J. Czarnołęska-Gosiewska, president of Environmental Citizens' Club "Czuwanie"[304] and Dr. J. Jaśkowski (publicly branded for his grossly inaccurate statements by the Polish Society of Medical Physics[305]).

Arguments against the development of nuclear power in Poland are focused on a number of key areas. The vast majority of these arguments is based on the economic viability of nuclear power projects (with frequent questions like: "how many wind turbines can be built for the price of 1 nuclear power plant"[306]). Other arguments result from concerns about a possible terrorist attack, a breakdown or a serious accident in a nuclear power plant and the potential environmental pollution that could pose a threat for humans. The example of Chernobyl is showcased regularly, but often based on wrong interpretation of data or even on information that is simply not true[307]. Usually the arguments do not include technological progress and developed security standards[308]. Other arguments include the examples of other countries that do not use any nuclear power or do not build any nuclear power

plants. Unfortunately, also in this case untrue data are frequently presented, which will be mentioned further in the chapter.

Unfortunately, many initiatives against nuclear power, which are often followed in the Internet remain anonymous, which makes serious discussion very difficult. In contrast to those involved in promoting the development of NPPs their authors remain unknown. The best example is the Portal of Antinuclear Initiative. How different is the manner of acting of the people involved in the development of nuclear energy can be seen on the Nuclear Energy site[309].

Characterization of all environmental organizations or initiatives bringing together the opponents of nuclear energy development is not necessary. Below, you may find a brief presentation of those organisations and their main assumptions and documents that are most familiar to the public.

Table 5.6.2 Selected organizations and associations against development of nuclear energy in Poland and their programs and documents concerning the issues discussed - the summary (the order of these organizations is not significant).

Organizations	Programs and documents relating to nuclear energy
WWF Poland WWF is one of the world's largest organizations for environmental protection[310]. The organization was founded on 11 September 1961. The idea for its establishment came from the Director-General of UNESCO, Sir Julian Huxley Switzerland became the seat of the organization. In time, also national divisions of the foundation were founded in many countries. In Poland, WWF works to protect rivers, forests and endangered species, including large predators and Baltic mammals (so-called umbrella species). It conducts educational activities and promotes legal solutions to prevent climate change. It fights animal smuggling and illegal trade in endangered species.	Document **„Atomic energy is a wrong answer"**[311] • The published document refers to the nuclear power industry in the world, it does not take into account the Polish reality; • The main theses of the document: *- nuclear power is dirty energy (referring to radioactive waste);* *- nuclear energy is economically unviable and inhibits the fight against unemployment,* *- nuclear power is dangerous,* *- nuclear energy is useless to us.*
Inicjatywa Antynuklearna [Antinuclear Initiative] As stated on the website of the organization[312], *Inicjatywa AntyNuklearna was established as a reaction to the Polish government adopting energy policy objectives, in which the construction of nuclear power plants, is regarded as a necessity*. According to the Organization *construction of nuclear power plants entails risks and a lot more damage than potential benefits*. The aims of the organization are to *overcome one-sidedness of official media, the public presentation of critical analysis on nuclear energy, calling an open public debate and promoting alternatives.*	Arguments raised[313]: • *Polish economy is 3-4 times more energy consuming than in Western European countries;* • *The measure of society development is not the amount of energy consumed;* • *High actual costs of building a nuclear power plant;* • *A nuclear power plant poses an immediate threat to the environment;* • *Production of energy from fission of an atom is a threat to human health and the environment also at the stage of obtaining the fuel;* • *Energy source that produces deadly waste cannot be called pure or "ecological". It is immoral is to leave future generations with a problem in the name of an ad hoc profit of business groups. Some of the waste generated at nuclear power plants will be dangerous for hundreds of thousands to millions of years;* • *Disassembly of nuclear installations is expensive and takes many years, radioactive waste disposal is expensive and paid for by taxpayers;* • *Development of nuclear energy in Poland will block efforts to develop energy conservation and renewable energy sources (budget is not*

Organizations	Programs and documents relating to nuclear energy
	unlimited); • *construction of nuclear power plants will not stop climate change and reduction of CO_2 emission;* • *Nuclear power plants are the perfect target for terrorists;* • *Construction of nuclear power plants is a further restriction of civil rights, including right to information.*
Instytut na rzecz Ekorozwoju [Institute for Eco-Development] Instytut na rzecz Ekorozwoju (InE) is a non-governmental *think-tank* organization founded in 1990 at the initiative of several members of the Polish Ecological Club, active in the foundation formula[314]. InE promotes and implements the principles and solutions for sustainable development of Poland. The Institute works on the European Forum at the European Environmental Bureau and in the country in coalitions of social organizations, among others Climatic, EU Funds, Polish Rural Forum.	**The position of Instytut na rzecz Ekorozwoju on the draft of "Polish Nuclear Program" dated 16 August 2010 prepared by the Government Plenipotentiary for Polish nuclear energy in the Ministry of Economy.**[315] General conclusion: *Nuclear power, whose development is proposed by the government, will not solve the basic problems of power industry in Poland in the required time, i.e. satisfying growing needs for electricity in the perspective of 15-20 years and reducing greenhouse gas emissions under the EU's commitments current and expected in the future. At the same time the costs of nuclear power, which according to the assessment of many experts are underestimated by 50-65% with the necessary guarantees from the state are a very expensive and risky option of meeting the energy needs ...*
Koalicja Klimatyczna [Climatic Coalition] Koalicja Klimatyczna is an association of non-governmental organizations interested in the actions for the protection of global climate[316]. The Coalition was founded June 22, 2002, during the conference, "Stop global warming" in Kazimierz Dolny. The mission of the Coalition is a joint action to prevent human-induced climate change for the good of the people and the environment. In the cited websites there is a list of 20 committee members, which include among others WWF, Greenpeace, Klub Gaja, Nature Protection League, and others.	**Position of Climate Coalition on the draft "Polish Nuclear Energy Programme"**[317] (selected fragments): *... Climate Coalition maintains a negative position on nuclear power development in Poland. Shape and direction of this development proposed in PNEP confirms the earlier concerns of the Coalition that the decision to build nuclear power plants in Poland, undertaken by the government unexpectedly in 2009 without the necessary economic and strategic analysis, is detrimental to Poland.* *... Essential remarks:* *To justify the development of nuclear energy PNEP presents four arguments ...* *... According to the Climate Coalition, none of these arguments has merit ...* *... Submission for public discussion an incoherent, self-contradictory program may be evidence that government agencies do not take seriously this document and public consultation ...*
Greenpeace Polska According to information posted on the organization website[318], Greenpeace is an international non-governmental organization working for environmental protection. The organization focuses its efforts on the most important, global threats to biodiversity and the environment ... Greenpeace offices are located in over 40 countries worldwide. The organization says that in order to preserve its independence it does not accept grants	**Assessment of Polish Energy Policy draft until 2030.**[319] Main theses: • *According to the report, "An Energy Revolution for Poland (Report ER-1), prepared by independent experts, in 2030 it is possible to reduce electricity production from coal to 30% and 46% coverage of demand for electricity from renewable energy sources (RES).* • *Implementation of the document in such a shape*

Organizations	Programs and documents relating to nuclear energy
from governments, political parties and corporations.	*will impede development of renewable energy in the period 2020-2030.* • *The draft does not contain a clear vision of systemic support for the development of RES. Although the current system of support for RES turned out to be inefficient and did not give a sufficient stimulus for the intensive development of this sector, the draft does not provide for its revision.* • *The draft does not contain a program that could effectively reduce the energy consumption of Poland to the present level of the EU average ... Moreover, the document envisages an increase of demand for primary energy by 21% by 2030. This is in contrast with an assumed zero-energy goal of economic growth assumed in the same document.* • *decision on the development of nuclear energy will halt development of renewable energy and energy efficiency, to which Poland is obliged by EU directives.* • *With 10 times less assets one can obtain half from the planned production of energy in nuclear power plants.* • *Postulates of changes in the Polish Energy Policy until 2030 proposed by Greenpeace, were backed by more than 10 thousand people.*
71 NGOs, participating in the meeting / conference organized by **FERSO Foundation** (Fundacja Edukacji i Rozwoju Społeczeństwa Obywatelskiego [Foundation for Education and Development of Civil Society]) The aim of FERSO Foundation is to support sustainable development of civil society through education, art and multimedia technologies. The Foundation pursues its objectives, in particular through the organization and financing of lectures, seminars, symposia, workshops and trainings[320]. The first meeting of a group of people interested in setting up the Foundation was held in early 2003.	**The position of environmental NGOs on the government's plan to introduce nuclear energy in Poland**[321] (Meeting of the Ecological NGOs – eKolumna 2010, Spała, 15 May 2010 r.), content of the position: *We found that the Polish government for several terms have sought to run a nuclear power program without thorough public debate and information about environmental, social and economic risks associated with it. Development of nuclear power will not prevent the country's energy problems, but will block the development of the renewable energy sector and measures to improve energy efficiency.* *We postulate the introduction of legal and financial instruments to facilitate:* • *reducing the energy consumption of the economy;* • *increasing the efficiency in the economy through modernization of existing energy infrastructure;* • *development of renewable wind, solar, biomass, geothermal energy sources;* • *research on other ways compatible with sustainable use of energy and solutions for climate protection and their implementation.* *Unanimously, we urge to withdraw from the program for nuclear energy and issuing public funds for its promotion. We demand a general social and national debate and real consultation on the future Polish energy policy.*

In addition to creating the above documents, the organizations opposing the construction of nuclear power plants in Poland also collect signatures of persons who identify with previously prepared petitions. An example of such a petition is presented below[322]:

Petycja przeciwko budowie w Polsce elektrowni jądrowych
Inicjatywa AntyNuklearna www.ian.org.pl

Ja niżej podpisany, jestem przeciwny budowie w Polsce elektrowni jądrowych (EJ). Nie zgadzam się też na jednostronność medialnej kampanii informacyjnej dotyczącej energetyki. Jako alternatywy dla EJ stanowczo domagam się - dla dobra mieszkańców Polski i przyszłych pokoleń, a także dla dobra środowiska naturalnego:

- oszczędnego korzystania z już produkowanej energii (m.in. usprawnienia sieci przesyłowych, zmniejszanie energochłonności procesów produkcyjnych, zapobieganie urbanistycznemu rozrostowi miast, właściwa izolacja budynków itd.);
- decentralizacji systemu produkcji i dystrybucji energii;
- przechodzenia gospodarki na odnawialne źródła energii (jako znacznie bardziej ekologiczne i zdrowsze oraz tworzące zielone miejsca pracy - np. biogaz, biomasa, energia słoneczna, energia wiatru), a odchodzenia od paliw kopalnych i szybko wyczerpywalnych;
- zaprzestania marnotrawienia moich podatków na subsydiowanie korporacyjnych zysków przemysłu jądrowego, wprowadzającego tylnymi drzwiami nieefektywne rozwiązania energetyczne, jakim jest budowa EJ;
- powszechnej, rzetelnej i rzeczowej debaty społecznej na temat planów wielkich strategicznych inwestycji mogących zagrozić zdrowiu mieszkańców, środowisku i ekologicznej gospodarce;

Chcę, aby Polska - wzorem innych krajów Europy (Austria, Dania, Grecja, Irlandia, Włochy, Hiszpania, Belgia, Niemcy, Holandia, Wielka Brytania, Szwajcaria) zrezygnowała z planów rozwoju przemysłu nuklearnego oraz, idąc za przykładem Austrii, zagwarantowała niepodejmowanie takich decyzji w przyszłości odpowiednim zapisem w konstytucji i przystąpiła do Nuclear Free Zone.

IMIĘ I NAZWISKO	ADRES	PODPIS

Authors of the petition do not mind the fact that in reality, most countries listed as a model for Poland, did not abandon their nuclear power plants, instead, they decided to build them (Italy, United Kingdom, Sweden, Switzerland, the Netherlands) or to continue operation of existing nuclear power plants (Germany, Spain).

Another manifestation of actions against the development of nuclear energy are the manifestations and protests. They are encouraged by such posters, taken from the websites of Nuclear Initiative:

Fig. 5.6.1 Posters of Antinuclear Initiative

Protests against the construction of nuclear power plants took place before indication of potential locations for the plants. An example might be a manifestation in Gryfino, organized in 2009 by a 40-person group of Polish and German Green party activists[323]. Recently, similar demonstrations were

organized by Antinuclear Initiative Warsaw[324] (April 2010) and Gdańsk[325] (July 2010). However, protests from 1987-90 against the construction of a nuclear power plant in Żarnowiec went down in history.

Considering the events that take place beyond our western border and the fact that the Polish environmental organizations are inspired by their dynamically operating foreign counterparts / partners exacerbation of conflicts related to the implementation of the Polish Nuclear Programme cannot be excluded. Provocations by extremist activists seem particularly alarming.

We should note that the activities of Inicjatywa Antynuklearna and other environmental organisations are often propaganda-like. It applies in particular to the practice of presenting unverified or even false information.

However, some environmental organisations that promote cleaner environment and protection of nature also promote nuclear power. Environmentalists for Nuclear Energy (EFN) is one of them. It was established back in 1996 and now has about 9 thousand members around the world. In Poland, Stowarzyszenie Ekologów na Rzecz Energii Nuklearnej (SEREN) is the leading organisation of this type. Its objectives are to: create an association for the supporters of nuclear power for peaceful purposes, and to present to the society the complete and objective information on the power sector and its environmental impacts.

Considering the initiatives related to opting against nuclear power, we can also mention the relatively new phenomenon, which is integration of people with similar views on the online social networking sites. The most popular, Facebook, created in the US, has a profile „No to the Nuclear Energy = No to expensive electricity!”. On 12 December 2010, 51 other members of the same portal signed up in the profile. At the same time on the similarly operating profile, "Nuclear Power Plants for Poland" 610 people signed up.

Opinions expressed by Patrick Moore, co-founder of Greenpeace are also very suggestive. Moore changed his mind about nuclear power and now opposes the official position of his organisation. In an article published in 2006 in Washington Post, he states that nuclear power must complement the power generation sector based on renewable energy sources[326]. Other experienced environmentalists are of the same opinion: including Stewart Brand, author of the „Whole Earth Catalog[327]”, James Lovelock, originator of the Gaia Theory[328] (member of EFN), or the late British bishop Hugh Montefiore (founder and one of directors of Friends of the Earth[329]). Last year, they were joined by Stephen Tindale who had acted as the Executive Director of Greenpeace in the United Kingdom for many years (from 2000 to 2005). In 2009, he took a U-turn and with a group of other respected British environmentalists expressed his support for the development of nuclear power[330].

5.6.3 The overview of main problems related to the development of nuclear power – arguments for and against

The development of nuclear power in Poland will encounter a number of barriers: incompatibility of the Polish law, lack of clear vision of the future – how to meet the energy security requirements with the ever-increasing need to protect the natural environment and to meet the society’s expectations, and different views expressed by various groups. The relatively low level of public knowledge of nuclear power and opinions based on inaccurate information will be also a major source of barriers.

Presented below is our review of the main problems related to the development of nuclear power in Poland that are discussed by the public and the media. These problems are discussed from the perspective of both the supporters and opponents of nuclear power – for each item, arguments and views for and against are presented. In this way we are trying to ensure an impartial approach to the problem.

Table 5.6.3 Arguments for and against the introduction of nuclear power relating to the feasibility of a nuclear power project in Poland.

AGAINST	PROBLEM	FOR
"With the current consumption, world's uranium reserves are sufficient until 2061. Expansion of the nuclear industry and the increasing energy consumption of our civilization may lead to depletion of those resources already in 2030"[331] “The expected bottlenecks in uranium ore supplies may become a more serious problem than we would expect – given the disproportion between countries that extract uranium ore and countries that use it. Of all countries in the world that operate nuclear power plants, only Canada and Republic of South Africa are not dependent on uranium imports. The largest ‘atomic’ countries either do not extract their own uranium ore (France, Japan, Germany, South Korea, Sweden, Spain) or have uranium ore resources that will not be sufficient for their reactors in a longer term (the USA, Russia). If we consider the problem of fuel supply for nuclear reactors, nuclear power cannot be the main source of domestic electricity production almost anywhere in the world. Russia in particular will soon face the first uranium supply crisis. This in turn may affect operators of nuclear power plants in the European Union that purchase about one-third of their nuclear fuel from Russia. China and India may also be forced to cope with a similar crisis if they continue to increase the number of their nuclear reactors, as they have declared.”[332]	**Sufficiency of raw materials**	“The available resources of uranium depend strongly on its market price. Until 2001, the price of uranium ore was exceptionally low – about $20/kgU. It was caused mainly by overproduction of uranium by 1990 and lack of social acceptance for nuclear power, resulting in overstocked inventories of uranium ore accumulated by power utilities. Nuclear disarmament reduced the prices even further by introducing cheap uranium from dismantled nuclear heads to the market. The inventory of uranium that came from disarmament has been almost used up by now, and the threat of a climate disaster put nuclear power back in the picture. As a result, the price of uranium has increased significantly. In 2005-2007, a ‘uranium bubble’ occurred – a sudden, exponential increase in the price of uranium, up to $300/kgU. The current price (2009) is settled around $100/kgU. This trend made it possible to explore uranium deposits that had been considered economically unviable before. With the increased outlays on the prospecting of new uranium ore deposits in 2001-2007, the known resources of cheap uranium increased by 40%. In 2007, the assured uranium resources that could be mined at less than $80/kgU were estimated at 5,469,000 tonnes. IAEA estimates that these resources will suffice for at least 100 years of operation of nuclear reactors currently used, and the expected discovery of new deposits should extend this time frame up to 300 years. Civil nuclear power sector has been developing for 52 years only.(…). In the next 20-30 years, the introduction of Fast Breeder Reactors (that are currently developed as part of the Generation IV nuclear power programme) will make it possible to use both spent nuclear fuel produced by reactors currently under operation and the resources of depleted uranium left after the enrichment process. As a result, current resources of uranium will suffice for thousands of years.”[333] “The security of supply of nuclear fuel for Polish nuclear power plants should not raise any concerns if we adopt the solutions developed in the European

AGAINST	PROBLEM	FOR
		Union. Still, when paving the way for the first nuclear power plants in Poland, we must actively follow the situation in the uranium market and fuel cycle services market. When doing so, we should use documentation prepared by the EURATOM Supply Agency and other global organisations (IAEA, OECD/NEA) and participate in the relevant long-term EU projects (especially SNE-TP). The focus on the uranium and fuel cycle services market in the coming years may give us valuable information well in advance as to the resistance of the future Polish nuclear power sector to potential disruptions in the fuel market in its first 'formative' years."[334]
"The question whether radioactive waste can be isolated from the biosphere for hundreds of thousands of even millions of years is a philosophical question. It just goes beyond our imagination. Only 5 thousand years have passed since the pyramids were built, and we must now think about how to safely deposit waste produced by German nuclear power plants in 2010 until 10010 or even 100010. However, we do not have a choice: because nuclear waste does exist and we cannot be 100% certain about the answer to this question, we must develop the most optimal technical solution to the best of our today's knowledge."[335] "In 2000, the amount of spent nuclear fuel deposited in the world totalled 220,000 tonnes. This amount increases at a rate of about 10,000 tonnes every year. Still, although many methods of deposition of spent nuclear fuel have been analysed for the past decades, including its deposition in space, the nuclear power industry has not found a solution to this problem yet. Most proposals for the management of highly radioactive waste involve its deposition in deep geological formations. However, we cannot predict whether containers, repository, or surrounding rocks will prove a sufficient barrier to radiation. An example of the repository foundation plan, which was a total fiasco is the project from Yucca Mountain, Nevada, USA. After twenty years of analyses and billions of dollars spent on the project, not even one gram of spent nuclear fuel was deposited in Yucca Mountain. The very fundamental	**Deposition of radioactive waste**	"...highly radioactive waste is deposited deep underground, e.g. at the depth of 500 meters, and radiation is no problem as long as its stays there – only several meters of the ground are enough to reduce radiation to undetectable levels. The only risk is the potential corrosion of containers caused by water, which may wash radioactive waste out of glass in which it was vitrified and move it up towards the surface and sources of potable water. Radioactive waste may become a threat only when ingested by humans. But, as an example, salt deposits would dissolve in water long time ago if water was able to penetrate through to them. And salt is dissolved in water much faster than glass! If we deposit containers with nuclear waste in salt layers, we can be sure that water cannot get through to them. But for how long? For much longer than the period during which nuclear waste remains hazardous. Our life is short compared to half-life of some radioisotopes, but geological changes take much longer time. The rate of removal of vitrified nuclear waste from glass will be slow, because methods of containment of waste used by the nuclear power industry are very effective. As a result, waste will be separated from the biosphere for a very long time, and even if it is removed from glass, the infiltration rate will be very slow. Moreover, the storage of nuclear fuel in tight containers will separate it from the environment for thousands of years! It is technically feasible and not difficult – the nuclear power industry is ready to build

AGAINST	PROBLEM	FOR
questions regarding the geological feasibility of this area were never answered. On top of that, it was discovered that scientific data had been manipulated, which triggered an investigation. Problems with radioactive waste deposition are not limited to highly active waste (i.e. the most radioactive waste generated in a reactor that can cause death on exposure). There are many examples of depositories for low-active nuclear waste that are a source of harmful radiation. Drigg in the UK and La Hague in France are just two of them. Nuclear waste emits radiation for tens, or even hundreds of thousands of years. No human language has survived for more than several thousand years, and no one can tell whether pictograms or other symbols will be interpreted correctly in the future. Therefore, there is no way of ensuring that the future generations are warned about radioactive waste repositories.[336]		this type of depositories for radioactive waste in a number of countries. How much land is needed to deposit highly radioactive waste? According to the EU studies, if nuclear power plants with the capacity of 30,000 MWe operate for 60 years without breaks and at full capacity, they will produce 5400 m^3 of high-active nuclear waste (after reprocessing of spent nuclear fuel). After this waste is vitrified and closed in cylinders (22 cm in diameter and 110 cm high), it may be deposited in 600 openings drilled in the area of just 0.4 km^2.[337]
Nuclear power plants are an attractive target for terrorist and military attacks, given their importance in the power sector, threats resulting from the release of radioactive substances, and their symbolic meaning. An attack targeted against a nuclear power plant may result in a disaster several times more serious than in Chernobyl. Nuclear facilities may be attacked during wars if they are allegedly used for military purposes. They may be attacked in a variety of ways – from the sea, land, or air. There is evidence that more and more terrorist groups are considering potential attacks on nuclear facilities. In this context, the decision of the nuclear power industry and governments of some countries to increase the number of nuclear reactors worldwide is a sign of their stupidity and recklessness.[338] "We may also assume with 100% certainty that none of the 436 reactors used at the beginning of 2010 around the world would withstand a targeted attack of a filled-up wide-body jet aircraft. In Western industrialised countries the risk of accidental crashes of small passenger or military aircraft was taken into account when building many nuclear reactors. However, accidental crashes of filled-up large passenger aircraft were considered so	**Terrorist attack**	"It may seem that nuclear facilities (including power plants) are an easy target for terrorists – it is enough to plant a bomb, throw a hand grenade, or crash an aeroplane. But in reality, nuclear facilities ensure ***the best possible protection against potential terrorist attacks*** – much better than for example chemical plants, water intake points, or coal-fired power plants(…). The system of protection of nuclear materials and facilities is a combination of administrative measures and a number of different types of physical barriers. This system consists of many interrelated elements: procedures for the personnel, methods of operation of equipment, plans of location of physical barriers in the expected sensitive areas in the facility, etc. (...). Terrorist attacks in New York proved that an external attack is easy. Therefore, certain measures are now more commonly introduced to prevent terrorist attacks such as destruction of physical barriers with armoured fighting vehicles filled with explosive materials, or a similar attack from the air or (potentially) the sea (as in Japan) in cases where nuclear facilities are located on coastal sites. In these cases, special coastal patrols are organised. Although a number of factors that may potentially lead to a nuclear accident have been considered

AGAINST	PROBLEM	FOR
unlikely that this scenario was not assumed by any country in the world and no effective procedures were developed. A planned attack using a passenger aircraft as a targeted missile was beyond the limits of imagination of nuclear reactor designers."[339]		since the early years of nuclear power, analyses indicate that older nuclear facilities that had been built in countries that used Soviet technologies, as well as the first nuclear reactors built in Western countries whose structural elements were affected by natural degradation, are not 100% resistant to this type of attacks. There are in urgent need of upgrades, just as certain facilities located near airports. In the United States, the mandatory safety zone of 10 miles around the reactor was introduced. If the damage caused by a terrorist attack is limited to one function or a single component of a nuclear reactor (e.g. a breakdown of the primary loop cooling system or external power failure), small corrective action will minimise this damage to a large extent. However, the situation is more serious if a number of elements are damaged. Structural design of a reactor building plays a major role in minimising the impact of a potential terrorist attack targeted at a nuclear facility with a reactor (power plants, research centres) – both external attack and internal sabotage. New buildings that house a reactor core have double walls (nearly 1 meter wide) made of reinforced concrete (with a free space of about 2 m between the walls that is monitored on an on-going basis) and additionally reinforced with a steel wall (several centimetres wide). The structure of this wall is similar to a ship's hull. Inside the building, a reactor core is placed in a safety containment made of steel and reinforced concrete (several meters wide). Simulations have proved that ***this structure can be damaged from the outside only by a major nuclear explosion***. This construction of the building can withstand strong earthquakes and hurricane-force storms (Three Mile Island plant in the US withstood 6.7 on the Richter scale and hurricane-force winds at 200 miles/h)."[340]
"It was calculated that a nuclear power plant emits 1/3 of CO2 (a greenhouse gas) compared to a modern gas-fired power plant with the same capacity. However, this ratio will be multiplied if we add emissions of greenhouse gases from deposited nuclear waste and from nuclear decommissioning after the nuclear power	**Nuclear power vs. climate**	"Nuclear power plants have less harmful impact on the environment than other commonly used sources of energy - they do not produce greenhouse gases, they do not release into the atmosphere any pollutants and waste generated during the production of energy is stored in secure locations and under strict control. One can

AGAINST	PROBLEM	FOR
plant is closed. Highly radioactive waste must be cooled down 24 hours a day, for thousands of years! One of the methods of management of low- and medium-active nuclear waste is to build underground repositories in rocks for concrete or steel containers with nuclear waste. All these energy-intensive processes are a source of greenhouse gases. Therefore, the relative benefits that may be expected only assuming a failure-free operation of nuclear power plants (which cannot be guaranteed), are neutralised by the damage caused by GHG emissions."[341] "Nuclear energy is the most expensive and most dangerous of all types of energy. The risk of proliferation of nuclear weapons, the problem of radioactive waste, the possibility of breakdowns and threat of terrorist attacks – these factors make it an unviable alternative. It is high time we stopped wasting public money on 'dirty' technologies and focus on renewable energy sources that are the only way to stop climate changes".[342]		often see big clouds of smoke rising from the chimneys of nuclear power plants, but this is water vapour, completely harmless to the environment, free from additional contaminants. In addition, nuclear power plants do not deplete valuable resources that can be used for other purposes. Moreover, they are able to generate high capacity using a relatively small area. Modern nuclear power protects the environment by eliminating some 2.4 Gt (or 2,400,000,000,000 kg) CO_2/year. Obviously, nuclear power will not eliminate CO_2 emissions altogether, but it sets the direction – how not to increase GHG emissions, at the very least. Just as an example: a coal-fired power plant with the capacity of 1000 MWe uses from 2 to 6 million tonnes of fuel per year (depending on the type of coal), and at the same time produces and releases 6.5 million tonnes of CO_2 (960 t CO_2/GWh) to the atmosphere. A similar gas-fired power plant uses 2 to 3 billion cubic meters of gas and produces 480 t of CO_2/GWh. An oil-fired power plant will use 1.5 million tonnes of fuel oil and produce 730 t of CO_2/GWh. A biomass plant with the same capacity will need an area of 6000 square kilometres as a source of biomass, a wind farm will cover an area of 100 square kilometres, and a solar power plant – 50 square kilometres. Unlike these facilities, an emission-free nuclear power plant with the capacity of 1000 MWe will use only 35 tonnes of fuel per year and will cover only several square kilometres. Only in the European Union nuclear power plants allow to save about 700 million tonnes of CO_2 per year, that is as much as all the cars of citizens of all Member States produce in a year."[343]
"The CapEx of a nuclear power plant construction project assumed in the Programme (3.0-3.3 billion euro/1000MW) is not up-to-date. Data presented by power utilities and rating agencies put the figure at 4.5 up to 5.4 billion euro/1000 MW. This data is confirmed by EDF. In its published results for Q2 FY 2010, EDF informed about the increase in the cost of construction of a nuclear power plant in Flamanville, France – from 3.3 to 5 billion euro. It suggests that the CapEx for nuclear power plant projects assumed in the Programme is	**Costs of nuclear power**	"The cost of electricity generated in nuclear power plant is 35 €/MWh, in coal fired power plant 64.4 €/MWh, in gas power plant 59.2 €/MWh, peat-fired plant 65.5 €/MWh and wood-fired plant 73.6 €/MWh (wood is not subject to tax on CO_2). Wind turbines can provide electricity at a price of 52.9 € / MWh, assuming that they are working at full capacity for 2200 h in the year and not incur any costs because of intermittent operation. In a nuclear power plant, investment outlays are the key element of costs, and the cost

AGAINST	PROBLEM	FOR
underestimated by as much as 60% and does not reflect the real costs of their construction. CapEx translated into electricity depends to a large extent on the interest rate on borrowings and the period of repayment of the construction loan. As nuclear power plants are commercial projects, cost analysis is based on data assumed for a typical commercial loan for the construction of a power plant. If we assume the interest rate on a loan at 7% and return on equity at 10.5% (1.5 x borrowing costs), and 70% of funds coming from borrowings, the average cost of capital will reach 8.05%. The cost of capital per 1 MWh of electricity produced in a nuclear power plant depends on the loan repayment period. Typically, loans are granted for 20 years, of which 5 years for construction and 15 years for operation of the project. In order to take out loan for a period longer than 20 years, especially for the construction of a nuclear power plant, state guarantees will be required. Still, even if a state guarantee is secured for the nuclear project and the period of loan repayment is extended, which is not possible under regulations currently in effect, this project will be economically unviable compared to other technologies. For a 20-year period of loan repayment, CaPex will reach 100 – 80 PLN/MWh for coal-fired power plants, 65.64 PLN/MWh for gas-fired power plants, and 282.61 PLN/MWh for nuclear power plants. For a 50-year period of repayment, these costs will reach, respectively: 66.90, 43.48 and 195.45 MWh – that is, three times higher when compared to coal-fired power plants and five times higher compared to gas-fired power plants. The Programme says virtually nothing about the operating costs in nuclear power plants. The complex technology and stringent safety requirements increase the OpEx in nuclear power plants. According to data from US nuclear power plants where production is managed at a very high level, these costs amount to 138 PLN/MWh. However, we must take into account total costs. Calculations were based on the following assumptions: 1 euro = 4 PLN, CO_2 = 30 euro/Mg, fuel cost: HC - 11.5zl/GJ. BC - 6.7 PLN/GJ; gas = 320 USD/1000mJ, atom 12.5 USD/MWh show that the energy from		of nuclear fuel is low. For other power plants, costs of fuel are the main cost component. Wind farms are an exception to this rule. In wind power plants, CapEx per one unit of peaking capacity is two times lower than in nuclear power plants, but much higher per one unit of average capacity during the year."[345] "Total cost of coal and CO_2 emissions will reach ***413 million euro/year.*** This figure is much higher than in a nuclear power plant, but CapEx in a nuclear power plant is much higher compared to coal-fired power plants. In the Flamanville nuclear power plant, CapEx amounts to 2450 euro/kW, i.e. ***3266 USD/kW***. We should note that the Flamanville 3 project is implemented without delays and in accordance with the adopted budget. CaPex of the first nuclear power plant in Poland may be higher than in nuclear power projects currently implemented in France, but to compare a number of plants we should assume average CapEx typically adopted around the world. The latest estimates of OECD assume 2.75 billion euro per 1000 MWe. For the second and every subsequent nuclear power plant in Poland, we may assume the positive effect of the learning curve in the nuclear power industry and lower investment costs. However, we will assume the worst-case scenario – CaPex will be higher than the latest OECD estimate and will be equal to CaPex of the second unit in the Florida nuclear power station in the USA – ***3220 €/kWe.*** These investment costs are higher than in Flamanville 3, because CapEx in the USA is always higher than in Europe (by about 20-30%) – not only for nuclear power projects, but also for coal-fired power plants. Therefore, CapEx assumed at 3220 €/kWe gives us a large safety margin. For coal-fired power plants in Poland, prices in 2008 reached from 1800 €/kWe to 2000 €/kWe. We will assume the cost of 1875 €/kWe, just as for the new power plant in the former Czeczot coal mine. The resulting difference in CapEx for the second and every subsequent nuclear power plant in Poland amounts to 1345 €/kWe. This is an amount equal to the difference in fuel costs and CO_2 emission charges that

AGAINST	PROBLEM	FOR
nuclear power plants is the most expensive and its cost is almost 100 Euros/MWh with a very long period of repayment. It is over two times higher than assumed in the Programme. Publication of underestimated costs of electricity production in nuclear power plants may be interpreted as an attempt to mislead the public opinion."[344]		must be incurred when burning imported coal instead of nuclear fuel during a 4-year period. Obviously, these findings should not be interpreted as a complete economic calculation, only as an illustration presenting the key elements that determine the final cost of electricity produced in nuclear and coal-fired power plants. As we can see, thanks to very low cost of nuclear fuel, ***nuclear power is an economically viable alternative despite the high capital expenditure"***[346]
"We don't need a nuclear accident to release radioactive substances to the air, water and soil. Everyday operation is enough, since government regulations allow such emissions. Radioactivity is measured in curium units. 1000 medical laboratories that use radioactive isotopes will contain the equivalent of 2 Ci. An average nuclear reactor in its core contains ca. 16 billion Ci, as much as long-term radiation from at least 1000 bombs dropped on Hiroshima. Pipework, valves and tanks of the reactor may have leaks. Leakages can be also caused by mechanical breakdowns or human errors. Ageing affects the entire reactor and its individual components, and leakages are more frequent with time. A portion of contaminated water is discharged on purpose from the reactor pool to reduce the amount of radioactive substances and corrosive compounds that would otherwise destroy valves and pipes. Water is filtered and then headed back to the cooling system or drained into the environment. A typical 1000 MW nuclear power plant with a PWR and a cooling tower needs 80 thousand litres of water from a river, lake or the sea per minute for cooling. This water is transported through 80 km of pipes. 20 thousand litres per minute are discharged back to the source, and the rest is released to the atmosphere as water vapour. A 1000 MW reactor without a cooling tower needs even more water – up to several million litres per minute. The water discharged after circulation is contaminated with radioactive elements,	**Radiation in the area of nuclear power plants**	"In the Flammanville nuclear power plant in France with two PWRs with the capacity of 900 MWe, the typical dose of radiation from all emissions from this power plant is 0.0003 mSv/year. The Souleau Committee appointed by the French government determined that the maximum doses of radiation corresponding to the allowed limits would amount to 0.3 mSv/year, and the actual dose of radiation measured outside of the power plant reached 0.01 mSv on average, i.e. 30 times lower than the adopted limits and 200 lower than the dose coming from natural background radiation. Also in the USA, the average radioactive emissions from all nuclear power plants are much lower than the acceptable maximum levels. Negative health effects caused by these low emissions have never been determined, and it is expected that they will never occur. Despite the claims presented in publications by anti-nuclear activists, a study by the US National Cancer Institute conducted on a wide scale (500,000 persons) confirmed that there are no signs of the increased cancer rate in the vicinity of nuclear power plants in the USA. Poles should not think that results recorded by the Swiss, Germans or Americans are beyond our reach due to some differences at the level of technical culture or social conditions. In the neighbouring country of Slovakia, a nuclear power plant was built in late 1980s with two WWER-440 reactors (similar to those planned in the Żarnowiec power plant in Poland). The political changes in Slovakia put the Mochovce project on hold for a couple of years, but the project was never abandoned and finally both reactors were put into

AGAINST	PROBLEM	FOR
whose concentration is neither known nor easy to measure, but it affects lives. Some radioactive gases expelled from the reactor cooling water are stored in decay reservoirs prior to release to the atmosphere through fans with a filter. Some gases are released inside the nuclear power plant buildings and are removed from time to time during what is known as 'airing'. These free gases will contaminate not only the air, but also water and soil. Radioactive leaks from a nuclear reactor that occur during normal operation are often not fully detected and not reported. Emissions from the accidents may not be fully verified or documented. For certain key side-products of a nuclear reactor (radioactive hydrogen – tritium, noble gases such as krypton and xenon), there are still no effective and economically feasible techniques of filtering and monitoring. Some liquids and gases are stored in tanks for decay of less durable radioactive materials before the release into the environment. Government regulations allow the discharge of radioactive water into the environment, containing "permitted" levels of pollutant concentrations. But 'acceptable' does not necessarily mean 'safe'. Detectors installed at reactors are set up to allow the release of unfiltered water that contains more pollutants than 'acceptable'. Detection of leakages and predicting the spread of radioactive pollution by US Nuclear Regulatory Commission is based on reports and computer models provided by operators of nuclear power plants. Much of the environmental monitoring data comes from extrapolation rather than from observation. There is simply no accurate analysis of all nuclear waste released into the air, water and soil from the entire production cycle of nuclear energy. This cycle includes: mining and milling of uranium ore, chemical processing, enrichment, fuel production, nuclear reactors, and pools, ditches and barrels in which the waste is stored. Growing as a result of deregulation of the electricity generating industry, economic pressures to reduce costs may further undermine the already tenuous monitoring and reporting of radioactive leaks. Delayed upgrades may increase the emissions of		operation – after the introduction of certain modifications. These reactors now produce electricity that is 50% cheaper than electricity produced in conventional power plants, and at the same time they meet all safety requirements adopted in the EU. Radiological analyses indicated that doses of radiation in the area are so small that they cannot be even measured. When measurements were finally taken, it turned out that in the period of 6 years since the opening of the Mochovce nuclear power plant, additional annual doses of radiation from this facility never exceeded one MILLIONTH of a sievert (ranging from 0.1 to 0.7 micro Sv)."[348]

AGAINST	PROBLEM	FOR
radioactive substances and the resulting risks. Many side-products of nuclear reactors are able to emit radioactive particles and rays for a very long time – defined based on their 'half-life'. Radioactive materials will emit harmful radiation for at least 10 half-lives. The half-life of one of the isotopes of iodine (iodine 129) is 16 million years, technetium 99 - 211 thousand years, and plutonium 239 - 24 thousand years. Noble gas xenon 135, is transformed into caesium 135, the isotope with half-life period of 2.3 million years. It is a scientific fact that low level radiation damages tissues, cells, DNA and other vital molecules, causing progressive cell death (apoptosis), genetic mutations, cancer, leukaemia, neonatal deformation, and disorders of reproductive, immunological and endocrine systems." [347]		
"Polish nuclear power plants will pose a threat of another Chernobyl disaster. The system selected by the Polish government is so hazardous that the British decided to ban the construction of this type of reactors. Polish experts have no experience and blindly believe the producers - the recognized nuclear energy expert warns. "The UK Nuclear Installations Inspectorate refused permission for the construction of EPR nuclear reactors (European Pressurised Reactor - a new reactor with a capacity of 1600MW), justifying this with concern about the safety of their operation," - explains in "Virtual New Industry" prof. Assoc. Eng. Wladyslaw Mielczarski, full professor at the Technical University of Łódź, a member of the European Energy Institute. And British experts are among the most experienced nuclear energy experts in the world. They claim that reactors that Poland intends to purchase have major safety issues. There are problems with maintenance of the optimum temperature and pressure. In case of problems the plant operation cannot be stopped quickly. In his opinion, there is no discussion in Poland on reactor safety, and the government presents the device as a super-safe. "Some time ago, people were convinced that they had built a super-reliable machine. It was a ship – and her name was the Titanic. Since that	**Safety**	"Since the very beginning of nuclear power, nuclear power plants in Western countries have been designed in such a way as to ensure that the effects of any potential (even very unlikely) accident do not exceed the acceptable level. A number of different and reliable safeguards were used, mainly based on natural mechanisms such as the force of gravity, safety systems with three or four redundant subsystems, large safety margins assumed in the design, and many other design and organisational measures described in the article "*Protection against threats from failures in nuclear power plants*" published in the September issue of PSE Public Information Bulletin. As a rule with respect to design failures it was assumed that the NPP safety systems must be sufficient to control failure in any NPP component, even if the failure occurs in the most inconvenient element for the operator and in the most unfavourable condition of NPP, and is accompanied by a single failure that can occur in any power plant system, even one that is designed to master this very failure. For such assumptions, the designer had to develop a failure scenario, assuming the most unfavourable assumptions, such that failure results in loss of electrical power from the external network (regardless of additional single postulated damage in any system) and prove that the existing safety systems in NPP are enough to provide

AGAINST	PROBLEM	FOR
time, nothing has been called super-safe or reliable. When I hear lobbyists singing praises about the safety of nuclear reactors, it is worthwhile to stop and think – maybe they are trying to sell us a ticket for the new Titanic?", said prof. Mielczarski. As suggested by Mielczarski, Polish experts have no experience. They have completed one-week courses and information from producers is all they have to rely on. And this information is not always true. That is why the decision regarding the selection of a particular type of a nuclear reactor for Poland in 2010 must be well prepared. Otherwise, the new Polish nuclear power plants may destroy Poland."[349]		power plant shutdown, cooling down and preventing the release of radioactive substances. We did witness one accident in a nuclear power plant that included a PWR core meltdown. It happened during a nuclear accident in the Three Mile Island (TMI) nuclear power station, where the power supply was not interrupted, but wrong decisions taken by operators caused the failure of the emergency core cooling systems and melting of the nuclear fuel. However, although the core and the entire nuclear reactor had been damaged to such an extent that the subsequent repair of the nuclear power station was not possible, the reactor pressure vessel maintained its integrity, and the safety containment prevented the release of fission products – as a result, the doses of radiation outside the nuclear power plant were negligibly small. Nobody lost their life or health as a result of the TMI accident. The TMI case proves that even 'old' reactors have safety margins that will ensure the containment of the effects of beyond-design basis accidents involving the nuclear core meltdown. At the same time, the TMI accident serves as a warning – human error is possible and fast and effective interpretation of the emergency processes may be difficult and may lead to very wrong decisions. Therefore, analyses were launched to determine whether effective rules of procedure can be developed to prevent human error on the part of operators. At the same time, additional safeguards were introduced to the planned and existing reactors to contain the release of radioactive substances in the worst-case scenario of the most serious hypothetical accidents. There works took many years, and the resistance of nuclear power plants to beyond-design basis accidents have improved over time. At the end of the 20th century, the EU Member States adopted the practice that safety features and systems in a nuclear power plant should be able to contain not only design-basis accidents, but also beyond-design basis conditions in order to prevent the release of large amount of radioactive substances outside of the safety containment. Now, after 25 years since

AGAINST	PROBLEM	FOR
		the TMI accident, both the EU and the USA have developed state-of-the-art reactor designs (Generation III reactors) that will guarantee safety for inhabitants of the local area even in the event of serious nuclear breakdowns with nuclear core meltdown."[350]

5.6.4 Educational and information programs concerning nuclear energy in Poland

The project to build nuclear power plants returns. We should take a look at how the approach of authors of development of nuclear energy to informing the society has changed, since the society has a right to be informed of any actions which can impact the environment.

It was included in the raft Polish Nuclear Programme that in order to increase the knowledge of society in terms of nuclear energy (including nuclear power industry), constant education and information actions are necessary. Both types of activities should be correlated and coordinated, conducted in parallel. The burden of educational activities should be distributed between the ministries responsible for education, training and promotion of science, collaborating with the Ministry of Economy, cooperating in the future with Nuclear Energy Agency. Educational activities should also be pursued by other bodies and institutions. Educational activities should be conducted from the lowest levels of education - from primary school level. They must also be supported by an investor/investors, both within their policy of CSR (Corporate Social Responsibility) and in cooperation with institutions training staff training for nuclear energy sector. Thus, the activities proposed by PEJ include:

- information campaign,
- education campaign.

According to PEJ society will be entitled to receive information on the operation of nuclear power sector, all the information will be available, unless legally protected in accordance with applicable regulations on protection of information covered by intellectual property rights recognized by the Investor/OEJ Operator as sensitive information concerning the physical protection of nuclear materials and security and those whose disclosure would endanger public safety. NEA will be required to protect data and information obtained from the Investor/OEJ Operator against access by unauthorized persons and entities, Nuclear Energy Agency (NEA) will be required to collect data and information on nuclear energy in Poland and abroad, to process and publish and share them with interested natural and legal persons.

Provisions quoted above correspond to the needs identified in the CBOS research results cited in the preceding subsections concerning low awareness of Poles about nuclear power. Informing the society is a necessary factor, which must accompany the development of nuclear energy. It is important that the principle of transparency recommended in the Draft is applied, allowing for social control and increase in public trust for conducted projects. In this scope, actions of potential Investors will also be crucial, as mentioned above. Achieving the objectives will be aided by "Human resources development plan", which according to PEJ should be adopted by the end of 2011.

Information action and dialogue concerning the plans to build nuclear power plants have already been started. The initiative is implemented by a series of meetings during the tour across the country on the so-called Atomic bus. As stated on the website of the Project[351] The main objective of the

project "Atomic Bus - Mobile Lab" is to reach students in major academic centres and to provide reliable information on peaceful uses of nuclear energy in the context of the government's program of building nuclear power plant in Poland.

The educational project is run from November to December 2010 in collaboration with leading universities in selected localities. As part of the Project the university and polytechnic departments hold seminars on various aspects related to the introduction of nuclear power. Sample topics include the following: psychology of radiation; nuclear power reactors - construction, operation, operational safety, biological effects of ionizing radiation; staff for nuclear power industry, the prospects for applying thorium in nuclear reactors. A supplementary objective of the project is to attract and possibly deepen the knowledge of existing conditions and social attitudes and perceptions of nuclear power industry issues by students, residents of visited cities and local leaders. In direct conversations with students around the information and education booth and during seminars and open discussion, the staff of the Foundation offers free of charge, objective and most current knowledge in the field of radiation protection, the essence of radioactivity, used reactor construction technologies and security systems and the construction costs of the future nuclear power plant taking into account environmental aspects.

"Atomic Bus" is also a mobile information centre, equipped with a range of interactive teaching aids (audio-visual equipment, demonstration facilities and equipment and nuclear mini-laboratory) that are presented and made available to visitors. Foundation employees involved in the project, in addition to presentations and distribution of information materials and brochures, will be able to perform demonstrations and experiments in the field of nuclear physics and radiation protection, and demonstrate the performance of a typical nuclear power plant using a specially prepared model. In pursuit of the objectives of this Project, the experience with similar projects is taken into account.

The Atomic Bus Project also allows for substantive discussions of representatives of the Antinuclear Associations with representatives of Atomic Forum. For example, the presentation at Wroclaw University of Technology was closely observed by representatives of Stowarzyszenie Ekologiczne Eko-Unia who, by handing out information materials and discussions tried to present a quite different approach to the subject of nuclear energy. This kind of public confrontation of groups with two different views on nuclear energy in Poland allows persons not yet having to deal with this subject to refer to the arguments of both sides and fully consciously decide which arguments are correct and which side should be supported.

Popularization of knowledge of nuclear power industry is promoted by professional websites, being an increasingly frequent and easy source of knowledge. For this purpose the website „Nuclear energy[352]" was created in Poland. It deserves special attention as it is created in cooperation with the most prominent specialists in the field of energy, including nuclear power industry, of course. Thematic tabs include materials devoted to technology, security, ecology, law and current events that are related to the subject. A rich base of presentations, comprehensive publications and specialist publications can be found on the website. They are usually made available in form of PDF files.