Project

Ministry of Economy
Government Commissioner for Nuclear Power

Polish Nuclear Power Program

Warsaw, January 2011

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Chapter 1. Introduction

The basic goal of the Poland's energy policy is to ensure that companies and citizens are supplied with enough power at competitive prices and in compliance with environmental protection requirements. For the decades to come, efforts aimed at achieving this goal will be determined by capital expenditure requirements related to the development of generation infrastructure and the participation of Poland in pursuing the European Union's climate and energy package policy. A conversion of the electricity generation structure will be necessary by replacing sources with high CO_2 emission levels with low-emission sources of energy. In this context, nuclear power seems to be the most promising option because of zero-emission of CO_2 and more stable supply of energy resources.

The priorities of the Polish energy policy in relation to the nuclear power have been defined by the Council of Ministers on 10 November 2009 in the document entitled *Poland's Energy Policy by 2030* and more specifically in Section 4 of the document: "*Diversification of electricity generation through the implementation of nuclear power*".

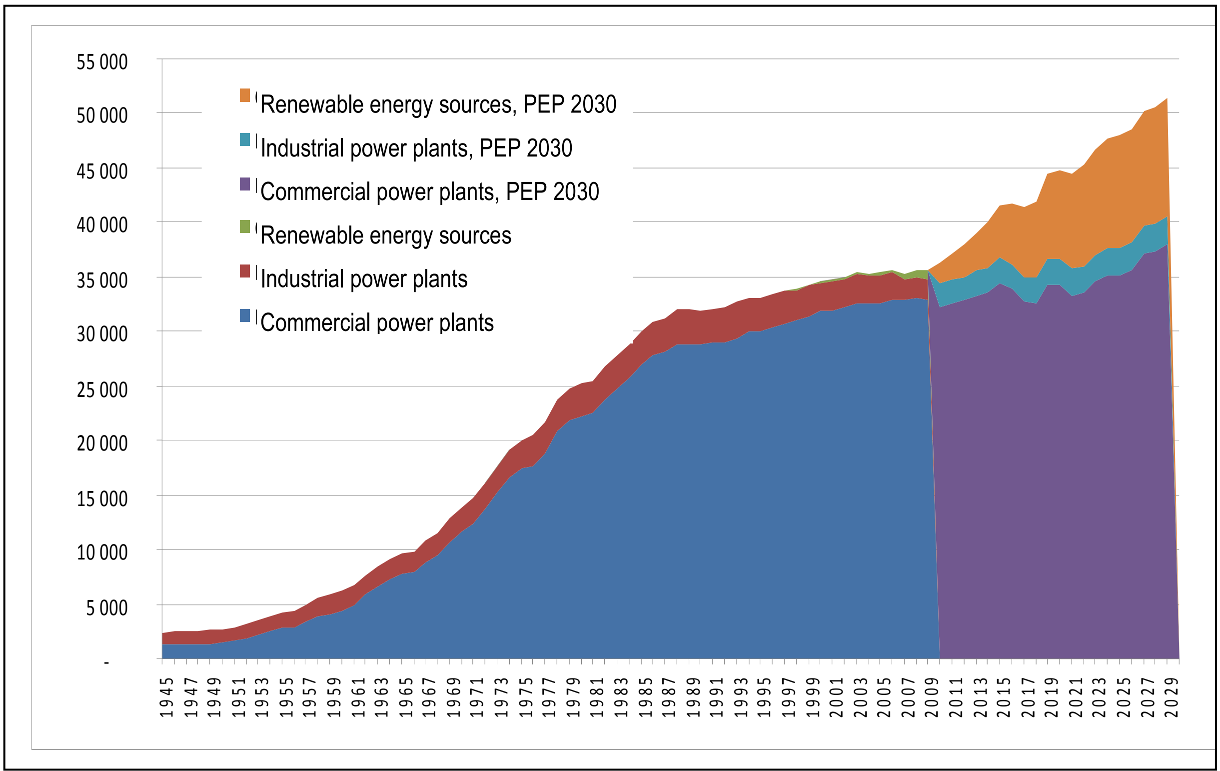
It is estimated that electricity consumption in Poland will grow. The estimation is based on – among the others – the fact in the long run it will be impossible to maintain the current relatively low consumption. According to EUROSTAT (May 2009), Poland is ranked 24th among EU countries in terms of annual consumption of electricity per capita. The figure of about 4,000 kWh is much below the EU average of about 7,500 kWh.

According to the forecast of demand for fuels and power by 2030 contained in *Poland's Energy Policy by 2030*, domestic gross demand for electricity will go up from 141.0 TWh in 2010 to 217.4 TWh in 2030, i.e. by about 54%. It will be necessary to increase the generation to meet the growing consumption of electricity. In addition to new, highly effective coal fired power plants, generation capacities based on other sources (including nuclear, gas and renewable resources) will have to be built. The scope of tasks for the power sector in terms of the required increase of generation capacity is illustrated in Fig. 1.1. According to the above-mentioned forecast, the installed capacity of power generators should grow from about 35,000 MW in 2008 to about 52,000 MW in 2030 or by about 50 percent.

Poland has been a net energy importer since 1980 and – given its limited potential of primary energy resources – the tendency will continue. Its own resources of raw materials needed for the generation of electricity are not sufficient to maintain the adequate level of energy security for Poland

However, the necessity to change the fuel structure in the electricity generation is dictated first of all by the dominance of hard coal and lignite in the Polish power generation sector historically shaped after the World War II when the government facing the deficit of hard currency for possible purchase of imported fuels had to build the sector on resources available in Poland. In 2009, the share of hard coal and lignite was above 92 %. Such structure adversely affects Poland's ability to meet environmental protection requirements, especially in the area of CO_2 emission. The requirement to reduce CO_2 emissions by 20 percent by 2020 forces a modification of the fuel structure in the power generation sector.

Fig. 1.1. Changes in the installed capacity in the years 1945-2030
Source: ARE study, 2010

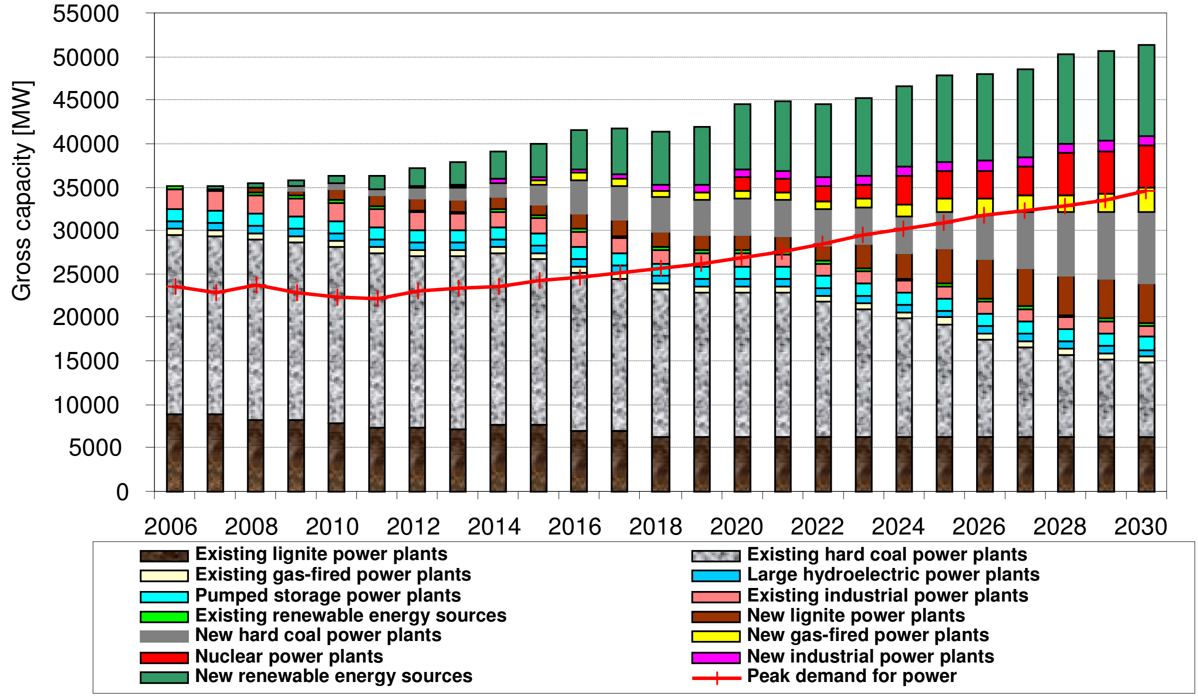


Meeting the requirements set by the European Union for Poland to achieve a 15 % share of renewable energy in the gross final energy structure by 2020 is possible only at the expense of a significant increase of the share of renewable energy sources during that period while the cost of generation will be still high.
According to the aforementioned forecast concerning the demand for energy and fuels by 2030 – developed with consideration of expected results of efficiency-improving projects, European Union's requirements with respect to the reduction of emissions to the atmosphere and the expected growth of fossil fuel prices by 2030 – nuclear power should appear in the structure of primary energy sources after 2020 as it would enable reduction of CO_2 emissions in the power sector and mitigate the increase in electricity prices resulting from high costs of CO_2 emission reduction. Ideally, in terms of the cost structure, nuclear units should be the dominating components of the new power plant system.
If the mandatory increase of renewable energy sources is achieved the structure of capacity of electricity sources in 2030 will be as shown in Fig. 1.2.

Despite the fact that environment protection standards are getting more and more stringent, coal will remain the most popular resource used to generate electricity and heat. It is expected that within the next 20 years, i.e. by 2030, the coal sector should provide enough fuel to maintain the total electricity generation at hard coal and lignite power plants at an even level of about 110 TWh, i.e.: 112.9 TWh in 2010, 102.7 TWh in 2020 and 114.1 TWh in 2030.

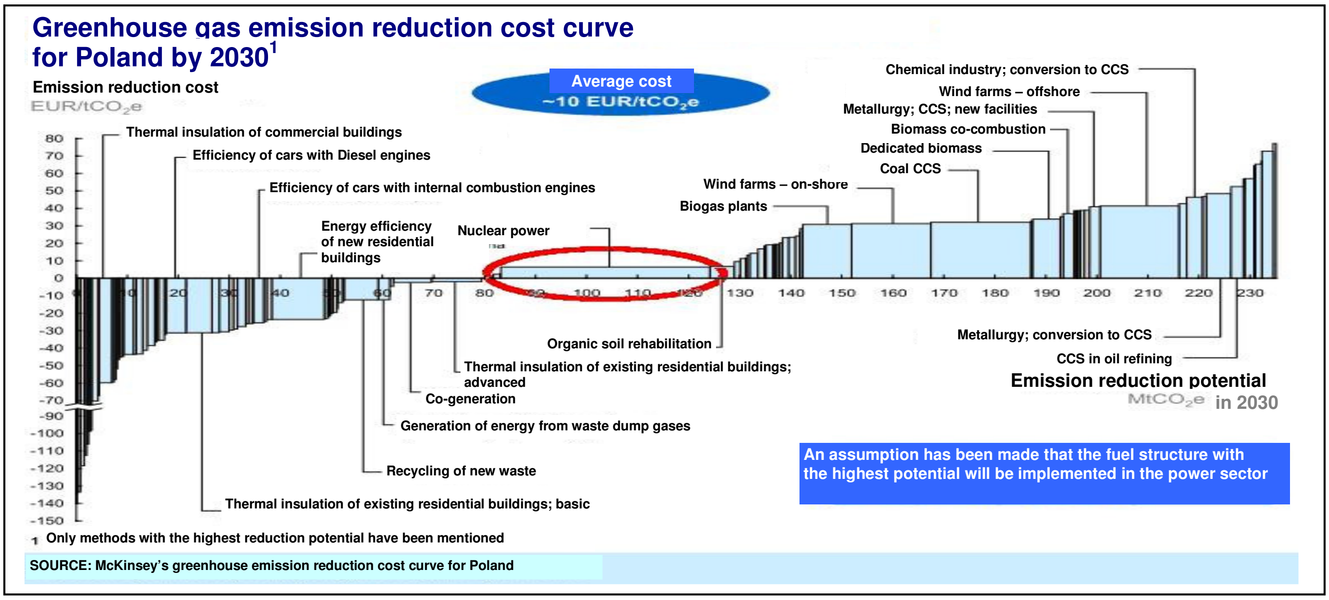
It seems that going nuclear would be an effective way of cutting carbon emissions from the Polish power generation sector. It has been confirmed by the McKinsey report entitled "*Evaluation of the potential to reduce emissions of greenhouse gases in Poland by 2030"* carried out in 2009 and commissioned by the Ministry of Economy. The potential is illustrated by the greenhouse gas reduction cost curve in Fig. 1.3. As shown in the diagram, the use of nuclear energy sources is the most cost-effective method of CO_2 emission reduction as far as the electricity generation is concerned if a fuel structure is achieved that ensures making the most of the emission reduction potential.

Fig. 1.2. Capacities of electrical energy sources by 2030
Source: ARE analysis carried out in 2008 and commissioned by the Ministry of Economy



Enhanced **nuclear security standards** and **protection and security of nuclear power facilities** at international and national levels in countries that operate nuclear power reactors justify perceiving nuclear power as a significant opportunity of economic and technology growth.

Fig. 1.3. Greenhouse gas emission reduction cost curve for Poland by 2030
Source: McKinsey& Company, 2009



Nuclear power means advanced technology. Therefore the availability of highly qualified resources with high technology and management culture and living by established principles of responsibility for safety and quality and standard of life of current and future generation is an essential issue.

The government's tasks in the development of civil nuclear power include preparing a multifaceted justification of going nuclear with total awareness that it is not a universal solution to all power generation issues – even in view of the global challenges related to economy and ecology. However, it is an important part of such solution. Also, Poland's active participation in global efforts aimed at the reduction of CO_2 emission, with being aware of the fact that this goal will not be achieved by an increased share of renewable sources of energy alone, requires that Poland face the challenge of building new nuclear power units. However, even if the today's restrictive greenhouse gas emission limits are made less stringent in the future, the cost-effectiveness of power generation at nuclear power plants will have to be able to defend itself. From the onset, the government must be far-sighted because going nuclear requires consistent and sustainable approach to the development of the nuclear power sector. The state must also assume the related responsibility and be able to control the risks.

By choosing the nuclear option, the Republic of Poland will be able to keep its obligations in the areas of sustainable development and provision of electricity at reasonable prices and with consideration of environment protection requirements. Efforts must be taken to prepare regulations that not only encourage to such project but also form a long-term vision for the nuclear power sector and outcomes of such decision in the long run.

It is very important that an independent, competent and professional nuclear supervision authority is established. The quality of selected technology and transparency of the entire process of its implementation with a built-in component of reliable communication must be first ensured before social acceptance of the technology is sought. These matters are very important at every stage of the Program preparation and implementation.

In a more distant perspective, as the nuclear technology progresses, it will be necessary to establish partnerships for development of future generations of power reactors with enhanced operation performance and for finding solutions in the area of treatment of spent fuel and radioactive waste. Reasonable, safe and socially accepted management in that area is crucial for the operation of the nuclear power sector and for achieving the social acceptance for the nuclear power option.

The nuclear power sector is fully responsible for outcomes of its operations, from the preparation of construction of nuclear power facilities, project implementation, safe and cost-effective operation, to decommissioning of nuclear power facilities, and for the implementation of solutions in the area of spent fuel and radioactive waste treatment. Every project owner and operator of nuclear power facilities must be aware of these challenges at the time of making any investment decisions.

Preparations related to the implementation of nuclear power in Poland must be carried out within certain legal framework established with consideration of the international law and EU regulations and in accordance with recommendations of the International Atomic Energy Agency (IAEA). These actions must be also based on the experience of the countries that have already successfully implemented nuclear power and won social acceptance for it.

The Program of nuclear power development is the largest project ever in the history of the Polish energy market and the country's post-war economy. It cannot be successfully implemented without support from international organisations that have knowledge and experience documented by an extensive collection of standards, guidelines and recommendations and, most importantly, that are willing to share their knowledge. The potential partners include first of all the International Atomic Energy Agency (IAEA), the OECD Nuclear Energy Agency (NEA/OECD) and various international initiatives implemented under the auspices of these organizations.

The basic areas of possible partnerships should include:
- comprehensive security system including nuclear security and physical security of nuclear facilities and radioactive material;
- training of highly qualified resources for the nuclear power sector including project owners' staff and officers of government agencies;
- availability and security of supplies of nuclear fuel;
- spent fuel and radioactive waste management procedures

A specific example of a program that supports every country in implementing its nuclear power program is the IAEA Integrated Nuclear Infrastructure Review (INIR). Information on the preparation of the INIR mission to Poland can be found in Chapter 5.

It should be noted that development of civil nuclear power industry in the context of today's geopolitical factors entails also the necessity for Poland to fulfil its obligations related to preventing the proliferation of nuclear weapon and nuclear materials

Pre-feasibility studies on implementation of nuclear power in Poland, global development trends in nuclear power and experience of countries that have operated nuclear power facilities for years have demonstrated that nuclear power is a safe technology that allows generation of electricity at reasonable and lower cost as compared to other generation technologies and with lower emissions, the latter being especially important for the achievement of greenhouse gas emission reduction goals accepted by Poland.
Government's decisions made in 2009 open a new chapter in the development of a nuclear power program for Poland. However, the way from a decision on preparing the program to launching the first unit with a nuclear power reactor is a long process and an efficient action plan must be developed to achieve the goal as soon as possible.

The *Polish Nuclear Power Program* (the "Program") outlines the scope and structure of activities needed to implement the nuclear power, ensure safe and effective operation of the nuclear power facilities and their decommissioning and develop a safe procedure of management of spent nuclear fuel and radioactive waste.

A legal framework is required to support the Program. Government agencies, project owners and future operators of nuclear power facilities will be able to take any efforts aimed at the implementation of the nuclear power only if the Program is accompanied with drafts of legislation governing the activity of these entities.

Chapter 2. Goal, objectives and schedule of the *Polish Nuclear Power Program*

2.1. Goal of the Program

The implementation of nuclear power – a project that is important for the country's economic and social development and for its energy security – requires establishing a program of development in this area. The program must be compliant with the Act on principles of conducting the development policy.

This document contains the description of the Program, which is a "development program" in the meaning of Article 15 (4)(2) of the Act of 6 December 2006 on principles of conducting the development policy (Journal of Laws of 2009, No. 84, item 712, as amended).

2.2. Program period

The duration of the program is determined for 2011-2020 - to the end of construction first unit of the first Polish nuclear power plant, with the prospect of the year 2030 - the duration of the *Polish Energy Policy until 2030*.. Programme Costs were estimated to the end of the First Key Stage: commissioning of the first nuclear power plant. The Program will be reviewed every each four years, which let to make the verification the costs of the Program implementation.

2.3. Assessment of the situation in the areas covered by the Program

According to IAEA's recommendations, the implementation of the nuclear power requires from 10 to 15 years of preparations, including the construction of the first nuclear power plant itself. The duration of this period will depend on the level of development of the country implementing the Program.
In the case of Poland, the implementation of nuclear power will require building almost the entire technical infrastructure necessary for the development and operation of nuclear power facilities (including legal framework; organizational, institutional and research systems; personnel training system etc.).
A detailed assessment of issues important for the nuclear power development is presented below in the Program – in chapters pertaining to specific areas. This approach is based on the fact that the Program is the first comprehensive document on the nuclear power in Poland and issues related to the development of nuclear power in Poland must be presented in a more detailed way as compared to other documents.

2.4. SWOT analysis

Strengths and weaknesses of the Polish economy as well as opportunities and threats related to the development of nuclear power in Poland have been presented below:

Strengths

- Advantageous geographical location of Poland.
- Large installed electricity generation capacity in place.
- Well-developed system of education, including higher education.

- Increased demand for electricity and the necessity to replace the obsolete generation facilities.
- Increasing social support for the development of nuclear power.
- Large market for the generated power, with good prospects of constantly growing demand (high population, consistently growing wealth of households), proximity of markets of the new central European EU member states and largest EU markets (especially Germany).
- Good integration with power systems of EU countries.
- Advantageous macroeconomic environment of Poland: stable economy, good achievements in economic growth in recent years, low inflation, stable banking system.
- Relatively low labour costs; although they are expected to grow constantly in the coming years, they will be still far below the level recorded in highly developed countries.
- Highly qualified human resources: relatively high qualifications of employees.
- Political stability of Poland.
- Poland has an active nuclear supervision authority.
- Efficient radioactive waste management system.
- Poland has research nuclear reactors.
- Membership in all major international organisations involved in nuclear power development.
- Prospect technology suppliers highly interested in their engagement in nuclear power development.
- Potential and capabilities of the project owner.

Weaknesses

- Deficit of human resources qualified in nuclear power.
- Poor (on the national level) transport infrastructure (roads, railway, airports).
- Low efficiency of partnership between the research and business sectors.
- Underdeveloped scientific and research base.
- Administrative constraints (excessive bureaucracy, time-consuming and endless procedures).
- Not transparent and inconsistent legal framework; complex regulations.
- Disadvantageous demographic forecasts; limited availability of human resources in the long run.

Opportunities

- Economic recovery of regions and faster growth of the national industry.
- Development of the scientific and research base, also in the areas related to nuclear power.
- More innovation in the country’s economy.

- New jobs.
- Possible reduction of coal and natural gas imports.
- Building stable and economic (in the long-run) sources of electricity.
- Reduced emissions of pollutants: CO_2, NO_x, S_xO_y, solid particles and heavy metals.
- Diversified structure of electricity generation.
- Development of relevant university majors and courses – building a strong human resource base for the nuclear power sector.
- Increased attractiveness of Poland for investors, as a place with secure supplies of electricity and stable prices.

Threats

- Not enough funds for the Program implementation.
- Inability to secure enough qualified human resources.
- Problems with financing the construction of nuclear power plants.
- Insufficient social acceptance of the nuclear power development including objections of local communities against the location of nuclear power plants and radioactive waste repositories.
- Delays in the construction of power plants and resulting increase of the construction cost.
- Not enough time for the implementation of all activities.
- Occurrence of an incident in a nuclear power plant somewhere in the world and the resulting reduced social acceptance of the project.

2.5. The major goal and objectives

The goal of the Program is to implement nuclear power in Poland to ensure security of supplies of electricity at reasonable prices while meeting the environmental protection requirements.

The goal will be implemented with activities described below.

The following **objectives** will support the achievement of the major goal:

1. Draft of the legal framework for the development and operation of nuclear power.
2. Research and examine potential locations of nuclear power stations.
3. Build a repository of low and intermediate level waste for the nuclear power sector.
4. Ensure the highest level of security of nuclear facilities.
5. Implement a reasonable and effective system of management of radioactive waste and spent nuclear fuel.
6. Establish an institutional base for the development of the nuclear power sector.
7. Ensure that social acceptance of the nuclear power development is growing and is maintained.
8. Improve the public education about nuclear power.
9. Ensure human resources for the purposes of development and operation of nuclear power.

10. Establish a strong and efficient scientific and research base for nuclear power.
11. Improve the innovativeness and technological level of the Polish industry.
12. Ensure security of supplies of nuclear fuel for nuclear power plants.
13. Prepare the National Power System for the development of nuclear power.
14. Develop an efficient method of financing the construction of nuclear power plants.

Objective 1:
To be achieved by implementation, drafting and adoption of relevant legal framework and then by continuous control and modification of its efficiency;

Objective 2:
To be achieved by continuous updating – in partnership with local self-government bodies – of the list of and information of possible locations of future nuclear power plants;

Objective 3:
To be achieved by choosing the site for a repository of low and intermediate level waste and by building such repository;

Objective 4:
To be achieved by preparing the National Atomic Energy Agency, and then the Commission for Nuclear Supervision, to perform functions of a competent and efficient nuclear supervision authority.

Objective 5:
To be achieved by implementation of a system of management and financing the management of radioactive waste and spent nuclear fuel and by regular assessments of the efficiency and effectiveness of the system;

Objective 6:
To be achieved by establishing institutions responsible for implementation and coordination of activities related to the Program and for its periodic updates;

Objective 7:
To be achieved by implementation of a nuclear energy information campaign and by involving the public as much as possible in the implementation of the Program;

Objective 8:
To be achieved by structured implementation of an education campaign;

Objective 9:
To be achieved by introducing courses and subjects related to nuclear power in university and secondary school curricula to educate human resources for the new nuclear power sector;

Objective 10:
To be achieved by establishing, development and efficient functioning of a consolidated scientific and research base for the nuclear power sector;

Objective 11:
To be achieved by creating environment that will encourage Polish entrepreneurs to engage in the nuclear power development;

Objective 12:
To be achieved by entering into contracts that will secure stable supplies of nuclear fuel for years and by regular assessment of options and stability of fuel supply from internal and external sources;

Objective 13:
To be achieved by preparing the plans of adjustment of the National Transmission System to the requirements related to the development and operation of nuclear power and then by consistent implementation of the plan including the construction of the network infrastructure for commissioning and operation of nuclear power plants;

Objective 14:
To be achieved by carrying out comprehensive analyses of options of financing the construction of nuclear power plants and then by selection and implementation of the most effective method.

2.6. Related strategic documents

Preparations related to the implementation of nuclear power in Poland are carried out according to the national legislation. International and European law is also observed and IAEA recommendations are followed.

The Program is consistent with medium term national development strategy - the opinion of the Minister of Regional Development on this issue is Appendix 5 to the program.

The Program implements objectives of the *Energy Security and Environment* strategy that is currently under development.

Objectives of the Program are included in the following priorities of the developed Strategy:

- Operational objective 1: Ensure balanced demand for electricity and fuels and security of supplies
- Operational objective 3: Protect and improve the environment and adapt to the climate change.

Objectives defined in the document are also consistent with the *Poland's Energy Policy until 2030*. They are in line with the Objective 3 of the Policy: *Diversification of the structure of electricity generation by implementation of nuclear power*.

The program is also a component of a platform that should ensure good outlooks for the economic growth by the improvement of the potential of the Polish power sector described in the report entitled *Poland 2030: challenges of development*.

The objectives of the *Europe 2020 Strategy* adopted by the European Council on 17 June 2010 have been considered in the Program. The strategy sets objectives in the area of employment and smart, sustainable and inclusive growth.
The achievement of the **20/20/20** objective in the area of climate and energy is especially important from the Program perspective.

As regards to Poland, the European Commission has identified five most important challenges in the document. The implementation of the Program will help to solve the following challenges:

- Improvement of the innovation potential of companies involved in delivery of innovative projects, diversification of economy and reorientation towards the knowledge-based manufacturing and services by strengthening links between higher education and research sector and economy;

- Addressing the problem of insufficient general level of capital expenditures, including especially expenditures on transport and power infrastructure;
- Further improvement of the labour market, with special focus on the employment rate.

The objectives of the Program are also consistent with the *Concept of Horizontal Industrial Policy in Poland*, a document issued on 30 July 2007 and defining activities that most effectively support long term growth and development of the Polish industry. The activities will include improvement of competitiveness of industrial companies and lead to:

- increased competitiveness of products with innovation as their key competitive advantage;
- increased productivity;
- increased employment rate.

Activities planned in the Program are complementary to activities defined in the *National Program of Reforms for the implementation of the Europe 2020 Strategy*.

The Program is consistent with the *Strategic Plan of Governance*, a document outlining intentions of the Polish Government for many years ahead. The document was announced on 24 February 2008 (areas: Building Welfare and Dynamic Growth).

The Program follows the recommendations of the revised and updated *Lisbon Strategy* focused on employment and economic growth with consideration of the sustainable development and better mobilisation of all relevant national and Community's resources.

The Lisbon Agenda on Economic Growth and Employment covers activities in three key areas:

- Europe as a more attractive place to invest and work;
- Knowledge and innovation as drivers of economic growth;
- More jobs of better quality.

The Program directly touches each of these areas. It will especially help to achieve the following objectives defined in the *Revised Lisbon Strategy*:

- Increased investment and use of new technologies, with special focus on ITC technologies;
- Contribution in building a strong European industrial base;
- More jobs of better quality.

The Program is consistent with EU’s *Revised Strategy for Sustainable Development*. One of the key goals of the strategy is to ensure economic welfare that can be achieved – according to the Strategy – by promoting thriving, innovative and competitive economy that is based on comprehensive knowledge, reasonably uses natural resources and ensures high standard of life, full employment and quality jobs.

2.7. Monitoring and assessment of achievement of the major goal and objectives

2.7.1 Monitoring system

The implementation of the Program is monitored by continuous monitoring of each objective carried out by the Department of Nuclear Energy, Ministry of Economy. Any deviation from the implementation of an objective triggers a root cause analysis and results in taking corrective actions.

Monitoring results and Program implementation status will be included in annual reports of the Government Commissioner for Nuclear Power submitted to the Chairman of the Council of Ministers by March 31 of the following year.

The Program is planned to be updated every four years. Outcomes of completed works will be considered in such updates.

2.7.2 Set of indices

In order to quantify the Program objectives and monitor the implementation of the Program, a set of indices of achievement of Program objectives that can be quantified has been developed (for Objectives 1,4,6,10,12,13,14, the continued implementation of these objectives will the measure of their achievement).

Goal achievement index

Index description	Baseline in 2010	Value in 2020	Target value in 2030
Installed capacity of nuclear power plants (MW)	0	Min. 1,000	Min. 4,500

Objective achievement indices

Objective 2

Index description	Baseline in 2010	Target value in 2030
Number of examined locations short-listed as possible sites of nuclear power plants	0	6

Objective 3

Index description	Baseline in 2010	Value in 2020	Target value in 2030
Active repositories of low- and intermediate level waste adapted for the needs of the nuclear power sector	0	1	1

Objective 5

Index description	Baseline in 2010	Target value in 2030
Implementation of the Plan of management of radioactive waste and spent nuclear fuel from the nuclear power sector	0	100%

Objective 7

Index description	Baseline in 2010	Value in 2020	Target value in 2030
Social support for the nuclear power	50%	60%	66%

Objective 8

Index description	Baseline in 2010	Value in 2020	Target value in 2030
Knowledge about the nuclear power (at least "good")	18%	25%	35%

Objective 9

Index description	Baseline in 2010	Value in 2020	Target value in 2030
New university majors/courses related to the nuclear power technologies	1	15	25

Objective 11

Index description	Baseline in 2010	Value in 2020	Target value in 2030
Participation of Polish companies in the process of building a nuclear power plant in Poland	0	40%	60%

2.8 Evaluation

Evaluation will help to improve the quality and effectiveness of the Program.

The following evaluations of the Program are envisaged:

- On-going evaluation during the Program implementation:
  - Evaluations related to monitoring the Program implementation; they will be carried out especially after a significant deviation from expected results of the program objectives is detected or if reasons to introduce significant modifications to the Program occur;
  - Strategic evaluations, aimed at assessment of the Program in the context of national policies and strategies;

    - Evaluations related to Program updates.
- *Ex post* evaluation (after the complete implementation of the Program).

Evaluations will be carried out by independent external entities. Evaluation results will be reported to interested departments and agencies and made available to the public.

As there are no initial valuation criteria or applicable evaluation criteria, no *ex ante* evaluation (estimation) was carried out during the Program establishment phase. Provisions of the Article 15(8) of the Act of 6 December 2006 on principles of conducting the development policy (Journal of Laws of 2009, No. 84, item 712, as amended) apply to this situation.

2.9. Schedule and activities

The Program Schedule covers the following stages:

Stage One - <u>until 30 June 2011</u>:
- Development and adoption by the Council of Ministers the *Polish Nuclear Power Program* by 31 March 2012 [1],
- Adoption and entry into force of laws required for the development and operation of nuclear power;

Stage Two - <u>1 July 2011 – 31 December 2013:</u>
- Selection of the location and entering into a contract for the construction of the first nuclear power station;

Stage Three - <u>1 January 2014 – 31 December 2015</u>:
- Development of the technical design and obtaining permits/approvals required by law;

Stage Four - <u>1 January 2016 – 31 December 2020:</u>
- Obtaining the building permit and construction of the first unit of the first nuclear power plant; starting the construction of next units/nuclear power plants;

Stage Five - <u>1 January 2021 – 31 December 2030:</u>
- Continuance of works and starting the construction of next units/power plants.

It should be highlighted that stage milestones can be achieved on time only if the most important activities of the Stage One are delivered on time including especially the entry into force of laws required for the development and operation of nuclear power in Poland. Any delays in that area will result in shifting the deadlines defined for the next stages.

LIST OF ACTIVITIES

<u>Activity 1</u>
Legal framework for the development and operation of nuclear power in Poland

Activity aim – The aim of the activity is to draft, adopt and put into operation the laws and regulations required to start the construction and operation of nuclear power plants and related

[1] After finish the Strategic Assessment of Effects on the Environment; these findings will be presented to the Council of Ministers

facilities. The operation of these laws and regulations will be regularly monitored and evaluated. Necessary amendments will be introduced on ongoing basis.
Owners – Minister competent for the economy, President of the National Atomic Energy Agency (NAEA) (later: the Commission for Nuclear Supervision).
Deadline – an ongoing activity to be carried out until the commissioning of the nuclear power plant and throughout the period of its operation.

Activity 2
Analyses and expert opinions required for the implementation and update of the *Polish Nuclear Power Program*

Activity aim – The aim of the activity is to carry out analyses and draft expert opinions required for the implementation and update of the Program.
Owners – Minister competent for the economy,
Deadline – an ongoing activity to be carried out throughout of the Program implementation.

Activity 3
The final phase of the fuel cycle – management of radioactive waste and spent nuclear fuel – analyses and research of locations for a repository of low and intermediate level waste; design and construction of the repository

Activity aim – The aim of the activity is to select the location of a new low and intermediate level waste and to design and build such repository.
Owners – Minister competent for the economy, Radioactive Waste Management Plant.
Deadline – 31 December 2020

Activity 4
Final phase of the nuclear fuel cycle – management of radioactive waste and spent nuclear fuel – *National Plan of Management of Radioactive Waste and Spent Nuclear Fuel*

Activity aim – The aim of the activity is to prepare and introduce feasible and socially accepted management of radioactive waste and spend nuclear fuel as one of key components of operation of nuclear power.
Owners – Minister competent for the economy.
Deadline – an ongoing activity to be carried out throughout of the Program implementation.

Activity 5
Education and training of human resources for organisations involved in nuclear power

Activity aim – The aim of the activity is to prepare human resources for the Polish nuclear power sector. These resources will be responsible for preparation and development of the structure and for operation of nuclear power plants.
Owners – Minister competent for the science and higher education, Minister competent for the economy, President of the National Atomic Energy Agency (Commission for Nuclear Supervision).
Deadline – an ongoing activity to be carried out throughout of the Program implementation.

Activity 6
Information and education campaign

Activity aim – The aim of the activity is to provide the public with credible and reliable information on nuclear power and enhance the public knowledge about the issue by education activities.
Owners – Minister competent for the economy, Minister competent for education, Project owner.
Deadline – an ongoing activity to be carried out throughout of the Program implementation.

Activity 7
Scientific and research base

Activity aim – The aim of the activity is to create strong scientific and research base working for the nuclear power sector to enable Poland to exploit the opportunities and possibilities related to the implementation of nuclear power in different areas.
Owners – Minister competent for the economy, minister competent for science and higher education.
Deadline – an ongoing activity to be carried out throughout of the Program implementation.

Activity 8
Participation of the Polish industry in the nuclear power program

Activity aim – The aim of the activity is to ensure that the participation of the Polish industry in delivery of equipment and services for the nuclear power sector is as high as possible.
Owners – Minister competent for the economy,
Deadline – an ongoing activity to be carried out throughout of the Program implementation.

Activity 9
Initial phase of the nuclear fuel cycle – security of supplies of uranium from internal and external sources

Activity aim – The aim of the activity is to obtain data on uranium resources within the territory of Poland and on possibilities to use them, as well as to obtain information on the most cost-effective ways of supplying the Polish nuclear power sector with uranium.
Owners – Minister competent for the economy, Minister competent for the environment,
Deadline – an ongoing activity to be carried out throughout of the Program implementation.

Activity 10
Nuclear supervision

Activity aim – The aim of the activity is to ensure the operation of an independent, modern and professional nuclear supervision authority. The authority, as an institution of public trust, should be able to face challenges related to the development of nuclear power in Poland.
Owners – Minister competent for the environment, in conjunction with the Minister competent for the economy; President of NAEA (Commission for Nuclear Supervision)
Deadline – an ongoing activity to be carried out throughout of the Program implementation.

STAGE ONE (until 30 June 2011)

GOVERNMENT'S ACTIVITIES

A) NUCLEAR SUPERVISION

Prepare the National Atomic Energy Agency (NAEA) to perform functions of a nuclear supervision authority for the nuclear power sector

- Develop a concept of the NAEA as a nuclear supervision authority, with consideration of nuclear power sector's requirements. Draft and adopt necessary amendments to the Atomic Law.

B) OTHER AUTHORITIES

1. **Legal framework for the development and operation of nuclear power –** Adjust the Polish law to the needs of nuclear power – draft guidelines and bills, adopt them and put them into operation (Stage I).
2. **Analyses and expert opinions required for the implementation and update of the *Polish Nuclear Power Program* –** Carry out analyses and draft expert opinions required for development of the Polish Nuclear Power Program.
3. **Analyses and research of locations for a repository of low and intermediate level waste; design and construction of the repository** – Select a company that will analyse the research carried out so far and select the best location.
4. ***National Plan of Management of Radioactive Waste and Spent Nuclear Fuel*** – Draw expert opinions and carry out analyses required for the development of the Plan. Prepare the draft version of the Plan.
5. **Education and training of human resources for organisations involved in nuclear power** – Start and continue education of educators for polish universities – Establish partnerships with relevant international institutions and send at least two groups of educators.
6. **Information and education campaign** – Draw a concept of the information campaign; select a company responsible for its implementation and start the campaign, with the support from the project owner in the area of educational activities.
7. **Scientific and research base** – Optimise the organisational structure and improve the technical infrastructure for the scientific and research base.
8. **Participation of the Polish industry in the Program** – Take inventory of the capabilities of the Polish industry that could/should start compete for contracts by offering the quality required by the nuclear power sector, with the support of the project owner in the area of assessment of capabilities of the Polish industry and service providers.
9. **Security of uranium supplies from internal and external sources –** Research the resources of uranium within the territory of Poland – select a company for that task and carry out the required analysis.

PROJECT OWNER'S ACTIVITIES

1. Preliminary analysis of the location.
2. Preliminary discussions with potential partners
3. Preparation of the tender for the technology (the start of preparations).

STAGE TWO [from 1 July 2011 to 31 December 2013]

GOVERNMENT'S ACTIVITIES

a. NUCLEAR SUPERVISION

Prepare the NAEA to perform functions of a nuclear supervision authority for the nuclear power sector – provide more human resources and funds necessary for the operation and development of the technical base. Issuance of organizational and technical recommendations. training your own personnel. Participation in the activities set out below in point. B, points 1 and 3.

b. OTHER AUTHORITIES

1. **Legal framework for the development and operation of nuclear power –** Create legal framework for the development and operation of nuclear power in Poland. Prepare and adopt executive regulations (for Stage One changes). Prepare and adopt laws related to Stage Two of changes in legislation.
2. **Analyses and expert opinions required for the implementation and update of the *Polish Nuclear Power Program*** – Carry out analyses required for the evaluation and control of the Program implementation.
3. **Analyses and research of locations for a repository of low and intermediate level waste; design and construction of the repository** – Select the location for the repository.
4. ***National Plan of Management of Radioactive Waste and Spent Nuclear Fuel*** – Approval of the Plan by the Council of Ministers and implementation of the Plan.
5. **Education and training of human resources for organisations involved in nuclear power** – Continue education of educators for Polish universities and start training for organisations involved in nuclear power. Introduce new university majors/courses related to nuclear power.
6. **Information and education campaign** – Continue the information and education campaign, with the support from the project owner.
7. **Scientific and research base –** Further improvement of the infrastructure required for the scientific and research base.
8. **Participation of the Polish industry in the Program** – Promote the participation of the Polish industry in the Program. Update data on capabilities of the Polish industry to provide goods and services for the nuclear power sector. Carry out activities in partnership with the project owner.
9. **Security of uranium supplies from internal and external sources** – Assess possibilities of using uranium from the Poland's reserves in the future. Research of new technologies and possibilities to use them. Research possible suppliers of fuel for Polish nuclear power plants; involve the project owner in the research with respect to its needs in order to determine project owner's capabilities to secure future supplies of fuel

PROJECT OWNER'S ACTIVITIES

1. Site studies.
2. Environmental impact assessment.
3. Choosing the best site
4. Acquisition of rights to land, the referendum, the decision on location.

5. The permission for the preparatory work.
6. The research terrain for design, site preparation, preparation facilities (uptake).
7. Negotiations, signing contracts (agreements) potential partners.
8. Notification of nuclear regulatory acceptable technologies, the tender for technology, booking the main elements reactor.

STAGE THREE [from 1 January 2014 to 31 December 2015]

GOVERNMENT'S ACTIVITIES

a. NUCLEAR SUPERVISION

Establish the Commission for Nuclear Supervision (CNS). Hire more resources and develop the technology base. Making recommendations organizational and technical training their own staff. Participation in the activities set out below in point. B, point 1.

b. OTHER AUTHORITIES

1. **Legal framework for the development and operation of nuclear power** – Evaluate the operation of the legal framework and adopt amendments as necessary.
2. **Analyses and expert opinions required for the implementation and update of the *Polish Nuclear Power Program*** – Carry out analyses required for the evaluation and control of the Program implementation and for update of the Program as necessary.
3. **Analyses and research of locations for a repository of low and intermediate level waste; design and construction of the repository** – Obtain necessary permits and design the repository.
4. ***National Plan of Management of Radioactive Waste and Spent Nuclear Fuel*** – Control the Plan implementation and update the Plan as necessary.
5. **Education and training of human resources for organisations involved in nuclear power** – Continue to provide training for human resources required by organisations involved in nuclear power.
6. **Information and education campaign** – Continue the information and education campaign, with the support from the project owner.
7. **Scientific and research base** – Further improvement of the technical and scientific infrastructure required for the scientific and research base; involve it in the implementation of the nuclear power project.
8. **Participation of the Polish industry in the Program** – Analyse, in partnership with the project owner, the participation of the Polish industry in the Program. Support activities in the area of engaging companies in manufacturing for the global nuclear power sector.
9. **Security of uranium supplies from internal and external sources** – Update obtained data on possibilities of securing supplies of fuel for Polish power plants.

PROJECT OWNER'S ACTIVITIES

1. Researching the terrain for purposes of designing, preparation of the construction site and its infrastructure.
2. Designing, signing major contracts (uptake).
3. Developing the preliminary safety report.
4. Starting the administrative procedure for obtaining the building permit, including the nuclear supervision permit.

STAGE FOUR [from 1 January 2016 to 31 December 2020]

GOVERNMENT'S ACTIVITIES

a. NUCLEAR SUPERVISION

Issue at the request of the Investor permission for the construction in safety and security. Building control of the nuclear power plant in terms of safety. Issuing at the request of the Investor the start-up and operation permission in terms of nuclear safety and radiological protection. Supervision of security over the first and subsequent construction of nuclear units. Making organisational-technical recommendations. Training internal staff. Participation in the activities set out below in letter B, item 1. Supervision of the activities set out below in letter B, item 4.

b. OTHER AUTHORITIES

1. **Legal framework for the development and operation of nuclear power** – Evaluate the operation of the legal framework and adopt amendments as necessary.
2. **Analyses and expert opinions required for the implementation and update of the *Polish Nuclear Power Program*** – Carry out analyses required for the evaluation and control of the Program implementation and for update of the Program.
3. **Analyses and research of locations for a repository of low and intermediate level waste; design and construction of the repository** – Build the repository of low and intermediate level waste.
4. ***National Plan of Management of Radioactive Waste and Spent Nuclear Fuel*** – Evaluate the implementation of the Plan. Carry out the periodic update.
5. **Education and training of human resources for organisations involved in nuclear power** – Continue to provide training for human resources required by organisations involved in nuclear power.
6. **Information and education campaign** – Continue the information and education campaign, with the support from the project owner.
7. **Scientific and research base** – Further improvement of the technical and scientific infrastructure required for the scientific and research base; involve it in the implementation of the nuclear power project.
8. **Participation of the Polish industry in the Program** – Monitor the participation of the Polish industry in the Program. Support activities related to involvement of companies in manufacturing for the global nuclear power sector, in partnership with the Project Owner.
9. **Security of uranium supplies from internal and external sources** – Update obtained data on possibilities of securing supplies of fuel for Polish power plants and availability of other services related to the nuclear fuel cycle.

PROJECT OWNER'S ACTIVITIES

1. Building permits.
2. Construction of the plant .
3. Developing of the safety report.
4. Obtaining the permission to start.
5. Start-up, permits for a test run, trial operation.
6. Permission for permanent operation.
7. Starting to build more blocks.

STAGE FIVE [from 1 January 2021 to 31 December 2030]

GOVERNMENT'S ACTIVITIES

A) NUCLEAR SUPERVISION

Supervise the operation of active nuclear power plants and construction of new units/power plants. Making organisational-technical recommendations. Training internal staff. Participation in the activities set out below in letter B, item 1.

B) OTHER AUTHORITIES

1. **Legal framework for the development and operation of nuclear power** – Evaluate the operation of the legal framework and adopt amendments as necessary.
2. **Analyses and expert opinions required for the implementation and update of the *Polish Nuclear Power Program*** – Carry out analyses required for the evaluation and control of the Program implementation.
3. ***National Plan of Management of Radioactive Waste and Spent Nuclear Fuel*** – Control the Plan implementation. – Select the type of the nuclear fuel cycle and take actions aimed at its implementation. Identify the ideal location for a repository of spent nuclear fuel. Raise funds for the construction of the repository. Analyse the fuel cycle options within and outside the territory of Poland.
4. **Education and training of human resources for organisations involved in nuclear power** – Continue to provide training for human resources required by organisations involved in nuclear power.
5. **Information and education campaign** – Continue the information and education campaign, with the support from the project owner.
6. **Scientific and research base** – Further involvement the base in the implementation of nuclear power project.
7. **Participation of the Polish industry in the Program** – Analyse capabilities and support activities aimed at expansion of the participation of Polish companies in manufacturing for the global nuclear power sector.
8. **Security of uranium supplies from internal and external sources** – Update obtained data on possibilities of securing supplies of fuel for Polish power plants.

PROJECT OWNER'S ACTIVITIES

1. Construction of the next units / nuclear power plants.

Appendix 1 contains the Project Owner's Proposed Schedule of the construction of the first nuclear power plant.

Chapter 3. Role of nuclear power in long-term energy policy

3.1. Role of nuclear power in the European energy policy

The *Energy Policy for Europe* (COM (2007) 001 – of 10 January 2007 indicates the following main challenges: sustainable development and security of supplies of energy sources. The specified principal trends include reducing the environmental impact as well as decreasing the European Union's sensitivity to external factors which stems from the dependency on imports of hydrocarbon fuels. The European Union also aims at supporting employment and economy growth in order to provide consumers with secure energy supply at reasonable prices.

Chapter 3.8 of the *Energy Policy for Europe* emphasizes the role and advantages of nuclear power as a technology that enables CO_2 emission reduction in the European Union. However, the decision to implement nuclear energy has been left in the competence of the EU Member States. The aforementioned standpoint has been reflected in the European Parliament resolution of 24 October 2007 on Conventional energy sources and energy technology. The resolution emphasized the importance of nuclear energy for the stability of electricity prices due to the minor share of fuel costs in the total costs of electricity generation. Furthermore, the role of nuclear energy as a low emission source of CO_2 and other substances to the atmosphere was also underlined in the context of meeting the environment protection obligations.

Considerations on the implementation of nuclear power as a potential power generation technology were renewed in the Polish energy policy in the document "*Poland's Energy Policy until 2025*" published in January 2005. However, the tasks related to nuclear power specified in the Appendix to "*Poland's Energy Policy until 2025*" entitled "*Task implementation schedule to 2008*" were not performed.

Also, the structure of the electricity generation sector did not at that time create favourable conditions for such important investment challenges. The consolidation of the energy sector, carried out according to the Program for power engineering adopted by the Council of Ministers on 27 March 2006, proved to be essential from the investment potential perspective.

The energy sector in Poland has been facing major challenges for several years already. The country's economic development connected to the necessity of satisfying the increasing demand for energy, Poland's aging power generation assets, the disproportionate level of development of the generation and transmission infrastructure as well as of the transport infrastructure of fuel and energy, significant dependence on external supplies of natural gas and an almost complete dependence on oil import as well as the environment protection requirements, impose the necessity to take up decisive actions to prevent an aggravation of the situation of fuel and energy customers. The search for a diversified fuel base for electricity generation as well as introducing new energy sources that ensure the long term security and stabilisation (also in terms of prices) of supplies of electricity are stimulated by increasing costs of domestic hard coal output as well as problems with the acquisition of new lignite deposits which shall be less and less available to power industry in the future. It is beyond any doubt that nuclear power is a highly relevant option in this context.

Meanwhile, a series of negative events have affected the global economy in the past years.. Significant fluctuations of the prices of energy raw materials, rising demand for energy from developing countries, serious failures of power systems and increasing environmental pollution require a new approach to energy policy. Within the framework of ecological obligations, the European Union fixed quantitative goals for 2020 or so-called "3x20%" consisting of the reduction of greenhouse gas emission by 20% in reference to 1990, reduction of energy consumption by 20% in comparison with EU forecasts for 2020, increasing the share of renewable energy sources to 20% of total energy consumption in the EU (for Poland: 15% of the final consumption), with an increase of the use of renewable energy sources in transportation to 10%. The European Union adopted the Climate-Energy Package in December 2008. The Package provides specific legal instruments for the achievement of the aforementioned objectives. Through actions initiated at the national level, the energy policy represents a part of the implementation of energy policy objectives defined at the Community level.

As a member state of the European Union, Poland actively participates in creating the Community's energy policy and implements its main goals in specific national conditions. However, the implementation of the Community's energy policy objectives at the national level takes into consideration the preservation of the national economy's competitiveness, the protection of consumer interests, the country's energy resources and technological conditions of energy generation, distribution and transmission.

3.2. Important decisions related to nuclear power development

- On 13 January 2009, the Council of Ministers adopted Resolution No. 4 *concerning the actions taken with respect to nuclear power development.* According to the Resolution, at least two nuclear power plants are to be built in Poland of which one should be commissioned in 2020.
  The following premises were taken into consideration in the adoption of the Resolution:
  - the need to diversify energy generation sources and the need of new investment projects to replace the depreciated system power plants;
  - the fact that nuclear technologies practically does not emit CO_2, NO_x, S_xO_y, dust and heavy metals harmful to the environment;
  - the possibility of reducing coal and natural gas imports;
  - stability and predictability of the electricity generation costs in nuclear power plants over a long-term time horizon with lower costs per kWh in comparison with other power engineering technologies;
  - stability and guarantee of return on invested capital in a sixty-year operation period of nuclear power plants;
  - the possibility of building up long-term reserves of nuclear fuel;
  - nuclear fuel supply security as uranium suppliers are present in different regions of the world, including politically stable countries;
  - full responsibility of the investors and operators of nuclear power facilities for the safe management of spent nuclear fuel and radioactive waste;
  - internalization of external costs (CO_2 emission allowances, healthcare, etc.);
  - preservation of organic mineral fuels for future generations, including the conservation of coal resources as a valuable raw material for the chemical and pharmaceutical industries;
  - possibility of the economic recovery of regions and boosting the domestic industry;
  - development of research facilities of the nuclear power sector (Technical Support Organizations);
  - development of nuclear power university faculties;
  - increased innovativeness of the economy;

- increasing social awareness of the economic, social and environmental effects related to the implementation of nuclear power.

- Under the Regulation of the Council of Ministers of 12 May 2009, the Government Commissioner for Nuclear Power was appointed, holding the rank of Undersecretary of State in the Ministry of Economy. The Commissioner is responsible for matters related to the development and implementation of the nuclear power program, including tasks specified in the energy policy of the state as defined in art. 14 of the Act of 10 April 1997 – Energy Law (Journal of Laws of 2006, No 89, item 625 as amended). The duties of the Commissioner also include the preparation and presentation of *the Polish Nuclear Power Program* to the Council of Ministers.

- Actions related to nuclear power development were described in *the Framework Action Plan for the Nuclear Power Industry adopted* by the Council of Ministers on 11 August 2009.

- On 10 November 2009, the Council of Ministers adopted *Poland's Energy Policy until 2030*. One of the principal directions of the Polish energy policy is the *"Diversification of electricity generation through the implementation of nuclear power"*.

Directions of the energy policy defined in *Poland's Energy Policy until 2030* are, to a greater extent, interdependent. The improvement of energy efficiency limits the growth of fuel and energy demand thus contributing to the improvement of energy security by reducing dependence on imports. Furthermore, improved energy efficiency also curbs the power industry's impact on the environment by reducing emissions. Similar benefits are associated with the development of renewable energy sources, including the use of biofuel, introduction of clean coal technologies and the implementation of nuclear power.

The decision to implement nuclear power in Poland results from the necessity to secure the supply of adequate energy volumes at reasonable prices while also ensuring compliance with environmental requirements. Both climate protection and the Climate and Energy Package adopted by the EU impose the shift of energy production to technologies characterized by low CO2 emissions. The use of any available economically efficient technologies that increase energy security and reduce pollution emission has become particularly important in the present situation.

Nuclear power can be viewed as a great opportunity of economic and technological development as nuclear safety and security standards improve at both the international and national level in countries that operate nuclear reactors..

The hitherto decisions related to the need to develop nuclear power in Poland have also been influenced by clear signals of an investment boom in the nuclear power industry. Interest in nuclear power investments can be observed not only in Asia and America, but also in Europe whose ambitious goals to reconcile economic growth and improved standards of living, inclusive of environmental aspects, stimulate the search for solutions that guarantee energy supply security. The diversification of the power system's fuel base (energy mix) is one such solution.

The main goal of energy policy in the area of nuclear power consists of the preparation of a relevant legal and organizational infrastructure that would provide potential investors with adequate conditions to construct and commission nuclear power plants based on safe technologies. The aforementioned goal also calls for ensuring social acceptance and a high level of nuclear power safety at each stage of the investment: location, planning, construction, commissioning, operation and decommissioning of nuclear power plants. These objectives can be achieved only if adequate security of the investment project implementation is ensured for the project owner, including especially the security in the areas of the project owner's opportunities to enhance its market position that guarantees stable financing of the project and compete against other power sector companies in view of the further integration of the regional electricity market.

The particular objectives in this area consist of the following:

- Adaptation of the legal framework to ensure the efficient implementation of the process of nuclear power development in Poland;
- Providing human resources for the nuclear power sector;
- Public communication;
- Selection of sites for the first nuclear power plants;
- Selection of a site for a Low Level Waste (LLW) and Intermediate Level Waste (ILW) repository;
- Establishing research facilities for the Polish nuclear power program on the basis of existing research institutes (Technical Support Organizations);
- Preparing solutions of the nuclear fuel cycle which guarantee Poland's safe and continuous access to nuclear fuel, recycling of spent fuel and storage of high level radioactive waste.

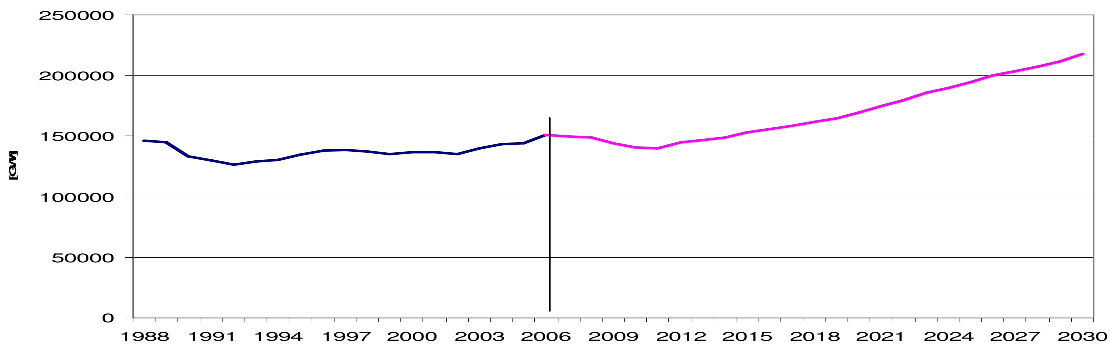
Chapter 4. Analysis of cost and economic rationale of the nuclear power development

4.1. Forecasted increase of demand for electricity

As it has already been mentioned in the *Introduction*, the economic development of Poland will entail an increase in electricity consumption. In the forecast of demand for fuels and energy until 2030 adopted in *the Poland's Energy Policy until 2030,* an increase of 54% in demand for energy is expected within the next two decades, from 141 TWh in 2010 up to 217.4 TWh in 2030.

The forecasted gross consumption of electricity until 2030 is presented below on Fig. 4.1.:

Fig. 4.1. Forecast of gross electricity consumption until 2030
Source: ARE analysis carried out in 2008 and commissioned by the Ministry of Economy



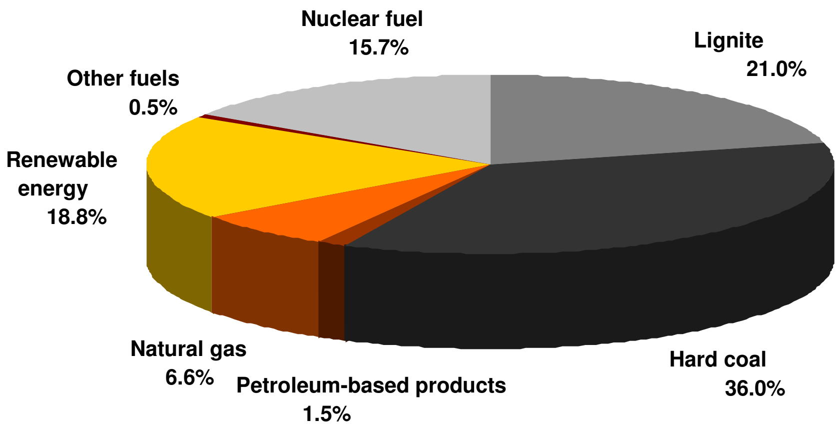
The generation of such volumes of electricity at reasonable costs, while satisfying the requirements of the environmental protection, will require building various sources based on different technologies of low CO_2 emission, including high-performance coal, nuclear, gas and renewable sources.

According to the above mentioned forecast of demand for energy and fuels until 2030 – prepared by the Energy Market Agency (ARE) and based on the expected effects of embarking on efficiency-oriented projects in the economy, use of still available reserves of the market transformation, EU requirements with respect to the reduction of air pollution emissions and the forecast of fossil fuel prices – until 2030 a moderate growth in the final demand for electricity will be recorded to around 172 TWh, i.e. by about 55% as compared to the baseline level in 2006. The peak demand for power will grow from 23.5 MW to some 34.5 MW during this period. Until efficient transboundary connections that enable meeting the increasing demand for electricity in Poland are installed it will be necessary to increase the generation capacity of the Polish power sector by implementation of the nuclear power program. However, it is a long-term goal that requires massive financial expenditures. Only an entity with a suitable position in the market will be able to afford it. The position of the entity should be assessed not only from the perspective of making the decision about starting the nuclear power plant construction but also from the perspective of a long-term investment with consideration of long-term capabilities of such entity to implement the project and repay obligations incurred during the implementation phase. It will be only possible when the entity implementing the nuclear power program in Poland has the opportunity to achieve the market position and enter into market that provides it with the ability to compete against entities with established positions in the regional market.

In 2020, nuclear power should appear in the structure of primary power sources to enable reduction of CO_2 emissions in the electrical power industry and to temper the increase in electricity prices resulting from, among others, the costs of mitigation of CO_2 emissions. According to the forecast, the fuel structure in electricity generation in 2030 will be as illustrated in Fig. 4.2.

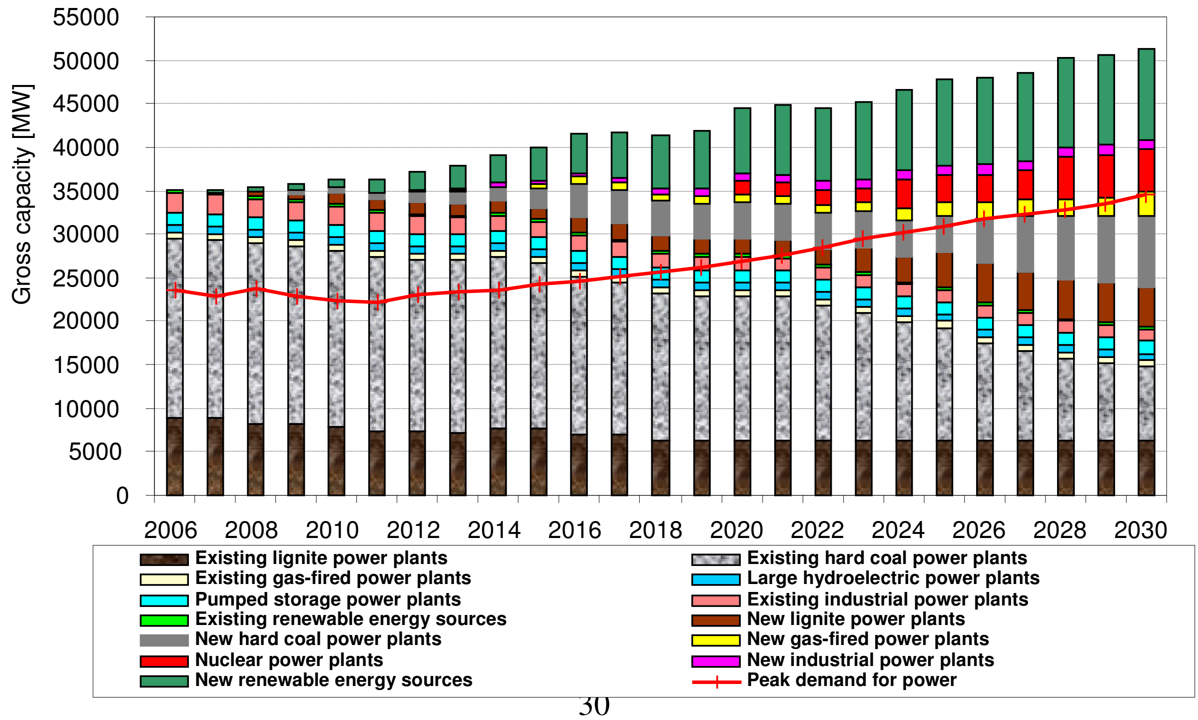
Satisfying the EU requirements concerning the 15% share of renewable energy in the structure of gross final energy in 2020 by Poland will result in a significantly increased share of renewable sources in that period despite the high costs of electricity generated from these sources.

Fig. 4.2. Fuel structure in electricity generation in 2030
Source: ARE analysis carried out in 2008 and commissioned by the Ministry of Economy



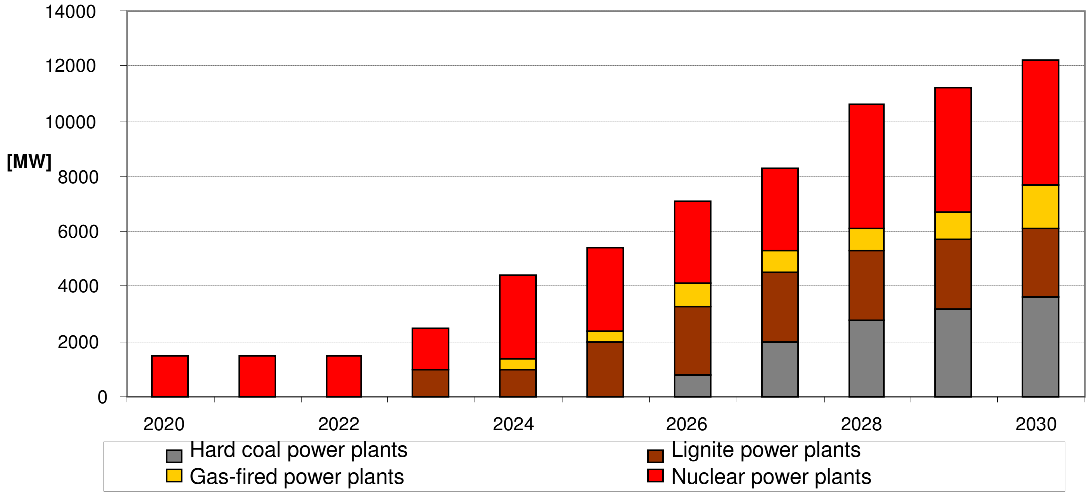
Therefore, with consideration of the mandatory increase of share of renewable energy sources, the structure of capacities of electricity sources will be as illustrated in Fig. 4.3:

Fig. 4.3. Capacities of electrical energy sources by 2030
Source: ARE analysis carried out in 2008 and commissioned by the Ministry of Economy



The forecast of cost-optimal structure of new capacities of system power plants is illustrated in Fig. 4.4:

Fig. 4.4. Capacity structure of new power plants in years 2020-2030
Source: ARE analysis carried out in 2009 and commissioned by the Ministry of Economy



In the cost-optimal structure of **new** system power plants, nuclear power units should be predominant after 2020. The first effects of the installed capacity of nuclear power units should appear in 2020, and by 2030 the net total capacity of nuclear power units should amount to **at least 4,500 MW**.

By 2030, a drop in the consumption of hard coal and lignite by about 16.5 % and about 23% respectively will take place in the electrical power sector, whereas the consumption of gas will go up by some 40%. It will mainly result from the expected introduction of obligation to purchase greenhouse gas emission allowances by power companies. The increase in consumption of gas will result from the profitability of the construction gas sources of heat operated in co-generation mode and from the requirement to build gas sources in order to provide reserve capacity for the significantly increased share of wind power plants.

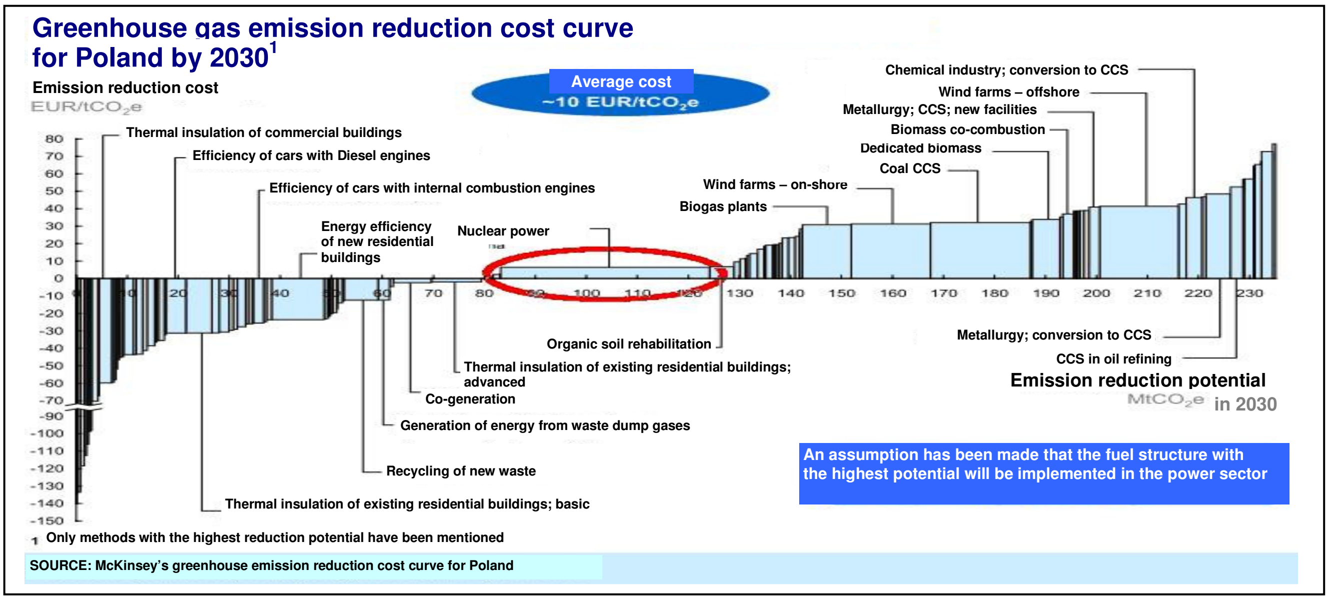
The coal sector is expected to provide supplies of fuels that will allow maintaining electricity generation at coal-fired power plants (hard coal and lignite combined) at the balanced level of about 110TWh within the next 20 years.

4.2. Analysis of the potential to reduce emissions of greenhouse gases

In 2009, the Ministry of Economy contracted McKinsey & Company to provide a report "*Evaluation of the potential of reduction of greenhouse gas emission in Poland by 2030*".
The CO_2 emission cost reduction curve for Poland by 2030 – for the scenario of implementation of the fuel structure that guarantees the highest theoretically possible reduction of emission – indicates two types of activities aimed at reduction of greenhouse gas emissions. On the left-hand side of the diagram in Fig. 4.5., activities aimed at saving electricity as the less expensive way of emission reduction are presented. However, the potential of reducing electricity consumption is in practice limited because adequate level of electricity generation must be ensured to guarantee economic growth and quality of life for

people. In the electricity generation section, nuclear power is the most cost-effective way to reduce CO_2 emissions.

Fig. 4.5. Greenhouse gas emission reduction cost curve for Poland by 2030
Source: McKinsey& Company, 2009



Each column corresponds to the analysed reduction method:

- Column width represents the CO_2 reduction potential in million tons.
- Column height represents the reduction cost in EUR per ton of reduced CO_2 emission.

4.3. Economic rationale of the nuclear power implementation

In the *Comparative analysis of cost of electricity generation at nuclear, hard coal and gas-fired power stations and from renewable energy sources* commissioned by the Ministry of Economy and carried out by ARE in 2009 the economic rationale of the nuclear power implementation in Poland is presented, in the perspective of the next decades until 2050.

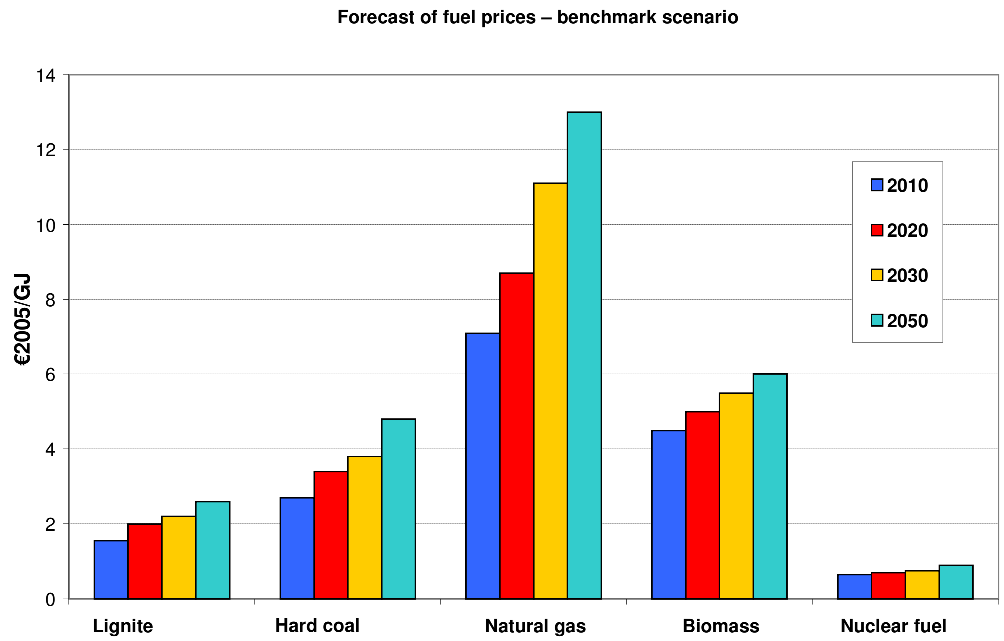
The analysis refers to the costs – to be borne by the national economy and the public – of electricity generation at power plants based on different technologies to be launched in Poland by 2050. Its findings play an important role in the process of forming the country's energy policy, especially in defining desired trends of investment in the electricity generation sector.

Basic assumptions for the above mentioned analysis can be found in Appendix No. 4.

4.3.1 Considered technologies

The analysis covers the cost competitiveness of all technologies of electricity generation used in the installed capacity. Technologies used at peak demand periods, for which generation cost depend on the structure of the primary sources in the system (e.g. pumped storage water power stations), or technologies with the generation cost dependent, to a large extent, on local conditions (run-of-the-river power stations or small scattered gas or biomass power stations with generation cost dependent on the local conditions of fuel supply), have not been included in the analysis. Combined heat and power stations have been also excluded from comparisons because the cost of generation of electricity in combination with heat depends on the local demand for heat and on external conditions such as regulated prices of heat in distribution networks, and it was impossible to calculate all these factors. However, cost of power generation at wind power plants has been considered, as it is often used as representative for renewable sources.

Fig. 4.6. Forecast of fuel prices till 2050 – benchmark prices scenario
Source: ARE analysis carried out in 2009 and commissioned by the Ministry of Economy



In the perspective of the year 2050, technological advancement in electricity sources that cannot be fully predicted today must be taken into account and this is why the comparative analysis covers only the technologies known today – although they may be at the early stage of their development.

It is also expected that nuclear technologies will be much more developed by that time. The availability of nuclear power plants with high-temperature gas reactors generating both electricity and high-temperature heat for chemical processes has been assumed. By 2050, thermal reactors of the fourth generation and fast breeder reactors cooled with liquid metal or organic refrigerant should be in operation. They will be used as links closing the nuclear fuel cycle and extending the resources of fuel for thermal reactors

Therefore, with respect to 2050, the same technologies have been considered as for 2030, however, with much different parameters to reflect first of all the escalation of prices. In addition, the following technologies have been included in the analysis:

- nuclear power plants with high-temperature gas reactors;
- nuclear power plants with fast breeder reactors.

Capital expenditures assumed for these technologies have been summarised in Table 4.1.

Table 4.1. Capital expenditures in €'05/MW according to forecasts of international research centres
Source: ARE analysis carried out in 2008 and commissioned by the Ministry of Economy

Source type	2010	2020	2030	2050
condensation power plants fired with pulverised coal **(PC)**	1500	1650	1600	1550
condensation power plants fired with pulverised coal with CO_2 capture systems **(PC+CCS)**			2400	2350
condensation power plants fired with pulverised lignite **(PL)**	1600	1750	1700	1650
condensation power plants fired with pulverised lignite with CO_2 capture systems **(PL+CCS)**			2500	2450
condensation power plants fired with fluidised coal **(FC)**	1500	1650	1600	1550
condensation power plants fired with fluidised lignite **(FL)**	1500	1650	1600	1550
nuclear power plants with 3G light-water reactors **(Nuclear LWR)**	3000	3000	2900	2800
nuclear power plants with high temperature gas reactors **(Nuclear HTGR)**				2250
nuclear power plants with fast breeder reactors **(Nuclear FBR)**				3400
power plants with gas turbines **(GT)**	450	500	500	500
gas turbine combined cycle power plants **(GTCC)**	750	800	800	800
gas turbine combined cycle power plants with CO_2 capture systems **(GTCC+CCS)**			1200	1100
coal integrated gasification combined cycle power plants **(IGCC_C)**	2100	2000	1950	1900
coal integrated gasification combined cycle power plants with CO_2 capture systems **(IGCC_C+CCS)**			2500	2450
lignite integrated gasification combined cycle power plants **(IGCC_L)**	2100	2000	1950	1900
lignite integrated gasification combined cycle power plants with CO_2 capture systems **(IGCC_L+CCS)**			2500	2450
power plants fired with pulverised multifuel (coal and biomass) **(PMF)**	1550	1700	1650	1600
biomass integrated gasification combined cycle power plants **(BM)**		2400	2300	2150
On-shore wind power plants **(Wind on-shore)**	1450	1350	1300	1200
On-shore wind power plants with energy accumulation installations **(Wind on-shore acc)**	2000	1850	1800	1700
Off-shore wind power plants **(Wind off-shore)**	1900	1800	1750	1650
Off-shore wind power plants with energy accumulation installations **(Wind off-shore acc)**	2450	2300	2250	2150

4.3.2. Key findings of the comparative analysis

Curves of competitiveness of energy generation in the electrical power system have been drawn up to determine the economic competitiveness of different power generation sources. The curves graphically illustrate the average annual generation costs referred to capacities of power sources and unit generation costs referred to generated power in relation to the capacity utilisation for a given source in the system per year. Wind power plants have been excluded from the competitiveness curves as they feature a limited time of full capacity unitisation and cannot be controlled by the system operator. However, wind power plants have been included into the comparison of the electricity generation costs from different sources with consideration of typical conditions of their operation in the system.

- The analysis revealed that nuclear technologies are definitely and increasingly competitive methods of electricity generation. The reasons include the expected growth of organic fuel prices and CO_2 emission allowance charges.

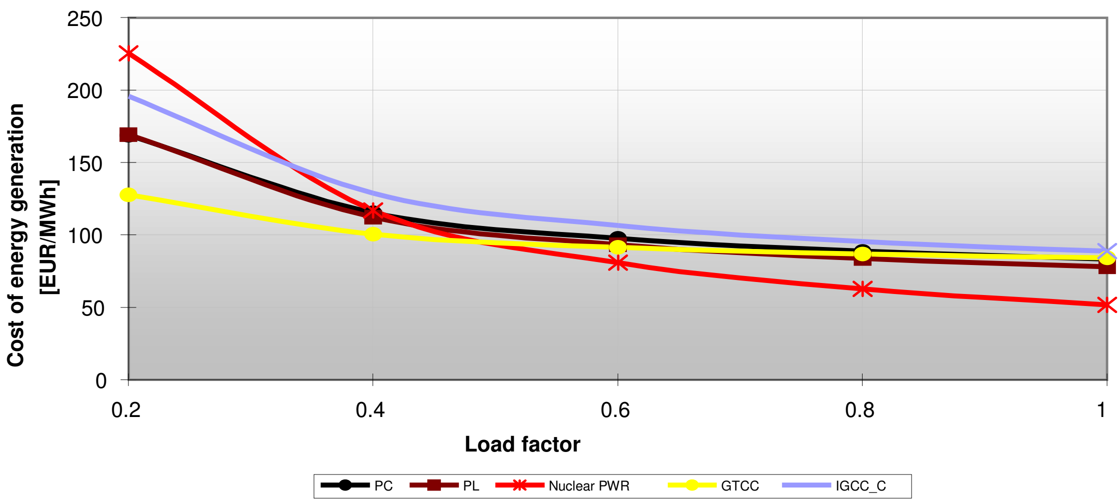
- For sources envisaged to be put into service around 2020, power generation at nuclear power plants (operated with the lowest load factor) is much more competitive than even the less expensive conventional sources (see Fig. 4.7.). Nuclear power plants with light-water reactors (e.g. PWR), that represent nuclear technologies available at that time, are competitive to organic fuel sources when the CO_2 emission allowance rate exceeds €15/tCO_2. The average cost of generation at a nuclear power plant for a typical load factor of 0.9 is about €57/MWh. The second most competitive power plant (pulverised lignite) will generate electricity at the cost of €80/MWh.

- The comparison of the competitiveness of sources to be put into service around 2030 is important due to the expected availability of commercial carbon capture and storage technologies (for both coal and gas-fired facilities).

- Coal-fired power plants with CCS systems have lower unit costs than power plants without these installations charged for emission after exceeding the threshold value of the load factor. The threshold value depends on the relation between the CCS costs and rates of the CO_2 emission allowance charge. For coal-fired power plants with pulverized-fuel boilers and CCS, the value is about 0.5 and is achieved when the full installed capacity is used for 4,500 hours a year. For lignite-fired power plants, the value in both instances is even lower. Nuclear power plants have advantages even over organic fuel boilers with CCS systems.

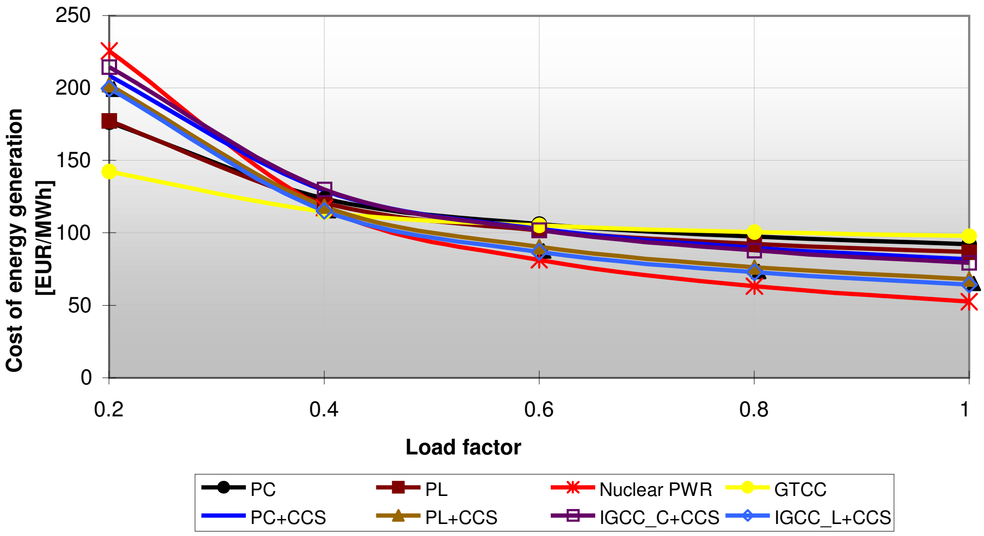
- For coal sources expected to be put into service in about 2030 (Fig. 4.8.), CCS systems become economically viable at the CO_2 emission allowance rate of above €25/tCO_2 for lignite and €35/tCO_2 for hard coal. For hard coal and lignite, the integrated gasification combined cycle with carbon capture and storage (IGCC+CCS) should be recommended. For natural gas, installations equipped with CCS systems become cost-effective at CO2 emission charge of €55/tCO_2. Gas-fired power plants – with or without CCS – may compete against coal power plants without CCS systems only if the CO_2 emissions charge exceeds €60/tCO_2.

Fig. 4.7. Competitive curves of energy sources envisaged to be put into service in about 2020 and representative for considered technologies
Source: ARE analysis carried out in 2009 and commissioned by the Ministry of Economy



- By 2050, the nuclear technology should be more competitive both in the case of PWR and HTGR-based nuclear power plants. The latter technology should already be well-advanced and mature by that time. It should not be expected that introduction of nuclear power plants with fast breeder reactors (FBR) will result in reduction of power generation cost at nuclear power plants – at least as long as uranium prices are not significantly increased. FBRs are developed to better utilise the existing resources of uranium fuel and benefits from their implementation can be seen only from the perspective of the complete nuclear fuel cycle cost.

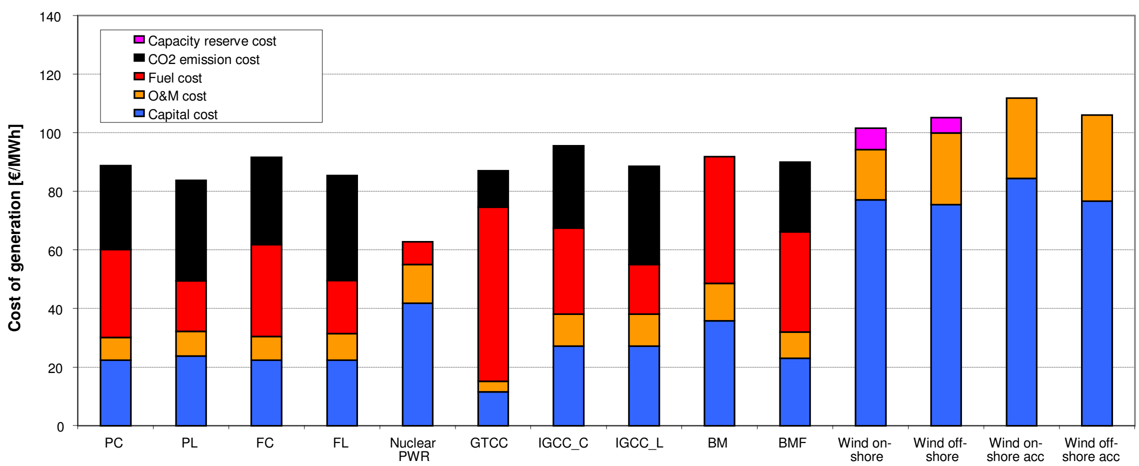
Fig. 4.8. Competitive curves of energy sources envisaged to be put into service in about 2030 and representative for considered technologies
Source: ARE analysis carried out in 2009 and commissioned by the Ministry of Economy



Competitiveness of sources for typical conditions of operation in the system

- For the sources expected to be launched in about 2020 and operated in typical conditions in the system, a competitive edge of nuclear power plants over organic fuel thermal power stations is clearly noticeable. The generation costs at coal-fired power plants and at GTCC gas-fired power plants are similar (Fig. 4.9.).

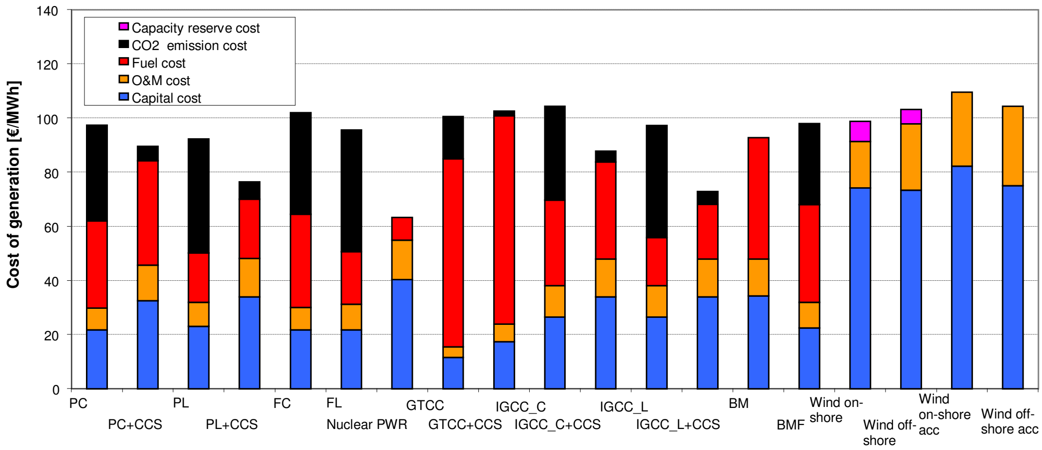
Fig. 4.9. Comparison of average cost and structure of electricity generation for sources expected to be put into service in about 2020
Source: ARE analysis carried out in 2009 and commissioned by the Ministry of Economy



- For power plants to be put into service in about 2030, in addition to highly competitive nuclear power plants, also installations for lignite gasification equipped with CCS systems seem very promising, provided that by that time these technologies are developed enough to be commercialised – Fig. 4.10.

The sensitivity analysis, based on assumed changes of technical and economical environment, has revealed that results of comparison of the considered technologies are relatively stable.

Fig. 4.10. Comparison of average cost and structure of electricity generation for sources expected to be put into service in about 2030
Source: ARE analysis carried out in 2009 and commissioned by the Ministry of Economy



4.3.3. Conclusion

The *Comparative analysis of cost of electricity generation at nuclear, hard coal and gas-fired power stations and from renewable energy sources* has confirmed that nuclear power plants are highly competitive sources of electricity and their competiveness is growing with time. These results have been obtained despite the fact that the analysis was based on components of cost of electricity generation taken from previous experience and projections of global research centres and that conservative approach was adopted for technologies with initial indices suggesting competitiveness (it applies especially to nuclear power plants).
Another finding of the analyses is that for securing the efficiency of the Polish power system after 2020, and to ensure that Poland fulfils its obligations, it will be necessary to integrate generation units of nuclear power plants into the system.

However, it should be stated that unit costs of electricity generation, irrespective of the method and correctness of the assumptions used in the analysis, are only indicative information about the direction of investments in electricity generation. This is because they do not make allowance for the complex operational conditions of the electric power system, and especially for the structure of sources that would guarantee cost-effective coverage of the twenty-four hour curve of power consumption, system restrictions resulting from the fuel structure of sources in the system, necessity to maintain a necessary capacity reserve in the system, development of renewable sources of energy and cogeneration, etc., as specified in the energy policy. That is why the project owner will have to carry out proper corporate analyses before making an investment decision.

Chapter 5. Organisation of work related to the implementation of the *Polish Nuclear Power Program*

5.1. Operational guidelines for the nuclear power sector

The specificity of nuclear power, a completely new sector to the Polish economy, requires customised approach in terms of organisation and legislation during the implementation and initial operation stages. The approach must take into account the strategic nature of the sector for the country's economy. The unique nature of nuclear power at the current stage of preparation for its implementation results, among others, from:

- importance of nuclear power for economic security of the country and its energy independence;
- joint responsibility of the state for ensuring nuclear safety and radiological protection (*nsrp*) within the country's territory at each stage of planning, construction, operation and decommissioning of nuclear facilities, manufacturing of equipment and the process of acquiring, use and storage of nuclear materials. The responsibility must take the form of establishing efficient controls, supervision and enforcing the fulfilment of the obligations of project owners and operators of nuclear power plants and other nuclear facilities as entities with direct responsibility for *nsrp*;
- subsidiary responsibility of the state for possible damages resulting from by nuclear accidents;
- social perception of nuclear power – necessity to win and maintain social acceptance for the use of nuclear power for satisfying the economic and social needs of the country;
- the effects of the advancement of nuclear power for the whole domestic economy, including possibilities of the stimulation of the economic growth, development of science and research institutions and transfer of new technologies;
- particular importance of addressing in the long perspective the issues related to the management of radioactive waste and spent nuclear fuel and decommissioning of nuclear power plants.

The implementation of necessary legal framework and establishing competent institutions (including government agencies) typical for the nuclear power should not restrict the competitive nature of the sector – at least not more than it is justified by the country's interest and *nsrp* requirements. Nuclear power sector, like the majority of national economy sectors, should be based on competition principles because they guarantee its economic efficiency. In the long-run, economic efficiency, in addition to the enhancement of the energy security of Poland, is one of the most essential reasons for each power-related project. In the competitive sector of nuclear power, the state is responsible for creating adequate and stable legal environment to enable project owners to build nuclear power plants and operate them in a safe manner. It means also establishing competent institutions equipped with necessary tools and staff that will be able to apply the adopted regulations.

It is important to define the principles and scope of the participation of the project owner, and then the operator, of a nuclear power plant in building the related infrastructure, incurring the costs of the construction of facilities for keeping and storing the spent fuel and radioactive waste, and paying fees for using these facilities. The engagement of the nuclear power plant project owner in such activities requires that the government creates stable, in the long-run, environment for conducting business.

5.2. Key entities in the Polish nuclear power sector

Four key entities can be distinguished in the model of the nuclear power industry in Poland:

1) **President of the National Atomic Energy Agency** – the central and independent government authority exercising the function of a nuclear supervision authority (from 2014: the **Commission for Nuclear Supervision**). Its basic responsibility is to exercise control, on behalf of the state, over nuclear safety and radiological protection (*nsrp*);
2) The **Nuclear Power Agency (NPA) –** the agency will report to the Minister competent for the economy (the agency is expected to be established by 2012). Its basic responsibility will be to support the minister competent for the economy in devising, coordinating and implementing the strategy of the nuclear power sector development. The strategy, aligned with the Poland's energy policy, will be subject to regular update and approval by the Council of Ministers. Drafts of the strategy of the nuclear power development will be prepared by the NPA.
3) The entity responsible for tasks related to the management of radioactive waste, that is the **Radioactive Waste Management Plant** (**RWMP**). Significant proportion of the costs related to the management of radioactive waste, including spent fuel from a nuclear power plant, will be incurred by the operator (project owner) of a nuclear power facility;
4) **Project owners responsible for nuclear power facilities**, and their **operators** (after commissioning of such facilities), that have experience, knowledge and adequate financial resources necessary to build and operate nuclear facilities.

Development of a nuclear power sector will not be possible and establishing and operation of the aforementioned entities will not be justified unless the ultimate regulatory solutions and involvement of the Government in the implementation of the Program provide adequate environment fostering development of project owners ready to invest in nuclear power facilities. Therefore, the proposed solutions must reconcile *nsrp* requirements, expectations in the areas of the energy security improvement, competitiveness and growth of the economy with business expectations of project owners involved in the development of nuclear power facilities, while reducing, to the maximum possible extent, risks in each of these areas.

5.2.1.Nuclear Supervision

The principal elements of the nuclear safety and radiological protection system or, in other words, the supervision infrastructure, are: an appropriate legal system composed of acts and executive regulations, an adequate supervisory office which grants authorisations (permissions) to pursue specific activities, supervises and controls these activities acting under legal regulations in force and within the limits specified by these regulations; sufficient technical base and trained staff consisting of an adequate number of people. Such a supervisory office has to have appropriate powers of attorney, authorizations and competences in order to perform the supervision efficiently and has to be independent of other governmental bodies, which are responsible for promoting and developing these professional activities that are subject to the supervision. The supervisory office also has to be independent of users, permission holders, designers and constructors of radiation sources used in various kinds of professional activity. The scope of responsibility has to be explicitly separated from the scope of responsibility of any other institution so that the representatives of the supervisory body – the authority in safety matters – could preserve independence of opinion and decision.

In Poland the supervisory (inspection) body is the President of the National Atomic Energy Agency, acting with the help of the National Atomic Energy Agency.

Activity of the President of the National Atomic Energy Agency (NAEA), as the central body of governmental administration competent for nuclear safety and radiological protection matters, is regulated by the act of 29 November 2000 Atomic Energy Law (Journal of Laws of 2007. No. 42, item 276, as amended) and secondary legislation to this act. The tasks of the President of the National Atomic Energy Agency also arise out of a number of other acts.
Since 1 January 2002, supervision over the President of the NAEA has been performed by the minister competent for environmental affairs.

Important elements of the nuclear safety and radiological protection system provided for by the President of the NAEA are:

- Supervision over activities that involve the use of nuclear materials and sources of ionising radiation, conducted through: granting permissions to perform these activities or to register them, controlling the manner of pursuing an activity, controlling the doses received by employees, supervising the training of nuclear supervision inspectors, radiological protection inspectors (experts on *nsrp* who function in organisational units pursuing their activity on the basis of permissions granted) and employees exposed to ionising radiation, controlling the trade of radioactive materials, keeping the register of radioactive sources, keeping the register of their users and the central register of individual doses, and, for an activity involving the use of nuclear materials – keeping also detailed records and accounts of these materials, accepting plans of their protection and controlling the technologies applied.
- Identification of the country's radiation situation, by means of coordinating (including standardisation) of field work of stations and institutions that measure the level of radiation doses, content of radionuclides in selected elements of the environment and potable water, foodstuffs and fodders.
- Maintenance of the services prepared to diagnose a radiation situation and to react in the case of a radiation incident (in cooperation with other competent bodies and services operating within the framework of the national system of emergency response).
- Performance of works aimed at fulfilling Poland's obligations arising out of treaties, conventions and international agreements related to nuclear safety and radiological protection.

Regarding nuclear power facilities (including power plants), repositories and bunkers for radioactive waste and spent nuclear fuel, the President of the NAEA grants *nsrp* permissions for their:

- construction,
- commissioning,
- trial operation,
- permanent operation,
- decomissioning.

5.2.2. Nuclear Power Agency

The NPA will be an executive agency reporting to the Minister competent for the economy. The Agency is expected to be established in 2012. Its key responsibilities will include supporting the Minister in planning and co-ordination of the implementation of the Poland's strategy in the area of nuclear power development with special focus on:

- expert support in preparing the plans and strategy related to the development and operation of nuclear power sector in Poland;
- assistance in the coordination of the implementation the Poland's strategy with respect to the development of nuclear power; preparing guidelines for its modifications;
- coordination the Poland's strategy with respect to the management of radioactive waste and spent fuel; preparing guidelines for its modifications;
- proposals related to the development of the legal framework required for the effective operation of the nuclear power sector in Poland;
- carrying out public communication, education and popularisation campaigns and activities in the areas of scientific, technical and legal information related to nuclear power;
- supporting the implementation of the nuclear power projects;
- activities aimed at providing competent human resources for the nuclear power industry;
- cooperation with the European Union agencies, international organisations, lobbying organisations and European nuclear power initiatives;
- encouraging the participation of the Polish industry in the performance of tasks for the nuclear power sector, including specifying quality requirements (standards) for Polish enterprises to be included into the supply chain of materials and equipment for the nuclear power sector – in compliance with regulatory requirements and principles of competition and non-discrimination with respect to entrepreneurs from the European Union;
- identification of uranium resources within the territory of Poland;
- co-operation with the government agencies and subordinate or supervised institutions in matters related to the research on nuclear power and also supporting the partnerships of Polish scientific and industrial organisations with relevant foreign establishments and international organisations with respect to nuclear power.

The above responsibilities mean that professionals with high qualifications in the area of nuclear power and in other fields will have to be employed to guarantee adequate level of management and performance of organisational and managerial functions of the NPA.

5.2.3. Radioactive Waste Management Plant (RWMP)

The RWMP will continue to build and operate nuclear waste repositories, including the future spent fuel repository. It will be advisable to transfer the ownership supervision over the RWMP from the Minster of Treasury to the Minister of Economy. The operator of a nuclear power facility will be financially responsible for waste management and it will be obliged to raise funds for this purpose and to finance activities in this respect.

5.2.4. Investors (project owners)/operators of nuclear power facilities

Entities with adequate financial resources as well as experience and knowledge necessary to build and operate nuclear power facilities, and that have a credible and reliable vision of the construction of a nuclear power facility, will be the project owners and then the operators of commissioned nuclear power facilities. The fact that the project owner fulfils the above mentioned requirements will be confirmed by a general decision issued by the Council of Ministers. The decision for a nuclear power facility (NPF), will express the Government's approval for the construction of a nuclear power facility in a certain location by a certain project owner, with the use of certain technologies.

Project owners/operators of nuclear power facilities will have several responsibilities including:

- raise funds for the preparation for storage and for store radioactive waste and spent fuel;
- raise funds for decommissioning of a nuclear power facility;
- decommission a nuclear power facility after its operation is over;
- satisfy requirements with respect to the civil liability for nuclear damages according to the Act on civil liability for nuclear damage;
- prepare plans in case of emergency events.

The construction of the first nuclear power plants will be a unique project, both due to its pioneering nature in Polish reality and the necessity of preparing the whole environment of the construction, operation and decommissioning of the nuclear power facilities to ensure effective operation of the nuclear power sector in Poland. Therefore, some additional solutions are envisaged with respect to the responsibilities of the Government and the project owner involved in construction of the first nuclear power plants, as well as with respect to their mutual relations.

Development of the regulatory, organisational, educational, research and other types of infrastructure will require significant financial expenditures. In the proposed model of the Polish nuclear power, it is assumed that these expenditures will be incurred both by the project owner responsible for the first nuclear power plants and by the government agencies. Due to this reason, and because of the strategic importance of nuclear power for the broadly understood national security, a company with a direct or indirect majority interest of the State Treasury is expected to be the project owner responsible for the first nuclear power plants with the installed capacity of about 6,000 MW. It means that PGE Polska Grupa Energetyczna S.A. (Polish Energy Group) will be appointed as the project leader with respect to the construction of the first nuclear power plants in Poland since it is the only Group in the power sector planned to be kept under the control of the State Treasury. The operator's activities in the first nuclear power plants are to be taken by a subsidiary/subsidiaries of PGE Polska Grupa Energetyczna S.A.
This is why it is important to enable the appointed project owner to strengthen its market positions by engaging in activities aimed at its development including acquisitions of other power industry enterprises in Poland and in other countries. The leading position of the project owner is necessary for undisturbed implementation of the nuclear power plant construction project. This is why achieving by the PGE Polską Grupę Energetyczną S.A. a position that is at least comparable with positions of key competitors in the region should be a matter of the highest priority. Such position would enable efficient and consistent with the guidelines implementation of the nuclear power in Poland without the risk that regional integration of the electricity market could adversely affect the achievement of the basic objectives of the Poland's energy policy in general and the nuclear power program in particular.

The selection of suppliers and contractors for nuclear power plants will be made in compliance with principles of competition and transparency, according to European and national regulations and also with consideration of clearly specified requirements to provide equipment compliant with *nsrp* standards. As far as the latter is concerned, only such suppliers should be invited to negotiations who may offer modern nuclear technology (III/ III+ generation) and whose installations meet the standards specified in the ***European Utilities Requirements (EUR)*** and in the US ***Utility Requirements Document (URD).*** Also, it will be necessary to modify the national public procurement regulations, to include in the procedure the above mentioned requirements and to apply procedures with shorter deadlines at individual stages, especially with respect to lodging complaints. In the course of the entire supplier selection procedure, from preparing key requirements for suppliers to the moment the choice is made, a permanent co-operation of the government's and the project owner's representatives is necessary.

The fact that the project owner fulfils the above mentioned requirements will be confirmed by a general decision. The decision will express the Government's approval for the construction of a nuclear power facility in a certain location by a certain project owner, with the use of certain technologies.

During the period of operation of the power plant, the operator will be obliged to co-operate with the CNS on on-going basis to ensure the complete security of the installations. Although the operation of the power plant will be supervised by the CNS, the responsibility for its safety and security and for damages resulting from any failures will lie with the operator, as provided for in national and international regulations.
After the operation of a nuclear power plant is over, the operator will be obliged to decommission the facility according to the CNS requirements based on the decommissioning plan approved by the CNS.

During the whole period of preparation for the construction, construction, operation and decommissioning of a power plant, the Project Owner/Operator will be obliged to conduct information and education activities targeted at the local community living in the municipality where the nuclear power facilities will be located and in the adjacent municipalities. In particular, it is proposed that the Project Owner/Operator is obliged to set up a centre of information about each nuclear power facility. The centres would be responsible for the provision of information and education on nuclear power.

The project owner should plan its activities to ensure that it has adequate human resources to operate a nuclear power plant.

5.3. Participation of government bodies

According to IAEA recommendations, the state's responsibility with respect to the management of a nuclear power development project should lie with a dedicated organisation called NEPIO – *Nuclear Energy Program Implementing Organisation*). At the current stage of preparation for the implementation of nuclear power in Poland, the Government Commissioner for Nuclear Power together with the Nuclear Energy Department in the Ministry of Economy forms such organisation. The activity of the Commissioner is supported by the interdepartmental *Polish Nuclear Power Team* and members of the *Social Team of Advisors at the Government Commissioner for Nuclear Power*. Members of the Social Team of Advisors actively participate in giving opinions about initiatives taken by the Minister of Economy and the Commissioner. The interdepartmental team established last year is expected to involve heavily upon approval of the Program and then during its implementation. Details of above mentioned teams are included in Appendix No. 3.

The tasks concerning the development of nuclear power will be carried out by:
- National Atomic Energy Agency (from 2014: Commission for Nuclear Supervision - CNS),
- Nuclear Power Agency (NPS; from 2012),

- President of the Energy Regulatory Office (ERO),
- Office of Technical Inspection (OTI) and other inspecting institutions in Poland,
- Organisations responsible for environmental protection and industry development,
- Organisations responsible for safety, physical security and contingency planning,
- Governor of the Province where the project is planned to be implemented,

Furthermore, the implementation of the Program will require the participation of almost all other ministries and agencies (Ministry of the Environment, Ministry of Finance, Ministry of Science and Higher Education, Ministry of Education, Ministry of Interior and Administration, Ministry of Health, Ministry of Treasury, Ministry of Foreign Affairs, Ministry of the Infrastructure, Ministry of Labour and Social Policy, Ministry of the Regional Development, Internal Security Agency).

All organisations with authority to inspect and supervise nuclear power facility projects in Poland will have to be ready for carrying out inspections of nuclear power facilities. This means that appropriate funds will have to be provided in their budgets for the employment of new specialists from this area or for holding training for the existing human resources and their certification.

Therefore, expenditures on tasks related to the Program implementation will have to be included in respective sections of the state budget for the above mentioned ministries and agencies.

The tasks of the two key entities responsible for the Program implementation (CNS and NPA) are described on pages 42-44. The other entities have the following responsibilities:

Ministries and government agencies directly or indirectly involved in the implementation of the Polish Nuclear Power Program

President of the Energy Regulatory Office (ERO)
Similarly as for of other electricity and heat generators, the operator of a nuclear power plant will need to obtain a Licence for generating electricity (and possibly heat) granted by the President of ERO.

Office of Technical Inspection (OTI) and other organisations with inspection authority in Poland
They will pursue all activities related to the technical supervision not related to the *nsrp*.

Province Governor competent for the planned project site
The Governor of the Province, in which the project owner plans to build a nuclear power plant will issue an "Identification of Location" decision and a decision on location of a nuclear power facility.

5.4. Legal environment

To ensure the necessary transparency of the legal framework governing the procedures defining the operation of the nuclear power sector it is assumed that two acts will be adopted that will govern individual areas of the nuclear power, including in particular:

1) **Act on preparation and implementation of nuclear power facility projects and accompanying investments.** The main goal of its passing is to introduce the regulations enabling efficient preparation and implementation of nuclear power facility construction projects with consideration of their importance of the country's energy security and large investment and financial risk.

   Amendment to the **Atomic Energy Law** the purpose of which is to specify security requirements for nuclear power facilities, including the construction and operation of nuclear power facilities at the highest attainable level according to international requirements and recommendations. The current amendment is aimed at implementing to the Polish law Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations. Furthermore, the amendment is aimed at completing the previous regulations on civil liability for nuclear damage, founding the Nuclear Power Agency, defining the procedure of preparing and updating the country's strategy regarding nuclear power and obligations of nuclear power facility operators to inform the community about the activity of such facilities. The next amendment to the Atomic Energy Law will propose the structure of the nuclear supervision fully compliant with the requirements for assuring the nuclear security of numerous nuclear power facilities in the country.

5.5. Integrated Nuclear Infrastructure Review – INIR

IAEA has developed a program or activities aimed at supporting states that intend to implement nuclear power. It is based on the *Considerations to Launch a Nuclear Power Programme* (GOV/ INF/2007/2) document. *Milestones in the Development of National Infrastructure for Nuclear Power* (NG-G-3.1) is another key document concerning the implementation of nuclear power. This document contains more detailed guidelines related to the three phases of nuclear power development for all 19 key areas, from national political decisions to public procurement procedures. The evaluation of fulfilment of the requirements contained in all 19 areas is based on the *Evaluation of the National Nuclear Infrastructure Development Status* document (NG-T-3.2).

The above mentioned documents form a basis for every country that wants to conduct a self-assessment of the progress of the implementation of a nuclear power program, or they can be used for the purposes of an external inspection, e.g. by the IAEA. Such an inspection is called the *Integrated Nuclear Infrastructure Review (INIR)* and can be carried out at different stages of the nuclear power implementation.
In December 2009, the Ministry of Economy applied to IAEA to organise an initial INIR mission in order to evaluate the status of the nuclear power implementation in Poland. 22 organisations declared their participation and carried-out self-assessments to define their roles in the implementation of nuclear power in Poland. A list of these organisations is presented in Appendix No. 6.

An IAEA's mission was held on 27-29 April 2010 to ensure that self-assessments of all participants are carried-out in the best possible manner. A report was presented (to be found in the website of the Ministry of Economy) as the outcome of the IAEA mission. The key findings of the report are listed below:

1. The coordination of the management and planning of work within the INIR team should be improved;

2. Working Groups should be managed by various participating institutions;
3. Activities of the Working Groups should support the planning of the Program and preparations for self-assessment;
4. Assigning areas of responsibility to individual Working Groups needs to be analysed and adapted to the results of the mission;
5. The project owner/operator (PGE SA) should increase its participation in the work on the Program;
6. PGE SA should consider creation of a team responsible for planning activities for the first nuclear power plant (strategic planning for the project and for the owner's functions).

Table 6.1. Working Groups for the INIR mission

No.	Working Group	Areas
1.	**National Policy; Management of implementation of the Polish Nuclear Power Program; Legal Framework**	1) National policy 3) Management of implementation of the PNP Program 4) Financing sources and methods 5) Legal framework 11) Involvement of stakeholders
2.	**Human Resources Development**	10) Human Resources development
3	**Physical Security and Security Systems**	6) Security systems 14) Contingency planning 15) Security and physical security
4.	**Regulations governing nuclear safety and radiological protection issues**	2) Nuclear safety 7) Regulatory framework 8) Radiological protection 14) Crisis situations 16) Nuclear fuel cycle
5.	**Involvement of the industry and Public Procurement**	18) Participation of the industry 19) Procurement and delivery procedure
6.	**Electricity market and transmission grid**	9) Power engineering market and systems
7.	**Facility location and environmental protection**	12) Location and auxiliary facilities 13) Environmental protection 17) Radioactive waste

7. The Program should form a self-assessment basis consistent with the procedure indicated by the Ministry of Economy:
    a. Define self-assessment rules, involved organisations and assessors;
    b. Assess of the status of the national nuclear infrastructure development in accordance with the aforementioned NG-T-3.2 document;
    c. Identify areas requiring further actions;
    d. Prepare an Action Plan to perform activities identified in c);
8. The self-assessment process should be summed up in a Final Report that will form a basis for the INIR mission invitation;
9. The INIR mission should take place after the Program is approved and the self-assessment process is completed.

The MAEA mission and meeting with involved organisations resulted in establishment of 7 Working Groups covering 19 areas listed in Table 6.1.

For each group a co-ordinator (sometimes external) has been appointed. For example the Working Group "Locations of nuclear power facilities and environmental protection" is coordinated by the General Directorate for Environmental Protection. It is important to ensure that activities between Groups or even between areas within one Group are co-ordinated.

Chapter 6. Ensuring conditions for safe use of nuclear power

6.1. Partnerships in the area of safe use of nuclear power

Nuclear safety and radiological protection (*nsrp*) of population and personnel with respect to nuclear power facilities together with physical protection of these facilities is the priority of the Program. Ensuring the *nsrp* requires the co-operation of all stakeholders, including first of all, the Government Commissioner for Nuclear Power, the NAEA in its role of the nuclear supervision authority, the project owner(s) and future operator(s) responsible for nuclear power facilities and potential suppliers of nuclear technologies. The co-operation will cover all issues related to ensuring the desired nuclear safety and security of nuclear power facilities and nuclear materials.

The most important components of the Program that affect the future safety level include the regulations related to the *nsrp* requirements provided for in the amendment to the Atomic Energy Law expected to be effective as of 1 July 2011, and the existing and the planned institutional infrastructure:

- NAEA, together with nuclear supervision officers and all the control and inspecting institutions involved in designing, construction, operation and decommissioning of nuclear power plants;
- NPA (after its establishment);
- RWMP

6.2. Nuclear facilities in Poland

Nuclear facilities active in Poland:

1) Maria research reactor with a technological basin, located in the Institute of Atomic Energy POLATOM (IAE POLATOM) in Otwock-Świerk;
2) Ewa research reactor (in decommissioning procedure) at the RWMP in Otwock-Świerk;
3) Two dry cask storages for spent fuel at RWMP in Otwock-Świerk.

Nuclear facilities (EWA reactor) have been operated since 1958. This means that Poland has had regulations ensuring nuclear safety since then and it had to fulfil all the international obligations related the nuclear safety and peaceful use of nuclear energy. Furthermore, in 2009, the first transport of spent nuclear fuel to Russian Federation was organised as a part of the *Global Threat Reduction Initiative – GTRI*).

Nuclear facilities are covered, with respect to the *nsrp*, by the supervision of the President of the NAEA (nuclear supervision). The supervision is exercised by granting new operation licences after expiration of previous licences or issuing annexes specifying amendments introduced to these licences. Both types of documents are issued on the basis of safety evaluations made by the nuclear supervision officers who examine and analyse documents submitted by managers of entities operating nuclear facilities and on the basis of on-site inspections. The inspections concern the compliance of the conducted activity with the safety report and the requirements specified in the regulations and licence terms and conditions. The nuclear supervision authority analyses quarterly reports submitted by managers of organisational units operating nuclear power facilities and verifies these reports in the course of inspections carried out in the facilities and during direct interactions of nuclear supervision officers with the operator’s personnel.

There is not and there has never been an isotopic enrichment unit, a nuclear fuel production unit, a nuclear fuel processing unit or a nuclear power plant in Poland.

In the 1980s, the construction of a nuclear power plant in Żarnowiec was started. The construction project was stopped in 1989, under a resolution of the Council of Ministers. In September 1990, the "Żarnowiec Nuclear Power Plant under Construction" was put into decommissioning.

Due to the fact that some nuclear power plants are operated in immediate neighbourhood of our country, the co-operation with nuclear regulators / supervision authorities of the neighbouring countries under intergovernmental agreements on early notifying of a nuclear accidents and co-operation in the area of nuclear safety and radiological protection is of extreme importance. Such agreements have been concluded by the NAEA with all the countries that border with the Republic of Poland, and with Austria, Denmark and Norway. In the course of the evaluation of possible radiation events, the parties to the agreements apply the same criteria specified in the so called INES system (*International Nuclear Event Scale*) discussed below in this Chapter.

By launching its nuclear power program, Poland becomes an important partner of the global nuclear safety system. With the status of a responsible partner of the system, Poland benefits from the participation in the international co-operation in this area. Joint efforts to implement programs in accordance with the IAEA basic safety rules and with other IAEA standards (or their equivalents – US and French standards) are a part of it.

6.3. Development process and key components of the planned nuclear safety system in Poland

The matters of nuclear safety of nuclear facilities are regulated in the Act of 29 November 2000 on Atomic Energy Law (Journal of Laws of 2007, No. 42, item 276, as amended) and in particular in Chapter 4 of the act (Articles 34-39).

The Atomic Energy Law and its executive regulations formulate provisions on requirements in the following areas:
1. Radiological protection (of staff, population and patients);
2. Nuclear and radioactive safety, including:
   - safety of nuclear facilities;
   - management of nuclear materials and sources of ionizing radiation;
   - radioactive waste and spent nuclear fuel;
   - transportation of radioactive materials and sources and spent nuclear fuel as well as radioactive waste;
   - evaluation of radiation situation and emergency procedure;
3. Physical security (of nuclear facilities and nuclear materials);
4. Non-proliferation of technologies and nuclear materials (security);
5. Civil liability for nuclear damage.

A number of acts of the international and Community law have been taken into account in the Atomic Energy Law. They are listed in Appendix No. 7.

The Republic of Poland is a party to the Treaty establishing the European Atomic Energy Community (Euratom). On the basis of the Treaty, a number of directives have been accepted and implemented into the Polish legal system.

The Directive of the Council 96/29/Euratom defining, among others, threshold radiation doses for employees of the organisational units engaging in activities related to the risk of exposure to ionizing radiation and for the whole population, principles of minimising the exposure to radiation and protection of population against ionizing radiation is of special importance for the safety of operations where ionizing radiation is present, and for the nuclear safety of nuclear facilities.

The Act imposes the obligation to meet the requirements of nuclear safety and radiological protection of a nuclear facility in the period of location establishing, planning, commissioning and test operation, on the investor and other participants of the investment process, proportionately to the scope of their responsibilities. During the period of permanent operation or decommissioning of the facility the responsibility for meeting these requirements lies with the manager of the operating unit (Article 35(1) and (2) of the Atomic Energy Law). Within the period from the planning stage all the way up to the end of the operation of a nuclear facility, technical and organisational solutions that, in the light of the achievements of science and technology, are necessary to guarantee the least contamination of the environment and exposure of people to ionizing radiation, with reasonable allowance made for economic and social factors (Article 35(3) of the Atomic Energy Law).

Under the current regulations, the location for a nuclear facility may be chosen on the basis of the local development plan, and in case there is no local development plan – on the basis of a decision on the land development conditions. If a nuclear facility is introduced in the draft of a local development plan the draft should be agreed upon with the President of the NAEA according to the procedures specified in the Act of 27 March 2003 on spatial planning and management (Journal of Laws No. 80, item 717, as amended). If there is no local development plan, a decision on the land development conditions must be issued to locate a nuclear facility. The competent body authorised to issue such decision will do that after obtaining a positive opinion of the President of the NAEA with respect to the nuclear safety and radiological protection (Article 36 of the Atomic Energy Law).

Engaging in activities related to the risk of exposure to ionizing radiation, including the construction, commissioning, testing and permanent operation and decommissioning of nuclear facilities, will require a licence with respect to nuclear safety and radiological protection (Article 4(1)(2) of the Atomic Energy Law). The licence will be granted by the President of the NAEA upon a request of the project owner (for construction, commissioning and test operation of a nuclear power plant) or the manager of an operating unit (for permanent operation and decommissioning of a nuclear facility). These licences are required as a prerequisite for obtaining a permit for the construction, operational use and demolition of a nuclear facility granted under the provisions of the construction law (Article 37 of the Atomic Energy Law).

Article 38 of the Atomic Energy Law provides for creating an area of limited use around a nuclear facility referred to in the Act of 27 April 2001 on Environmental protection (Journal of Laws of 2008, No. 25, item 150 as amended). Under §1 of the Regulation by the Minister of Environment of 30 December 2002 on detailed principles of establishing an area of limited use around a nuclear facility (Journal of Laws No. 241, item 2094), the area covers a zone, outside of which the annual effective dose from all sources of exposure does not exceed 0.3

milisivert (mSv). The Regulation specifies also the data and information to be used for the evaluation the annual effective dose for the purpose of determining the area of limited use (§2), examples of the requirements related to the method of using the area (§3) and behaviour and activities that are not permissible within the area of limited use (§3).

Activities that consist in using ionizing radiation, including activities related to the operation of nuclear facilities, will be subject to the supervision and control by the nuclear supervision authority. These authorities include: nuclear supervision officers, Chief Nuclear Supervision Officer as a superior of nuclear supervision officers and the President of the NAEA as the supreme nuclear supervision authority. The principles of the supervision and control with respect to observing the conditions of nuclear safety and radiological protection are specified in Article 63 and subsequent Articles of the Atomic Energy Law. The responsibilities of the nuclear supervision authorities include:

- granting permits/licences and other decisions on matters related to nuclear safety and radiological protection;
- carrying out inspections in nuclear facilities;
- giving, in the course of an inspection, ad-hoc instructions in order to eliminate a threat to nuclear safety and radiological protection; for immediate threats, these orders shall be enforceable immediately (Article 68(2) of the Atomic Energy Law);
- approval of the programs of staff trainings at organisational units conducting activities associated with nuclear materials or sources of ionizing radiation, radioactive waste or dealing with spent nuclear fuel (Article 64(4) of the Atomic Energy Law).

Units, on the premises of which nuclear materials, radioactive sources, equipment that contains such sources, radioactive waste or spent nuclear fuel may be found, are also subject to the supervision and inspections under the Atomic Energy Law even if they do not conduct activities with the use of such items covered by the licensing or reporting requirement (Article 70a of the Atomic Energy Law).

Any provisions related to the *nsrp* are and will remain included in the Atomic Energy Law. However, in order to ensure efficient operation of an independent, modern and professional nuclear supervision authority as an institution of public trust, it will be necessary for the NAEA to adopt the role of the nuclear supervision authority for the nuclear power sector.

On the initiative of the Government Commissioner for Polish Nuclear Power, two missions of the IAEA were invited to evaluate the preparations and efforts related to the development of nuclear power in Poland.

One of such missions of the IAEA: the Integrated Regulatory Review Service (IRRS) is aimed at evaluation of the operations of the nuclear supervision authority and review of the regulatory aspects related to nuclear safety of operated (research reactors, waste repository) and planned facilities (nuclear power plant, spent fuel repository on the premises of the power plant, radioactive waste repository). This directly refers to the NAEA. IAEA experts responsible for preparing the IRRS Mission visited Poland in November/December 2009.
Also, a concept of the NAEA as an office of the nuclear supervisor authority has been developed with consideration of the nuclear power sector needs. The legislative, organisational and functional changes that need to be implemented have been defined in the concept; a schedule of the implementation of these changes will be developed and responsible persons will be identified.
The other one of the above-mentioned (INIR) missions was discussed in Chapter 5.

6.4. Amendments to the Atomic Energy Law – Stage One

The first stage of amendments to the Atomic Energy Law, to be effective as of 1 July 2011, will change and significantly broaden the provisions governing nuclear facility issues. The Atomic Energy Law will specify basic requirements for nuclear safety and radiological protection related to location, designing, operating and decommissioning of nuclear power facilities, while more detailed provisions will be contained in regulations to this act. It constitutes the fulfilment of the obligation of the Republic of Poland to determine a national legal framework with respect to the domestic standards of nuclear safety (Article 4(1)(a) of the Council Directive 2009/71/Euratom).
The amendment will also specify issues pertaining to civil liability for nuclear damage, the founding and functioning of the Atomic Energy Agency, the procedure of preparing and updating the country's strategy related to nuclear power, and also to the obligations of nuclear power facility operators to inform the public about the activity of these facilities.

Principle of the safety priority

The envisaged principle of the safety priority in operation of a nuclear facility results from Article 6(4) and Article 5(3) of the Council Directive 2009/71/Euratom.

In the Atomic Energy Law, it was proposed that the head of the organisational unit which holds a valid licence for pursuing exposure-related activities and consisting in construction, commissioning, operation or decommissioning of a nuclear facility is responsible for ensuring of nuclear safety, radiological protection, physical security and protection of nuclear materials. The responsibility should continue until the decommissioning report of the nuclear facility is accepted by the President of the NAEA, even if the licence for carrying out the exposure-related activities was withdrawn or expired.
The above mentioned regulations are fully justified by the provisions of the IAEA documents, including the "IAEA Safety Standards – Licensing Process for Nuclear Installations - Project DS 416", where in clause 2.17 it is stated that the prime responsibility for safety is assigned to and assumed by the person or organisation responsible for any facilities and activities that give rise to radiation risk. In addition, compliance with regulations and requirements imposed by the regulatory body does not relieve the person or organisation responsible for any nuclear installations and their activities of the prime responsibility for safety.

Also the requirements to be met by other participants of the investment process will be extended, irrespectively of the duties of the head of the organisational unit in the process of the construction of a nuclear facility. The obligation to meet the requirements of protection of nuclear materials, in addition to the fulfilment of nuclear security, radiological protection and physical security requirements, will be imposed.

Moreover, the provisions of the new Article 35(4) of the Atomic Energy Law will extend the provisions of the existing Article 35(3) of this act. It will be stated that in the process of establishing location, planning, construction, commissioning, operation, including repairs and upgrade of a nuclear facility, and also in the process of its decommissioning, any technical and organisational solutions must be adopted that are necessary to ensure that at each stage of the nuclear facility operation the number of employees and other people exposed to ionizing radiation, and the doses of inonising radiation received thereby, is as low as possible with a reasonable allowance made for the economic and social factors.

Information activities

Under Article 8 of the Council Directive 2009/71/Euratom, the Republic of Poland should ensure that the information related to the regulation concerning nuclear safety, including the information on competences of the nuclear regulator is communicated to employees and general public. Therefore, a principle will be included into the Atomic Energy Law that everybody has the right to obtain, from the head of an organisational unit engaging into activities consisting in the commissioning, operation or decommissioning of a nuclear facility, written information about the status of nuclear safety and radiological protection of the nuclear facility, its impact on human health and the environment and about the size and isotopic composition of the releases of radioactive substances from the nuclear facility to the environment. Information on the aforementioned issues should be posted by the head of the organisational unit in its website at least every 12 months. Moreover, they should immediately inform the President of the NAEA, the authorities of a municipality on the territory of which the nuclear facility is located, and also these of the neighbouring municipalities about unplanned events in the nuclear facility that might cause or are causing a threat, and post, in the website of the organisational unit, information about unplanned events that have taken place in the nuclear facility in the recent 12 months and posed a threat. The above mentioned information should be also passed to the President of the NAEA.

Furthermore, it is proposed that the President of the NAEA should announce, according to the principles specified in the regulations on communication of information on the environment and its protection, participation of the public in environmental protection, assessments of the impact on the environment, information on the status of nuclear safety and radiological protection of nuclear facilities, their impact of human health and natural environment and the size and isotopic composition of the releases of radioactive substances from nuclear facilities to the environment, and also information about licences granted related to nuclear facilities, decisions taken by the regulator concerning the nuclear facilities and annual assessments of the status of security of nuclear facilities being supervised. However, the information about the physical security, protection of nuclear materials and information that constitutes trade secrets in the meaning of the provisions of the regulations related to combating unfair competition should not be made available.

In order to fulfil the requirements of Article 8 of Council Directive 2009/71/Euratom, a separate procedure regarding the public participation in the proceeding for an application to issue of a permission to pursue an activity associated with exposure to ionising radiation, consisting in constructing a nuclear power facility, will be introduced to the Atomic Energy Law. Should such an application be filed, the President of the NAEA will immediately have to announce in the Public Information Bulletin, on the Agency's President's pages, the content of the application to issue a permission, including an abbreviated safety report, and the information about:

1) the fact of instituting a proceeding for the issuance of the permission to build a nuclear power facility;
2) the possibility of filing observations and motions;
3) the manner and place of filing observations and motions, specifying at the same time the 21-day time limit to file these;
4) the date and venue of an administrative hearing open to the public, if it is to be held.

The information referred to in items 1-4 will have to be announced by the Agency's President also in the press whose reach covers the community within which the area addressed by the application to issue the permission is situated and its neighbouring communities.

It is expected that the possibility of filing observations and motions in writing, through oral protocols or by means of electronic communications, without the necessity of providing them with a secure electronic signature, will be accepted.

The President of the NAEA will be obliged to examine the observations and motions filed and to do so, they will be able to hold an administrative hearing open to the public. In the justification of an issued decision, the President, regardless of the requirements arising out of the Code of Administrative Proceedings, will have to provide the information about the public participation in the proceeding and about the way in which the observations and motions filed by the public have been considered.

The obligation to provide transparency regarding the safety of nuclear power facilities for the society and public participation in the whole life-cycle of a nuclear power facility is stressed by the document "IAEA Safety Standards – Licensing Process for Nuclear Installations – Project DS - 416". The regulatory body or licensee should provide easy access to relevant and comprehensive information relating to safety and to the licensing process and licensed activities. Such information should be published where it can be easily accessed, such as on the internet and in the mass media etc.

Location

It is proposed that the Atomic Energy Law should contain the principle that a nuclear power facility is to be located in an area that will make it possibile to ensure nuclear safety, radiological protection and physical protection during commissioning, operation and decommissioning of this facility, as well as to undertake an efficient emergency procedure in the event of a radiaton incident.
It is assumed that the investor of a nuclear power facility, as a future permission holder, should assess the area where the nuclear power facility is to be located by themselves, applying assessment methods that give measurable results and well reflect the actual conditions of the area.
Assessment results of an area where a nuclear power facility is to be located, including test and measurement results being the basis for such an assessment, should be prepared by the investor in the form of a location report the detailed content of which will be specified by a regulation of the Council of Ministers. The location report should be subject to assessment by the President of the NAEA in the course of the proceeding for the issuance of the permission to build a nuclear power facility. One of the prerequisites for the President of the NAEA to issue a permission to build a nuclear power facility will be the applicant's prior obtainment of the decision about environmental conditions of a project.
An adequate analysis of an area where a nuclear power facility is to be built is of extreme importance for assuring nuclear safety of the facility during the entire period of its operation.

It is proposed that an investor of a nuclear power facility should have a possibility to write to the President of the NAEA requesting the issuance of a forerunning opinion about the intended location of a given nuclear power facility. The investor will have to attach the location report to their request.

The planned regulations concerning the assessment of a location for a nuclear power facility are, in terms of nuclear safety and radiological protection, in compliance with the IAEA recommendations resulting from item 3.2 and the document “IAEA Safety Standards – Licensing Process for Nuclear Installations – Project DS - 416”.

Designing and construction

The amended Atomic Energy Law will specify basic conditions that should be met by a design of a nuclear power facility with respect to nuclear safety and radiological protection, as well as with respect to the safe work of technical equipment installed and operated in a nuclear power facility.
A design of a nuclear power facility should consider the necessity of assuring nuclear safety, radiological protection and physical security during construction, commissioning, operation, including repairs and updates, and decommissioning of this facility. It should also allow for the possibility of conducting an efficient emergency procedure in the event of a radiation incident. Furthermore, it should take into consideration the sequence of safety levels assuring that deviations from standard operating conditions, operational incidents, failures foreseen in design assumptions, and serious failures exceeding these assumptions are prevented. Where it is impossible to prevent these deviations, incidents or failures, a design should allow for their control and maximum reduction of radiological effects of a failure.
The foregoing requirement relates to the so called “defence in depth.” The principle of the defence in depth is that no single element related to the design, maintenance or operation of a nuclear power plant can be fully trusted. The defence in depth assures reserves of configurations with “active” safety systems so that when one sub-configuration is damaged there are others that can fulfil the required safety functions.
In accordance with the amended Atomic Energy Law, it will not be permitted during designing and building of a nuclear power plant to apply solutions and technologies that have not been tested in practice, while building nuclear power facilities or during adequate tests, examinations and analyses. Any design of a nuclear power plant should assure that its operations will be secure, stable, easy and safe in terms of management, with particular consideration of the human factor and the aspects associated with the cooperation of people with operated systems and technical equipment.
An investor, prior to writing to the Agency’s President to request the issuance of the permission to build a nuclear power facility, will conduct safety analyses and verify them. This process cannot be participated by the entities taking part in preparing the design of a nuclear power plant. Based on the results of these analyses, the preliminary safety report will be drawn up and presented to the NAEA, along with the request for the issuance of the nuclear safety and radiological protection-related permission to build a nuclear power facility.
When delimiting a limited use area around a nuclear power facility, it will also be necessary to allow for a potential failure of a reactor without its core meltdown. The amended Atomic Energy Law will contain also some regulations deriving from the currently valid regulation of the Minister of Environment on detailed rules for the creation of a restricted-use area surrounding a nuclear facility.

Contractors and suppliers of systems, structural elements and equipment for a nuclear power facility, as well as contractors for works performed while building and equipping a nuclear power plant should have adequate quality systems implemented with respect to the works conducted. An organizational unit engaging in an activity consisting in constructing, commissioning, operating or decommissioning a nuclear power plant should ensure that the nuclear supervision bodies are able to control whether these requirements are met, in

particular through adequate provisions in contracts entered into with suppliers and contractors.
It is proposed that the President of the NAEA should be vested with the following supervisory measures towards an organizational unit engaging in an activity consisting in constructing, commissioning, operating or decommissioning of a nuclear power plant:

1) a ban on using a specific system, structural element or equipment for a nuclear power facility where it has been ascertained during an inspection that it could have a negative impact on the state of nuclear safety and radiological protection of the nuclear power facility;

2) an order to cease specific works in a nuclear power facility if it has been ascertained during an inspection that they are carried out in a way that could have a negative impact on the state of nuclear safety and radiological protection of this nuclear power facility.

Controls by the nuclear supervision of suppliers and contractors of structural elements and equipment for a nuclear power facility are an important element, in terms of safety and also of the contractors of the works performed while building and equipping a nuclear power facility, for assuring the safety of a nuclear power facility. The monitoring by the nuclear supervision and their activity for the sake coordination with adequate state bodies and institutions in order to meet the provisions of Article 4(1) of Directive 2009/71/EC is of particular importance in the case of a country that initiates its the nuclear power program. Monitoring whether quality standards of appropriate strictness are followed will contribute to providing an infrastructure of the nuclear safety culture.

Commissioning

It is proposed that the Atomic Energy Law should contain a provision that a nuclear power facility shall be commissioned and operated in a way assuring the nuclear safety and radiological protection of employees and people, in compliance with the integrated management system implemented in the organisational unit. More detailed regulations should address the requirement to carry out the commissioning of a nuclear power facility as per its nuclear power facility commissioning program – the document that includes in particular a list of commissioning tests for structural elements and equipment of this nuclear power facility, as well as the procedure for their performance.

It is also proposed that the following supervisory powers should be granted to the President of the NAEA in relation with this stage:

1) issuance of a decision to cease the commissioning of a nuclear power facility where the commissioning test results for the facility indicate potential hazards or the risk that the facility will fail to meet the nuclear safety requirements; to make the issuance of such a decision possible, the manager of the organisational unit should be obliged to submit the commissioning test results to the President of the NAEA in the normal course;

2) approval of the commissioning report of a nuclear power facility that presents the commissioning results and is submitted within the time limit specified in the permit to commission a nuclear power facility; the commissioning of the nuclear power facility should be documented in the facility commissioning documentation.

The approval by the President of the NAEA of the commissioning report of a nuclear power facility should be one of the conditions for obtaining the permission to operate a nuclear power facility.
The safety requirements for the commissioning and operation stage of different kinds of nuclear power facilities will be set forth in a regulation by the Council of Ministers.
The requirements concerning the commissioning stage of a nuclear power facility have been based on the principal safety levels of WENRA and on the provisions of items 3.42–3.52 of the document "IAEA Safety Standards – Licensing Process for Nuclear Installations – Project DS - 416".

Operation

The Atomic Energy Law proposes to introduce the obligation of keeping the operation documentation of a nuclear power facility and of providing the President of the NAEA with current information about the working parameters of a nuclear power facility that are vital for safety, and the President of the Office of Technical Inspection with current information about the operational safety of technical equipment installed and operated in a nuclear power plant. This will allow on-going monitoring of the state of safety and radiological protection of a nuclear power facility, as well as of the operational safety of technical equipment.

The President of the NAEA should be authorized to issue an order to reduce power of or shut down a nuclear power facility where continued operation of such a facility threatens nuclear safety or radiological protection. Increasing the power or re-commissioning of the nuclear power facility shall require a consent of the President of the NAEA. Furthermore, in the course of operating a nuclear power facility, each update to a system, structural element or equipment of the facility that is vital for nuclear safety or radiological protection, as well as each case of starting the reactor after a break for loading the nuclear fuel and for an update to a system, structural element or equipment of the facility will require a written consent of the President of the NAEA.

A repair and update of the equipment installed in nuclear power plants that is subject to the regulations on technical inspection will require an arrangement with the Office of Technical Inspection.

During the operation of a nuclear power facility, an organizational unit responsible for the operation will be obliged to conduct periodical safety assessments of the facility with respect to its compliance with the permission to operate, legal provisions, domestic and international standards regarding nuclear safety and safe functioning of equipment, systems and structural elements belonging to a nuclear power facility. On the basis of this assessment, the manager of the organizational unit will draw up periodical safety assessment reports to be later approved by the President of the NAEA. Detailed requirements regarding the periodical safety assessments and the commissioning and operation of nuclear power plants will be set forth in a regulation by the Council of Ministers.

Decommissioning

It is proposed that the Atomic Energy Law should contain a general rule that a nuclear power facility shall be decommissioned in a way assuring nuclear safety and radiological protection of employees and people, in accordance with the permission and the integrated management system. When decommissioning a nuclear power facility, actions that could affect future generations more gravely than permitted with respect to the present generation should be avoided.

It is proposed that the decommissioning program of a nuclear power facility should be presented to the President of the NAEA for approval already accompanied by a request to issue the permission to construct, commission and operate the nuclear power facility. Subsequently, during the operation, the program should be updated and presented for approval at least once in 5 years, along with a financial forecast of decommissioning. In the situation of stopping to operate a nuclear power facility due to an extraordinary event, this should take place immediately.

After completing the decommissioning of a nuclear power facility, the manager of the organisational unit possessing the permit to decommission should submit for approval the decommissioning report of the facility to the President of the NAEA. The day when the President of the NAEA accepts this report shall be officially recognised as the date of decommissioning of this nuclear facility.

Creating a legal framework regulating nuclear safety of a facility at the decommissioning stage is necessary in relation with Article 3(4) and Article 4(1) of Council Directive 2009/71/Euratom and the guidelines of the International Atomic Energy Agency presented in the document “Decommissioning of Nuclear Power Plants and Research Reactors Safety Guide, IAEA Safety Standards Series No. WS-G-2.1.”

In accordance with Article 6(5) of Council Directive 2009/71/Euratom, the Republic of Poland should assure that the existing legal framework requires from permission holders securing and preserving of adequate financial resources in order to meet their requirements related to nuclear safety of a nuclear power facility. Therefore, it is proposed that the Atomic Energy Law should introduce a system financing the final handling of spent nuclear fuel, radioactive waste and commissioning of a nuclear power facility.

To cover the costs related thereto, an organisational unit which obtained a permission to operate a nuclear power facility with an energy reactor will be obliged to regularly transfer money to a separate bank account, referred to as the “decommissioning fund.” The money accumulated by the decommissioning fund can be earmarked only for covering the costs of the final handling of the radioactive waste and spent nuclear fuel coming from the nuclear power facility in question, as well as for the decommissioning of this facility.

To enable the President of the NAEA to supervise an organizational unit’s compliance with the obligation to perform payments to the decommissioning fund, it is proposed that the manager of this unit should provide the President of the NAEA with quarterly reports stating the amount due to the benefit of the decommissioning fund and the amount of the electric energy generated in that period. In cases of delays in effecting transfers to the decommissioning funds that exceed 18 months, the President of the NAEA will be entitled to issue an order to cease the operation of a given nuclear power plant.
In practice, the obligation of making the payments will lie with a nuclear power plant only from the moment of initiating production and selling the electric energy generated in this plant, namely from 2020. Still, the obligation of making such payments should be included in the Atomic Energy Law at the first stage of its amendment for two reasons:

1) to enable a nuclear power plant’s investor to take this obligation into consideration while planning the whole project; and

2) to shown the public that the expenses on handling of radioactive waste and spent nuclear fuel, as well as on power plant decommissioning, will not be charged to future generations but will be settled by a nuclear power plant's owner.

Physical security

According to the new provision of Article 41m(1) of the Atomic Energy Law, the supervision over physical security of nuclear facilities will be exercised by the President of the NAEA, and the Head of the Internal Security Agency, within their respective competencies. The physical security system of a nuclear power facility will be accepted by the President of the NAEA after receiving a favourable opinion of the Head of the Internal Security Agency.
At the same time, paragraph 2 of new Article 42a of the Atomic Energy Law will authorise the Council of Ministers to specify, by way of a regulation, the requirements to be met by the security of buildings and equipment not belonging to a nuclear facility, the damage or operational interference of which might significantly affect the nuclear facility safety; in such specification, the inspection competences of the Head of the Internal Security Agency must be taken into consideration. The necessity of ensuring adequate security of such buildings and equipment is provided for as well.

These amendments are justified by the need to improve the supervision over the physical security of nuclear facilities and over the security of facilities and equipment the functioning of which may seriously affect the operation of nuclear facilities in connection with the plans to build the first nuclear power plant in Poland and in connection with the necessity of implementing the provisions of the International Convention for the Suppression of Acts of Nuclear Terrorism, adopted by the General Assembly of United Nations on 13 April 2005.

Civil liability for nuclear damage

The draft provides that the civil liability for nuclear damage will be borne solely by entities that operate nuclear power equipment for purposes of peaceful uses of nuclear energy.
The draft regulates the issues related to the nuclear damage done in transit and to the moment of arising the insurance liability. It adopts the current solution to the requirements arising out of the ratification of the Protocol Amending the Vienna Convention – through extending the operator's limit of liability for nuclear damage to the amount equaling to SDR 3,000 million.
It will also authorize the Council of Ministers to issue a regulation specifying types of nuclear equipment or quantities of nuclear materials to which, according to the criteria set forth within this scope by the Management Council of the International Atomic Energy Agency, the provisions on civil liability for nuclear damage do not apply.

Nuclear Power Agency

The NPA will be an executive agency within the meaning of the Act of 27 August 2009 on Public Finance (Journal of Laws No. 157, item 1240, as amended). The NPA will report to the minister competent for economic matters.
The authority of the NPA will be the President of the NPA, appointed by the President of the Council of Ministers from among the persons selected in an open and competitive recruitment procedure, upon request of the minister competent for economic matters. The President of the NPA is dismissed by the President of the Council of Ministers.
The President of the NPA will manage its activity and represent it. The President of the NPA will act with the aid of two Deputies to the President of the NPA. The deputies will be

appointed and dismissed by the minister competent for economic matters in an open and competitive recruitment procedure, upon request of the President of the NPA.
The NPA will execute the tasks specified in item 5.2.2.
The NPA will be obliged to gather data and information on nuclear power energy in Poland and in the world in order to process, publish, and reveal them to interested natural and legal persons.

The country's strategy regarding nuclear power
The country's strategy regarding nuclear power will be defined by the Polish Nuclear Energy Program (hereinafter: the PNE Program). It will be developed and updated by the minister competent for economic matters, with the aid of the Nuclear Power Agency (after it has been established). The PNE Program will determine in particular:

1) goals related to the development of nuclear power in Poland;
2) tasks related to the development of nuclear power in Poland;
3) schedule of actions within the scope of social information, education, promoting, and scientific, technical and legal information related to nuclear power;
4) plan of cooperation related to scientific research in the field of nuclear power.

The PNE Program will be prepared in compliance with the sustainable development principle and will include:

1) assessment of the PNE Program execution corresponding to the previous period;
2) section of forecasts covering a period not shorter than 20 years;

program of executive actions for a period of 12 years, including the instruments to undertake them.

Social information

Each investor will be obliged to establish with each nuclear power facility (NPF), which at the same time is a nuclear facility, at the latest as at the date of obtaining the decision about establishing the location for a project involving building a nuclear power facility for the NPF, the Local Information Centre (LIC). The NPF's investor and the NPF's operator will be obliged to manage the activity of the LIC by the time of concluding the decommissioning of the NPF.
The Local Information Centre will be an information point located within the commune territorially corresponding to the NPF. The LIC, through the NPF's investor and the NPF's operator, will pursue the local informative, educational and promotional strategy within the scope of nuclear power.
The tasks of the investor/operator running a LIC will include:

1) publishing current information about the activity of the NPF;
2) publishing current information about the state of *nsrp* aroud the NPF;
3) cooperating with the NPA in what regards promoting among the public the reliable knowledge about nuclear power in the country and in the world;
4) cooperating with the President of the NAEA in what regards disclosing the information and data about *nsrp* and social education in this respect.

In order to assure adequate level of knowledge about project implementation and current operation of a NPF that is also at the same time a nuclear facility, the local community will have the right to appoint their Local Information Committee (LIC) which will play the role of a liaison between the community and its NPF's investor/operator.
The committee will have the following composition:

1. representatives of self-governmental authorities of the local community (1 person from each community within which an NPF, or a part thereof, is located);

2. representatives of the local community (any number).

The council of a commune where an NPF being at the same time a nuclear facility will be planned, will be constructed or will operate, will be entitled to set up a Commune Information Point (CIP) where it will pursue its communal strategy of promoting nuclear power and informing or educating about it.

The NPA and LICs will be obliged to provide CIPs with the data and information in compliance with the rules of this act.

6.5. Amendments to the Atomic Energy Law – Stage Two

Stage Two of amendments to the Act on Atomic Energy Law will include, among others, the provisions related to:

- transformation of the President of NAEA into the Commission for Nuclear Supervision (CNS)
- implementation of further EU legislation (Waste Directive, new Nuclear Safety Directive);
- further adaptations of the Act to the changing situation in Poland, mainly with respect to the operation of the nuclear power sector.

6.6. Radiation incident response procedure

Using nuclear power in a safe manner requires not only the above mentioned measures (including the most important ones, i.e. legislation and institutions), but also preparing a system of response to emergency situations (contingencies). In the area of using ionizing radiation, such situations are called radiation incidents. A radiation incident is an event occurring within the territory of a country or abroad, related to nuclear material, source of ionizing radiation, radioactive waste or other radioactive substances that causes or may cause radiation hazard and result in the possibility of exceeding the threshold values of ionizing radiation doses specified in the applicable regulations, and thus requiring instant actions to be taken in order to protect the staff or population.

The main groups exposed to radiation hazard include people working with radiation sources – at nuclear power facilities (nuclear power plants, nuclear waste and spent nuclear fuel repositories) in health care, industry, agriculture and scientific research; patients examined or treated with the use of radiation techniques and selected groups in the whole population of the affected area may be also exposed.

In case of emergency, (a radiation incident), response activities are taken, as specified in the regulation by the Council of Ministers of 18 January 2005 on the plans of emergency procedure in response to radiation incidents (Journal of Laws No. 20, item 169, as amended) – separately for incidents limited to the premises of an organisational unit ("in-factory" incidents), and for incidents with impact outside the organisational units ("provincial" and "national" incidents, including these with "transboundary" impacts).

For all response activities, the following persons are obliged to take them, depending on the range of the incident impact: the head of the unit, the province governor or the Minister of Interior and Administration. The President of the NAEA, through the Centre for Radiation Incidents (CEZAR) headed by them, is responsible for provision of information and consultancy, in particular with respect to the evaluation of the level of doses and contamination and other expert opinions, as well as for on-site activities; the President of the

NAEA is also responsible for communication of information to the communities affected as a result of the incident and for provision of information to international organisations and to neighbouring countries.

Nuclear power plants are designed and operated with consideration of strictly defined safety requirements. Safety systems are designed to minimise the probability of the emission of radioactive substances. Despite the fact that the probability of accidents is practically equal to zero, (requirements of EUR and EPRI (URD) are 1×10^{-5}, and for 3G reactors: EPR: 4×10^{-7}, AP-1000: 3×10^{-7}), planning for emergency situations in order to protect the personnel, emergency services and population outside the location of the power plant is a necessary component of the general system of safe operation of a power plant..

Adequate preparation with respect to planning emergency situations is one of the basic challenges to be faced by the organisations responsible for the implementation of a nuclear power program. It must be emphasised that irrespectively of the requirements imposed by the President of the NAEA – and the obligation of the operator of a power plant to satisfy them – the powers to manage for example evacuation remain with the local self-government. Therefore, it is increasingly important not only to prepare adequate procedures, but also to define the scope of responsibility of individual stakeholders, including the operator of a local nuclear power plant, the local self-government, the emergency services, etc.

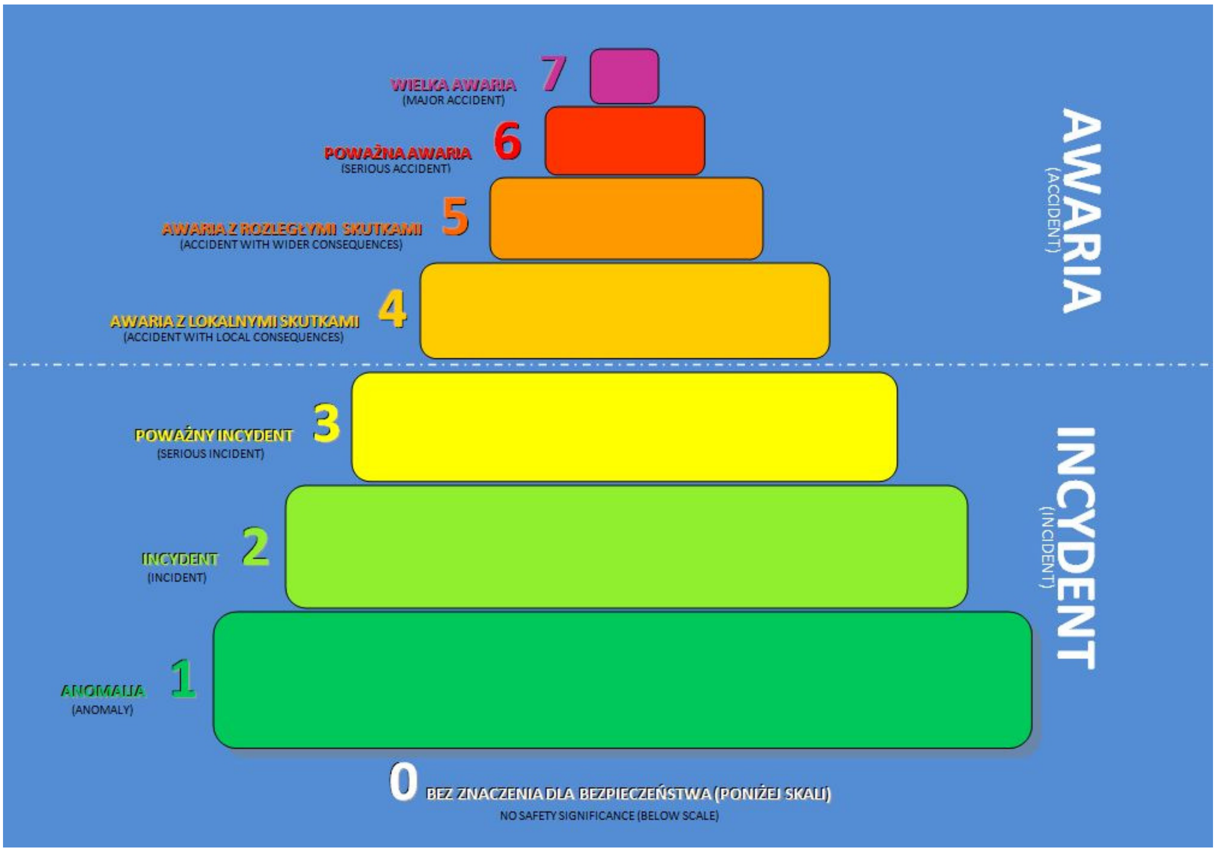
Contingency planning should refer both to the power plant itself and, in particular, to the most immediate area and that is why it is closely connected with the process of selecting of the location. Basic solutions used in contingency plans should be also included in the main topics in the information campaign (especially at the phase of the project implementation). Contingency planning has its local and international dimension resulting, among others, from future conventions on the principles of early notification and the coordination of activities of emergency services.

The International Nuclear Event Scale (INES) is an important tool of providing fast and relevant communication to the general public on threats caused by events in nuclear facilities. It makes it easier to interpret them by experts, mass media and the general public. It is commonly used by the IAEA and its member states (including Poland) to determine categories of nuclear incidents. The INES scale was designed by the IAEA and the NEA/OECD mainly to describe incidents in nuclear power plants. Its latest version (modified) enables describing incidents at civil nuclear installations and related to transporting radioactive materials.

The INES scale is widely used in the nuclear industry to determine the “magnitude” of incidents, and also when it is necessary to quickly inform the general public about the range of a threat and possible effects of incidents in nuclear installations.

The range of the scale includes seven levels: from below zero – for incidents that do not have any significance for safety – up to the seventh level – a serious accident with far-reaching consequences for the health of humans and environment (see Fig. 6.1). For example, the Chernobyl accident was evaluated as the most serious 7th level accident in the INES scale.

Fig. 6.1. International Nuclear Event Scale
Source: International Atomic Energy Agency (IAEA)



The majority of nuclear incidents described with the use of the INES are ranked below the scale or at the 1st level, but they are always attracting the attention of mass media. The scale proves to be very useful in passing information, first of all, due to the complexity of technical issues in nuclear power sector and highly specialist terminology.

In case of emergency, (a radiation incident), response activities must be taken – separately for in-factory incident, and for provincial, national or transboundary incidents. For all response activities, the following persons are obliged to take them, depending on the range of the incident impact: the head of the unit, the province governor or the Minister of Interior and Administration. The President of the NAEA, through the Centre for Radiation Incidents (CEZAR) headed by them, is responsible for provision of information and consultancy, also with respect to the evaluation of the level of doses and contamination and other expert opinions, as well as for on-site activities; the President of the NAEA is also responsible for communication of information to affected communities and for provision of information to international organisations and to authorities of neighbouring countries. This procedure is applied also if illegal trade in radioactive substances is detected (including illegal transboundary transport).

CEZAR has a dosimetry team that can take on-site measurements of the dose and radioactive contamination, identify contamination and abandoned radioactive substances as well as remove contamination and transport the radioactive waste to a RWMP.
CEZAR is an emergency service of the President of the NAEA, a National Contact Point (NCP) for the International Atomic Energy Agency (*ENAC – Emergency Notification and*

Assistance Convention), the European Commission (*ECURIE – European Community Urgent Radiological Information Exchange*), Council of the Baltic Sea States, NATO and countries that have bilateral agreements with Poland on, among others, notification and co-operation in case of radiation incidents. CEZAR is on duty 7 days a week, 24 hours a day. The Centre regularly assesses the radiological situation of the country. In case of a radiation incident computer-aided decision making systems (RODOS and ARGOS) are used.

In case of emergency, (a radiation incident), response activities are taken – separately for incidents limited to the premises of the organisational units (an "in-factory" incident), and for incidents with impact outside the organisational units ("provincial", "national" or "transboundary" incidents). For all response activities, the following persons are obliged to take them, depending on the range of the incident impact: the head of the unit, the province governor or the Minister of Interior and Administration. The President of the NAEA, through the Centre for Radiation Incidents (CEZAR) headed by them, is responsible for provision of information and consultancy, also with respect to the evaluation of the level of doses and contamination and other expert opinions, as well as for on-site activities; the President of the NAEA is also responsible for communication of information to affected communities and for provision of information to international organisations and to authorities of neighbouring countries. This procedure is applied also if illegal trade in radioactive substances is detected (including illegal transboundary transport).

If effects of an incident go beyond the premises of a plant, the Emergency Service will work together with the services of the Province Governor competent for the location of the incident. Co-operation of the Border Guard and the Customs Service with respect to counteracting illegal import and export of radioactive substances to and from Poland is especially important. However, like in other countries using nuclear power in a peaceful way, it is essential to continuously improve the systems of preparation for any kind of emergency situations. This may be achieved through adequate regulations and infrastructure development but also by constant improvement of the procedure, training the key personnel, on-going monitoring of the situation and simulations preparing of emergency situations. The NAEA (and later CNS), in partnership mainly with the Internal Security Agency, plays a key role in the preparation and exercising implementation of contingency plans in the area of nuclear power. Scenarios of such exercises should take into account all probable situations that threaten the security of nuclear installations, including terrorism, cyber-terrorism, "conventional" situations and typical hazards (fires, earthquake, flood, etc.). Reports on these exercises should be used as a basis for improvement.

The area of activity described above should be one of the subjects of international co-operation, in order to exchange experiences and the best practices. International co-operation is based first of all on the international conventions and treaties listed in Appendix No. 8 to this Program. The co-operation should be developed both on a bilateral and multilateral level. Bilateral co-operation with foreign nuclear regulators is a good form of continuous improvement of the nuclear supervision procedures. It may and should be pursued in partnership with the public administration in order to make the most of it. Multilateral co-operation is mainly pursued with international organisations involved in nuclear power and it is aimed at maximising the effects of Poland's membership in these organisations. These organisations and initiatives include: IAEA, NEA/OECD, International Energy Agency (IEA), and also *IFNEC – International Framework for Nuclear Energy Cooperation* (former *GNEP – Global Nuclear Energy Partnership*).

Chapter 7. Costs of implementation and sources of finance for the *Polish Nuclear Power Program*

7.1. Costs of infrastructure preparation and project implementation

Launching nuclear power is a long-term process. Infrastructure must be developed and adequate environment must be provided for project owners so they can build and start-up nuclear power plants based on safe technologies, with public support, with a high level of nuclear security at all stages of location selection, planning, construction, commissioning, operation and decommissioning of nuclear power plants. This will entail high expenditures to be borne both by the state budget and the project owner.

The Ministry of Economy has estimated, as a part of the preparations for drawing up the Program, public expenditures for the development of nuclear power sector. The following activities have been included in these estimations:

1. **Establishing and operation of a unit responsible for co-ordination of the of nuclear power development: the Nuclear Power Agency –** the aim of the activity is to create an institutional basis for the preparation and implementation of the Program;
2. **Obtaining necessary expert opinions and analyses on creation and application of legal framework governing the operation of the nuclear power sector –** the aim of this activity is to prepare bills governing the construction and operation of the nuclear power sector and related infrastructure;
3. **Obtaining analyses related to the implementation and update of the Program –** the aim of the activity is to provide comparative information about the costs of energy generation at nuclear power plants in relation to other generation sources by evaluation of the economic rationale of the implementation and operation of nuclear power and the required share of nuclear power in the energy-mix.
4. **Implementation of the *Program of Education of Human Resources for Organisatios involved in Nuclear Power* –** the aim of the activity is to prepare human resources for the Polish nuclear sector required for the preparation and implementation of the Stage One of the Program and for operation of nuclear power plants.
5. **Carrying out information and education campaign on nuclear power –** the aim of the activity is to provide the public with credible and reliable information on nuclear power and enhance the public knowledge about the issue by education activities; enhance the awareness about this area to improve the social acceptance for the development and operation of nuclear power.
6. **Operation of the nuclear supervision authority –** the aim of the activity is to ensure the operation of an independent, modern and professional nuclear supervision authority. The authority, as an institution of public trust, should be able to face challenges related to the development of nuclear power in Poland.
7. **Analysis of locations for nuclear power plants –** the aim of the activity is to research and identify potential locations for nuclear power plants.
8. **Analysis of locations for a nuclear waste repository; designing and construction of the repository –** the aim of the activity is to establish location for a new repository of low- and intermediate level waste due to almost total use up of the RWMP at Różan; prepare the design and build the repository.
9. **Provision of scientific and research base –** the aim of the activity is to create a strong scientific and research base for the nuclear power sector to ensure that Poland is able to

take advantage of the opportunities and possibilities related to the nuclear power implementation, a multifaceted and complete way.

10. **Preparing the participation of the Polish industry in the Program –** the aim of the activity is to ensure that Polish industry to the maximum possible extent participates in the delivery of equipment and services for the nuclear power sector and Polish companies are involved in construction, operation and decommissioning of nuclear power plants in Poland.
11. **Research uranium reserves in the territory of Poland –** the aim of the activity is to obtain information on uranium reserves within the territory of Poland and possibilities to use them.
12. **Participation in the cost of membership in international organisations and research programmes –** the aim of the activity is to acquire experience and knowledge necessary for the implementation and operation of nuclear power in Poland.

New costs related to the Program implementation have been calculated for the years:

1) 2011 - 2020 – estimated cost: PLN 790,377 million

The costs do not include:
- current expenditures from the state budget on the NAEA operation: about PLN 11 million a year;
- expenditures from the state budget (Minister competent for science) on the operation of research institutes involved in nuclear power:
  - grants for core projects in 2010 - PLN 47.4 million,
  - grants for construction and installation projects in 2010 – PLN 1.7 million

Detailed expenditures for the years 2010-12 related to the implementation of nuclear power are specified in Appendix No 3.

For 2011, expenditures are quoted as per limit of expenditures set for the draft budget for 2011 within relevant sections of the state budget.

In order to ensure funds and simplify the procedure of using financial resources for the development of nuclear power in Poland, the Program should have the status of a long-term program in the meaning of the provisions of Article 136 of the Act of 27 August 2009 on public finances, as a program supporting the implementation of the *Energy Security and Environment* strategy.

7.2. Costs of the implementation and sources of finance for investment projects

The construction of nuclear power plants is a long-term and costly process. According to the information obtained by the project owner from potential suppliers, the cost of construction of third generation reactors amounts to around EUR 3-3.5 million for each MW capacity. This means that two power plants of the capacity of about 3,000 MW each may cost EUR 18-21 billion. Therefore, the following methods of financing the construction of a nuclear plant can be used:

- *guaranteed loans or corporate lending* (for non-state-owned project owner, provided it can demonstrate adequate financial credibility and standing and finances the project from its own funds and from loans; creditors are then entitled to have recourse on the project owner's assets).

A combination of these methods is also possible.

The preparation and implementation of an investment project may be financed from the project owner's own funds, from external capital or sources (loans, credits, bonds), or from both these sources together. It all depends on the expected cost of capital and adaptation of the financing structure to specific requirements of a given project, such as construction of a nuclear power plant.

The availability of sources of financing, both domestic and international, is one of the most important factors that affect nuclear power plant construction project due to high cost of such a project, the duration of a construction process and the cost of capital.

The construction of a nuclear power plant can be financed by:
- international financial institutions;
- export credit agencies;
- international banks;

or by use of a financing solution provided by the seller (supplier).

International financial institutions providing financing for large projects include European Bank for Reconstruction and Development (EBRD) or European Investment Bank (EIB).

In the current environment of the global economy characterised by limited fluidity of international sources, export credits offered by export credits agencies from respective countries have a key role to play. Their task is to stimulate exports of goods and services by guaranteeing long-term financing on attractive conditions.

Export credits are special financial instruments that, for example, enable a foreign buyer of exported goods or services to defer payment or obtain collateral or guarantee. These instruments are usually connected with governmental support solutions such as government credits, insurance of export credits, subsidies to export credits interest or other types of official support.

Agreement with the OECD concerning officially supported export credits determines the boundary (i.e. the most beneficial) parameters of export credits for the importers eligible to obtain official support. The Agreement (Appendix II) provides for very special treatment of, for example, the official support for credits for exports related to nuclear power plants. It defines the most favourable financial conditions available to for example Poland to obtain technologies for nuclear power plants from foreign suppliers. It applies to the agreements on:
- exports of complete, or part of, nuclear power plants;
- modernisation of the existing power plants;
- supplies of nuclear fuel or its enrichment;
- management of spent nuclear fuel.

In accordance with the OECD Agreement, export credits granted on special conditions may be used to finance up to 85 % of the costs of equipment, engineering services, spare parts and materials from countries where respective export credit agencies are based. The amount can

be increased by financing local costs, up to 30% of the import value, insurance premiums and the interest paid during the construction process.
Given the scale, complexity and high level of risk of the investment project, it might appear necessary for the state to play an active role in supporting the project owner's activities by securing financial aid with the use various support measures – such as State Treasury guarantees.

It should be remembered that in the light of the development of local and regional electricity markets, the conditions should be created for the project owner, in the framework of the project implementation, to enable it to achieve the size and market position that allow for competing against other power industry companies in the regional market and repayment of the debt incurred for the project implementation.

Results of financial analyses of a nuclear power plant project, including the financing options available to the project owner, will be known after a feasibility study for the project is prepared. The study will cover a financial model for the project. The model will be developed in more detail as construction of the nuclear plant progresses.

Therefore, by end of 2013 in will be known if credit guarantees from the State Treasure are required for the construction of nuclear power plants and what is the scale of the required guarantees, if any.

Chapter 8. Location selection

8.1. Overview of location studies for nuclear power plants in Poland since 1990

Location studies for the first nuclear plant of the capacity of about 2,000 MW were first conducted in mid-1960. The research was focused on two seaside regions: Szczecin-Kołobrzeg and Hel-Ustka. The decision on the construction of the Lower Oder River conventional power plant resulted in exclusion of the Szczecin-Kołobrzeg region from further location studies. In 1969, the Lower Vistula River region was included into the location analyses.

Location studies conducted in the years 1969-1970 in the Hel-Ustka and Lower Vistula River regions led to the issuance, by the Planning Commission affiliated at the Council of Ministers, of a decision about the location of the first nuclear power plant on the Żarowieckie Lake. The decision was issued in December 1972 and construction of the Żarnowiec Nuclear Power Plant was commenced in 1982.

Location studies for the second nuclear plant were carried out with the assumption that it would be a power plant with four power units of the capacity of 1,000 MW each. The studies covered the northern part of Poland (north of the theoretical line Warsaw-Poznań), due to the greater water resources in that region and the fact that more energy resources (hard coal and lignite) were available in the southern part of the country.

On the basis of these studies, analyses, opinions and approvals, the Planning Commission affiliated at Council of Ministers approved the location Warta-Klempicz. In June 1988, the then Governor of the Pilskie Province made a decision on location the second nuclear plant "Warta" at the village of Klempicz.

Simultaneously with the final phase of the location studies and research for the second nuclear power plant, location studies were conducted in order to prepare materials to start a location process for the third one and subsequent nuclear power plants.

At the first stage, a macro spatial analysis of the location potential for nuclear power plants covering the whole territory of Poland was made. 62 potential location regions were selected. The stage was completed in 1989. At the second stage, 29 location areas were shortlisted. Further studies were stopped and the nuclear power program was abandoned.

8.2. Status of the location selection process for the first nuclear power plant

By the Regulation by the Council of Ministers of 12 May 2009 on appointment of the Government Commissioner for Nuclear Power, the Commissioner was made responsible for drafting a Program covering, among the others, potential locations for nuclear power plants.
In 2009, the Ministry of Economy, in conjunction with self-government authorities, updated the proposals nuclear power plant locations considered before 1990. New proposals were also collected. On the basis of these materials, a list of 28 potential nuclear power plant locations was drafted.

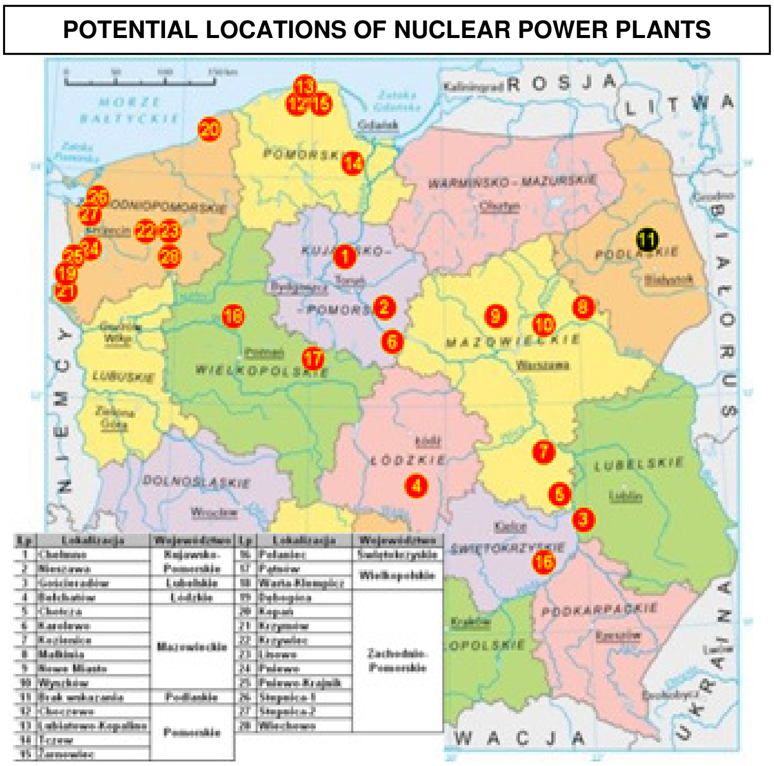
In 2010, a document commissioned by the Ministry of Economy entitled *"Expert opinion on the criteria of nuclear power plant locations and initial evaluation of approved locations"* was drawn up. Within the framework of this project, a ranking of the locations was made with seventeen evaluation criteria taken into consideration (the location for which geographic coordinates had not been specified was ranked on the last position; however, due to formal reasons, it should not be taken into account at all). The results of the assessment are shown in Fig. 8.1.

The results of the work have been published on the website of the Ministry of Economy and passed to the potential project owner responsible for the first nuclear power plant in Poland, the company of PGE S.A., for further research and analyses.

PGE S.A. is further analysing the first four locations list (Żarnowiec, Warta-Klempicz, Kopań and Nowe Miasto). The locations of Choczewo and Lubiatowo-Kopalino (items 8 and 18 in the Ministry's ranking) were also included. Their seaside situation has several advantages: better cooling conditions than in the case of inland facilities, expected shorter project preparation phase and possibly better cost-effectiveness of electricity generation.

At the same time, PGE S.A. is carrying out its own research of the potential locations for the first nuclear power plant. In result of these work, other locations than those from the list of the Ministry of Economy may be identified.

Fig. 8.1. Map of proposed locations for nuclear power plants obtained by the Ministry of Economy in 2009
Source: Analysis by Energoprojekt Warszawa, 2010

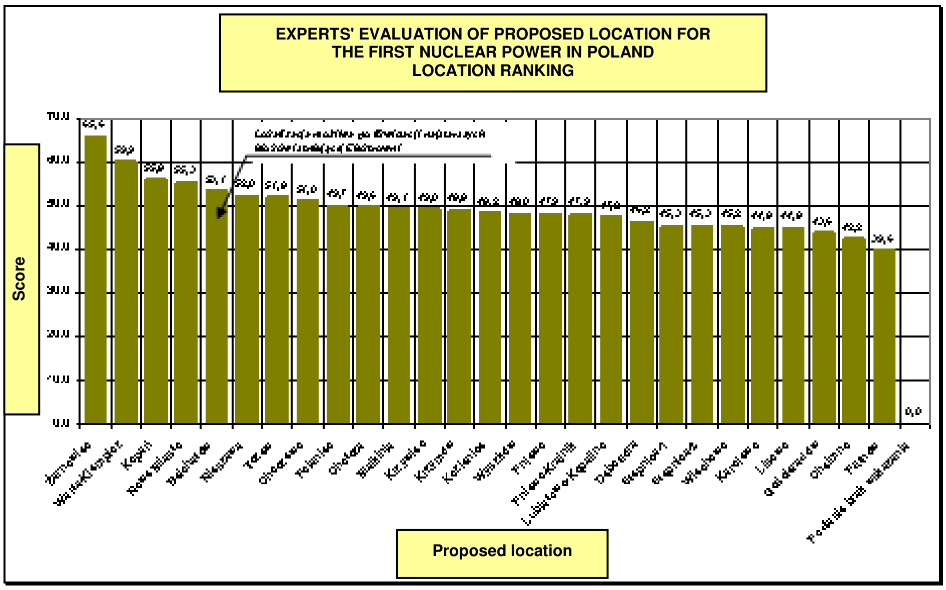


8.3. Requirements for nuclear power plant locations considered by the project owner

Selection of a location is an essential issue affecting the safety and security of a nuclear power plant. The following two aspects of location must be considered:

- The impact of a nuclear power plant on the environment both during its normal operation and during design-related and non-design related failures. The impact may not pose a higher threat that than provided for in applicable regulations. This means that in the planning, construction and operation of a nuclear power plant the limitations resulting from the location conditions must be taken into consideration;
- The impact of the natural environment and the man on a nuclear power plant. These impacts may not be a threat to the safety and security of a nuclear power station. That is why a nuclear power plant must be designed, built and operated with all the potential risk resulting from its location being taken into consideration.

Chart 8.1. Ranking of 28 potential locations
Source: Analysis by Energoprojekt Warszawa, 2010



The work necessary for the evaluation of a nuclear power plant location in Poland will be carried out according to international standards including especially the guidelines of the International Atomic Energy Agency (see above), as well as the European requirements (*European Utility Requirements - EUR*) and the American requirements (*Utility Requirements Document- URD*).

The project owner will be responsible for conducting detailed analyses and selection of the location.

The most important factors considered in the process of the selection of a location will include: available area for the power station and the site facilities; access to cooling water; possibility of power evacuation from the power plant; geological structure and seismic stability of the area; density and distribution of population in the power station neighbourhood; constraints for the construction and operation of a power station resulting from the environment, including environmental protection and site development requirements; access to communication routes; lack of threats from the nature and the human activities; and acceptable weather conditions. The above mentioned factors have been described in Appendix No. 8 to the Program. The methodology of location studies and the location selection criteria will be approved by the PGE S.A. in agreement with the NAEA / CNSRP.

By the end of 2010, a company responsible for carrying out detailed field studies for three potential locations indicated by the project owner will be selected. Results of the previous work will be used in this task. The work should be completed by mid 2013.

Chapter 9. Preparation and required modifications of the national transmission system

9.1. Basic determinants

To ensure reliable operation of a nuclear power plant, the importance of basic determinants of the proper location and stable connection of a nuclear power plant with the National Power System (NPS) must be highlighted. These conditions must ensure reliable power evacuation and back-up power supply for the power plant's own needs both under normal operation conditions and during possible disruptions in the operation of the power grid.
The National Power Transmission Grid (NPTG) includes 110, 220 and 400 kV lines. The 220 kV network is a well developed and multi-loop closed system. The 400 kV network is relatively well developed in the south but in eastern and northern regions of Poland "radial" lines still can be found. These lines are particularly exposed to disruptions and long-term shutdowns.
The lack of adequately developed 400 kV grids is one of the main obstacles hindering the introduction of new generation units (e.g. units with the capacity of above 1,000 MW or nuclear power plants) into the national system. Simultaneously with the development of the nuclear power sector, activities must be taken to accelerate the development of the infrastructure, including networks, stations and lines.

9.2. Proposed activities aimed at development of the National Power System (NPS)

Fast-paced extension of the 400 kV network in the northern part of the NPS is necessary. The role of the 220 kV network must be gradually limited by replacing it with the 400 kV network in the remaining part of the country, to the much larger extent than specified in the current version of the *Plan of development in the area of satisfying the current and future demand for electricity in the years 2010-2025* drawn up by PSE-Operator S.A. (PSE).

The concepts presented by the Power Transmission System Operator (PTSO) in the *Program of the power grid development and modernization* include development of 400 kV networks along the routes of existing 220 kV lines. Apart from this, the following activities must also be taken:

- increase the transmission capacity of the NPS through building new, multi-lane 400 kV networks;
- considerable investments in network resources related to the expansion and modernization of 400 kV lines and building stations attached to power plants;
- increase transmission capacities of the existing 220 kV lines;
- expand transmission and distribution networks around large urban agglomerations (Warsaw, Cracow, Poznań, Wrocław, Szczecin, Tricity) to satisfy the considerably increased demand for electricity in these areas and provide the required reserve capacity to ensure security of power supplies;
- improve the certainty and reliability of the NPS operation and reduce transmission losses;
- strengthen international connections to enable transmission (transit) of power and electricity;
- prepare feasibility, location and practicability studies for projects planned for implementation in the following years.

Also, at the stage of preparatory work, efforts should be taken to establish the basic criteria to be satisfied by the system of connecting the nuclear power plant to the NPS. In this area, for example the following issues must be addressed:

- selection of the main system design (layout) for the station attached to the nuclear power plant;
- the maximum acceptable (from the point of view of reliability) length of lines evacuating power from the unit transformers to the station;
- number of lines evacuating power from the nuclear power plant and their transmission capacity (depending on the installed capacity of the power plant);
- criteria of the operational reliability of power transmission and distribution networks affecting the operation of a nuclear power plant unit.

Effective development of the power engineering infrastructure requires precise coordination of studies and analyses, as well as resulting findings and actions.

These tasks need to be performed in close cooperation with PSE, local operator of the distribution system and Project Owner, with the support of independent consultants and experts.

Increasing demand for electricity, perspective of building the nuclear power plants and modernization of the power engineering infrastructure entail the necessity of manufacturing the required machinery and installation equipment. And this in turns requires involvement of the domestic electrical engineering industry.

9.3. Problems to be solved

Regulations – starting from the Energy Law, through Construction Law, Public Procurement Law, Acts on planning and spatial planning, or environmental regulations – play a key role in the implementation of power engineering projects, including especially the construction of power grids. In the past, a lack of uniform and consistent regulations governing efficient implementation power grid projects was noticeable. However, at present things are changing.

The Act on energy transmission corridors is being prepared. The act will cover the electricity transmission grids and should be passed in 2011. In the guidelines for the act, it has been pointed out that the legal framework governing investment projects should be simplified and clarified. New tools will be introduced to ensure efficient resolution of any disputes related to the ownership of land and availability of project sites.

It takes several years to prepare and implement a project related to evacuation of power from a large generating unit or nuclear power plant. Under current regulations, the process may take about 7-10 years. Analyses of individual stages of the project implementation for grid projects have demonstrated that the project preparation and complex spatial planning procedures are the longest stages of any project and may take several years. During these stages the application for a construction permit is processed and a contractor must be selected in a tender procedure. Before a construction permit is issued, a number of administrative decisions, opinions and approvals in the area of the project location and its environmental impact must be sought. These in turn require time-consuming procedures related to the integration of the project into local spatial development plans or obtaining a decision on the location for a public purpose project, obtaining the so-called right of way (right to use the land for the purposes of building a line or station) and conducting proceedings related to the evaluation of the project's impact on the environment.

Establishing the location is one of the items in the Stage Two of the Program Schedule. It means that the Project Owner should apply to the PTSO for the definition of terms and conditions of connecting the nuclear power plant to the National Transmission Grid as soon as possible to be able to hold necessary negotiations and sign an agreement on the connection of the Poland's first nuclear power plant.

9.4 Issues to be decided

PSE is responsible also for defining in a more precise way the legal status of the *terms and conditions of connection* (to what extent they are binding for both parties and to what extent they are conditional). Operational requirements of the PSE (base operation, energy quality, Grid Code) should be specified before the end of 2013. Future modifications of the Grid Code should be consulted by PSE the Project Owner and nuclear power sector agencies, and should be based on the best practices.
Legal issues and related technical requirements for the connection of a nuclear power plant (NPP) to the transmission system should be decided by the end of 2013, i.e. by the date when the Project Owner is to make the final decision about the construction of a nuclear power plant.
Initial analyses of the compliance of the technical specifications of nuclear power units with the Grid Code (GC), covering such parameters as frequency and voltage ranges, frequency control, operational stability or response during operation under non-normal conditions, have demonstrated that meeting GC conditions should not be a problem for a nuclear power plant. However, the need arises to adapt GC requirements to the specifics of a nuclear power plant operation with respect to the frequency range and operation under non-normal conditions.
It must be noted that issues related to the connection of a nuclear power plant to the grid require substantial modification of GC (the matter has been already mentioned above). GC must be amended to include new regulations related to the provision of additional safety of the nuclear power plant operation. A thorough comparative analysis of the technology chosen and GC requirements should be carried out by PSE, with active participation of the Project Owner.

Taking into consideration the possibilities of the localization of nuclear power plants in Poland, it is advisable that a target layout of the transmission system for the considered NPP locations is drawn. In these work, both PSE and the Project Owner should be involved and different alternatives should be taken into consideration, including:

- Investments in the low-voltage grid (extension of existing lines or building new lines) with 100% probability that decision on the construction of these lines will be made is required;
- Possible investment projects that proved to be useful in individual scenarios;
- Investments related to a specific project or location.

A Transmission Grid Development Plan drafted in this way might be used as the central point of reference for key decisions about the introduction of new power generation units to the NPS and further development of the transmission grid. The issues covered by these decisions would include:

- adoption of high and uniform technical standards for the entire grid infrastructure;

- systematic construction of two-lane 400 kV transmission lines even if, in certain cases single-lane transmission lines would be completely sufficient.

The model of the power engineering system operation will not be subject to substantial changes at the moment of launching the nuclear power. For example, GC requirements are definitely more stringent than requirements related to the frequency range, and the requirements for continuous operation of power generation units connected to the NPS are met for the majority of units with nuclear reactors. Fulfilment of these requirements by NPPs will have a direct effect on the result of the nuclear safety analyses.

Upon selection of the technology by the Project Owner, solutions with respect to technical aspects will have to determine, among others, the issues related to specifying more precisely the voltage range for alignment of power generation units, primary frequency control or base operation standards. The Operator will be responsible for adaptation of the Grid Code to the technical requirements of the connection of nuclear power plants.

As part of the process of selection of the technology, it will be necessary for the Project Owner to co-operate with PSE to specify the terms and conditions of co-operation of the nuclear power plant with the power transmission network under normal conditions and in emergency situations. Good co-operation is required in this area because definition of these requirements may be challenging for a new technology.

Chapter 10. Environmental protection

Climate protection and objectives defined in the Climate and Energy Package adopted by the EU require a shift in energy generation to technologies with low CO_2 emission. In the current situation, using all available technologies to improve the energy security and reduce emissions while maintaining economic efficiency is a matter of key importance.

The above mentioned conditions are reflected in the *Poland's Energy Policy until 2030.* As it has already been mentioned, the *Policy* aims at, among the others, *the reduction of the environmental impact of power generation*.
The primary objectives of the energy policy in this area can be summarised as follows:

- reduce CO_2 emissions by 2020, while maintaining a high level of energy security;
- reduce SO_2, NO_x and particulate matter emissions to the levels specified in the EU current and planned regulations;
- reduce the negative impact of power generation on surface and underground water;
- minimise waste disposal to landfills by their reuse, to the maximum possible extent;
- change the structure of energy generation towards low-emission technologies.

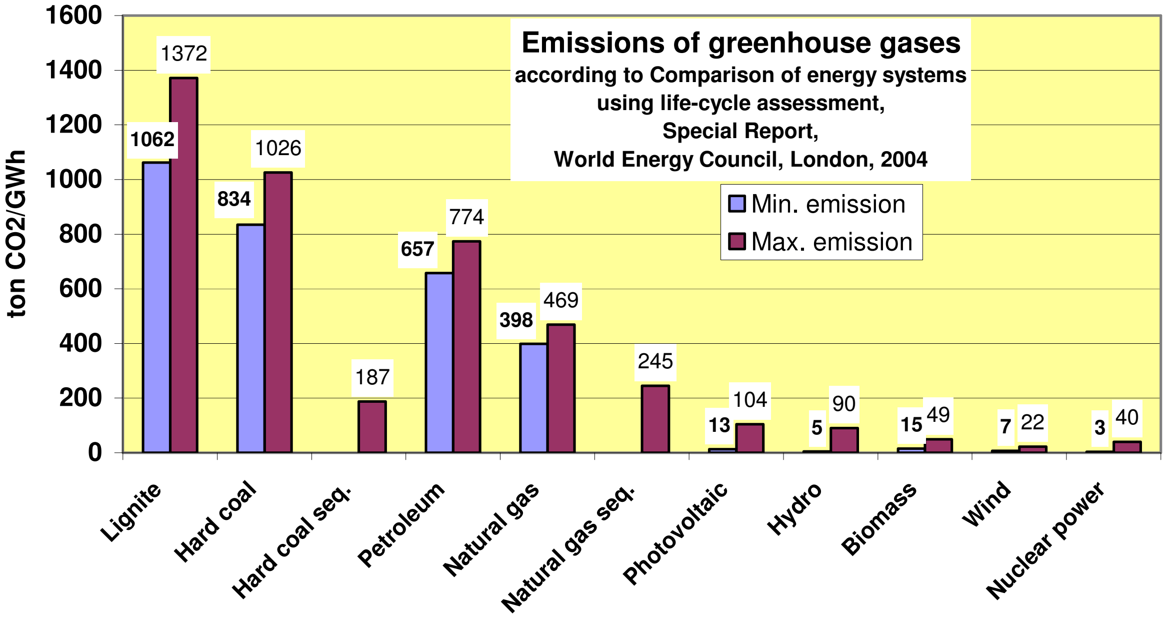
The work on raising security level of reactors that has been carried out recently resulted also in reducing the impact of nuclear power plants on the environment. Nuclear power plants do not emit oxides of sulphur and nitrogen, particle matter or toxic and carcinogenic chemical substances. Nor do they emit carbon dioxide, and emissions during other stages of the nuclear fuel cycle (e.g. during the transport of uranium ore from a mine to the ore processing plat) are insignificant as compared to the emissions from other sources of energy. Clear sky is a characteristic symbol of a nuclear power plant.
In Fig. 10.1., greenhouse gas emissions related to generation of electricity from different primary energy sources are compared. The comparison is based on data from World Energy Council and on external costs of electricity for various technologies.

Emissions of radioactive substances from nuclear power plants are constantly reduced. According to data collected regularly by nuclear supervision authorities in different countries, the annual radiation dose at the border of the buffer zone around the reactor is from 0.01 to 0.03 mSv/year, whereas the dose from the natural background is 2.5 mSv in Poland and 7 mSv/year in Finland. This means that <u>the additional exposure from nuclear power plants is one hundred times lower than the natural differences of radiation between Finland and Poland.</u> Moreover, even within the territory of Poland, differences in natural radiation many times exceed the exposure caused by nuclear power plants.

In order to fulfil the requirements of the environmental protection, with respect to the environmental impact of the project, evaluations of the environmental impact will be carried out at every stage of implementation of the nuclear power plant project. The evaluations will be performed according the Act of 3 October 2008 on making available the information about the environment and its protection, participation of the public in the environmental protection and on environmental impact assessments (Journal of Laws No. 199, item 1227, as amended). A forecast of the environmental impact is being prepared for the project covered by the Program. Then, subsequent stages related to drafting the *Strategic Environmental Impact Assessment*will be implemented. If the possibility of transboundary environmental impact of the project is forecasted a transboundary procedure will be initiated for the project – according to requirements of international conventions ratified by Poland (Espoo and Aarhus Conventions). The procedure requires Poland to provide the interested (exposed) states with

translated part of the documentation (project documentation and environmental impact forecasts) to enable these states to assess the potential impact.
After finishing of the Strategic Environmental Impact Assessment, the Conclusions of it will be attached to the Program as an Appendix and then Program will be send to the Council of Ministers for adoption
In addition, due to the requirements of the nuclear supervision authority, the Project Owner will prepare interim safety and security reports after each project implementation stage and the final safety and security report. The reports will be subject to approval by the President of NAEA / Commission for Nuclear Supervision.

Fig. 10.1. Emissions of greenhouse gases from electricity generation by primary energy sources
Source: Report of the World Energy Council, 2004



Chapter 11. Provision of qualified human resources

11.1. Current status of human resources

Acquiring knowledge and skills required for building a nuclear power plant is one of the key components of the Program implementation. The education of adequate number of specialists in different areas is the key component of launching nuclear power in Poland.

Unfortunately, at present Poland is short of nuclear power professionals. Most of them were actively involved in the Żarnowiec nuclear power plant project (in 1980s) but now they are retired or approaching retirement. The problem is present not only in Poland but also in other countries that want to develop nuclear power from the scratch or even in those with active nuclear power sectors. The fact that considerable number of countries is interested in training human resources for the nuclear power sector will make this process more difficult due to limited training resources.

Nowadays, Polish scientific centres are becoming more and more active in implementation of new initiatives aimed at the development of education and nuclear research. The following institutions will be involved in these activities:

1. Atomic Research Centre, a Science and Technology Consortium;
2. Polish Nuclear Technology Platform;
3. "Staff for Nuclear Power and Nuclear Technologies in the Industry and Medicine" Consortium

In Appendix No. 9, the objectives and lists of members of the aforementioned organizations can be found.

11.2 Fields of studies related to the nuclear sector

According to the act of 27 July 2005 „Higher Education Law" (Journal of Laws No. 164, item 1365, as amended), universities are autonomic entities and make independent decision on their offer of fields of studies and majors. The fields of studies have been defined in the regulation by the Minister of Science and Higher Education of 13 June 2006 on names of fields of studies (Journal of Laws No. 121, item 838, as amended). The field of study named "nuclear power" is not specified in the regulation. However, universities may create specialist courses within this field of study and curricula by exercising their authority in this area. The introduction of such specialist courses is not subject to approval by the Minister competent for science.

Polish universities offer several fields of studies/majors directly related to nuclear power although it is not a comprehensive system of education of human resources. Fields of studies indirectly related to nuclear power – such as electrical engineering, physics or automation – should also be mentioned in this context.

Below, there is a list of existing faculties/fields of studies directly related to nuclear power offered in Poland (in alphabetical order by the name of the university):

1. AGH University of Science and Technology:

- Faculty of Physics and Applied Computer Science; field of study: Technical Physics; major: Nuclear Power
- Faculty of Power Engineering; field of study: Power Engineering; major: Nuclear Power

2. "Staff for Nuclear Power and Nuclear Technologies in the Industry and Medicine" Consortium (Maria Curie-Skłodowska University, Wrocław University of Technology, University of Warsaw);

Wrocław University of Technology:

- Faculty of Mechanical and Power Engineering; field of study: Power Engineering; major: Construction and Operation of Power Systems.

Maria Curie-Skłodowska University in Lublin:

- Faculty of Mathematics, Physics and Computer Sciences; major: Nuclear Safety and Radiological Protection.

University of Warsaw:

- Faculties of Chemistry and Physics; fields of study: Power Engineering and Nuclear Chemistry, Bachelor Degree studies from the academic year 2011/2012 and Master Degree studies from the academic year 2012/2013

3. Gdańsk University of Technology:

- Interfaculty studies in power engineering (Faculties of: Ocean Engineering and Ship Technology; Mechanical and Electrical Engineering; Automatics)
- Faculty of Ocean Engineering and Ship Technology; field of study: Power Engineering.

4. Cracow University of Technology:

- Faculty of Electrical and Computer Engineering; field of study: Power Engineering.

5. Łódź University of Technology:

- Faculty of Mechanical Engineering; field of study: Power Engineering.

6. Poznań University of Technology:

- Faculties of: Electrical Engineering, Chemical Technology, Civil Engineering, Technical Physics; field of study: Power Engineering, major: Nuclear Power Engineering

7. Silesian University of Technology:

- Faculty of Energy and Environmental Engineering; field of study: Mechanical Engineering and Machine Building, major: nuclear engineering;
- Faculty of Energy and Environmental Engineering; field of study: Power Engineering, major: Nuclear Power Engineering;
- Faculty of Electrical Engineering; field of study: Electrical Engineering, major: Electrical Power Engineering.

8. Warsaw University of Technology:

- Faculty of Mechanical, Power and Aeronautical Engineering, field of study: Nuclear Power Engineering.

9. Wrocław University of Technology:

- Faculty of Mechanical and Power Engineering; field of study: Power Engineering; major: Heat and Nuclear Power Engineering.

10. Polish-Ukrainian European University in Lublin (in formation):

- Faculty of Engineering and New Technologies; field of study: Nuclear Power Engineering.

The majority of technology universities and some general universities are preparing to the Program implementation by opening fields of studies and courses (Bachelor and Master

Degree studies) directly related to nuclear power. These efforts have been supported by the Ministry of Economy by organising and financing training for educators for Polish universities. In 2009, a training course was held in France for the first group of 20 people. The second stage of the training (for 25 people) will be held in France from 4 October to 18 December 2010. The activity will be continued in the following years.

In the framework of the Fourth Priority of the Human Resources Development Operational Programme, it is possible to define specific fields of studies that can be supported from the European Social Fund – especially under sub-activity 4.1.2 "Increase the number of graduates from faculties of key importance for the knowledge-based economy". In the framework of the sub-activity, since 2008, the Ministry of Science and Higher Education has been announcing competitions for training in fields of study sponsored by the government in technical, mathematical and natural sciences. In 2010, *Power Engineering* was included in the list of *government sponsored fields of studies*, with the possibility of opening a unique major of *Nuclear Power Engineering*. However, in the two editions of the competition, no funds were granted to projects that covered the Nuclear Power Engineering major.

In the process of preparation and implementation of the Program with respect to human resources for new nuclear power plants, the following institutions are directly involved: Ministry of Economy, Ministry of Science and Higher Education, National Atomic Energy Agency, Office of Technical Inspection and other agencies responsible for supervision and control. Effective implementation of the Program and security of nuclear power plants in the future will depend on the decisions and co-operation of these institutions with the project Owner.

The process of construction of nuclear power plants and the related infrastructure will lead to the creation of thousands of new jobs. For the construction of every single power unit alone (excluding related projects: power lines, transport infrastructure, etc.) about 3,000-4,000 people must be employed to perform construction and assembly works. They will represent a wide range of professions – from workmen trained for work at a nuclear power facility construction site, welders, crane operators, drivers of construction vehicles, electricians, automatic system operators, surveyors, plumbers, to engineers, architects and many other professions. In addition, according to the IAEA document No. NG-T-3.3 "Workforce Planning for New Nuclear Power Programme", from 700 up to 1,000 professionals in more than 40 professions (related to power engineering and to other fields) must be provided for operation of a nuclear power plant with one or two reactors, respectively.

11.3. Objectives with respect to the development of human resources for the Program

The Program objective in the area of human resources development is to achieve a situation in human resources in terms of their quality and quantity that will guarantee effective and safe construction, operation and decommissioning of nuclear power plants.

The main tasks of the government are to:

- identify, in partnership with the project owner, the knowledge resources in the areas relevant for implementation of the nuclear power project;
- create possibilities of education and development of necessary personnel;
- establish training centres to serve the needs of the Program;
- supervise the implementation of these activities.

Development of a domestic base of nuclear power professionals is the most profitable option for the country in the long run. However, with a view to such an ambitious plan of building the first nuclear power plant in about 2020, it is necessary to compile different activities including:

- development and training of domestic human resources;
- use of international human resources such as the network of the IAEA specialists, as well as specialists from the countries that have already implemented their own nuclear programs;
- partnership with owners of nuclear technologies;
- partnership with foreign regulatory institutions from the nuclear sector, and with educational institutions;
- partnership with universities and economic organizations in the countries with advanced nuclear power sector.

In the implementation of the Program with respect to the development of human resources, the guidelines of the International Atomic Energy Agency as specified in the document „*Milestones in the Development of a National Infrastructure for Nuclear Power*" should be observed.

Polish specialists are being provided with the opportunities of international training. For example, the Ministry of Economy has taken efforts to establish international co-operation in this area. Partnership agreements have been signed with:

- Japan;
- United States; and
- Korea.

Further agreements are planned to be signed.

11.4. Basic knowledge necessary for the Program implementation

A system of quality management with much more stringent procedures and requirements and implementation of advanced program and technical tools to analyse, design and install components and structures of a nuclear power plant are required to ensure nuclear safety and radiological protection. Except for nuclear safety and radiological protection, the majority of technical skills needed to plan, construct and operate nuclear power plants are similar to these necessary for large industrial and power engineering projects. Therefore, and in accordance with IAEA guidelines for a nuclear power program, competences in the following areas should be developed:

- analysis of a nuclear power plant project;
- quality management and quality control;
- project management;
- operation and maintenance.

11.5. Measures and methodology

The Project Owner will have to create a complete catalogue of knowledge and skills in disciplines related to science, technology and economy. The catalogue will enable a reliable assessment of the Polish human resource potential required for the Program implementation. This assessment will be accompanied by an analysis covering the Polish industry and managers in terms of attitudes and organisational culture, their usefulness for the nuclear power sector and practical instilling the safety culture in the required scope. Moreover, the Project Owner – in cooperation with the Minister of Science and Higher Education and the Minister of Economy – will have to:

- assess the availability and quality of experts in different areas in Poland;
- assess education capabilities (financial, human and organizational resources, culture, time availability and hands-on training) of Polish and international experts in the above mentioned areas, in cooperation with selected universities/scientific institutions;
- propose solutions related to training and education – based on partnership with Polish and international universities and/or businesses;
- assess the availability of specialist training for human resources offered by Polish and international providers;
- assess the scope of expert knowledge with respect to the business and technology required for the preparation of the site and application for a construction permit;
- assess the scope of expert knowledge with respect to politics and social communication.

After the assessment of needs of the Polish nuclear power sector with respect to human resources, a *Plan of human resources development* will be drawn up by the Minister competent for the economy. The *Plan* should be approved by the end of 2011. In order to implement the *Plan,* activities will be taken to expand the infrastructure with respect to the training of human resources. The solutions will include modification and modernization of the existing infrastructure in vocational schools, secondary schools and universities. In *the Plan,* tasks to be performed and measures to achieve them will be specified. Needs of the administration, government agencies, schools, universities, scientific, research and development base and entrepreneurs will be taken into account in the *Plan*. The *Plan* will specify necessary qualifications and the number of specialists required at each stage of the Program implementation. It will make allowance for possible threats to the achievement of certain indices specified in it and will be consulted with scientists and entrepreneurs.

The program of government sponsored fields of study implemented by the Ministry of Science and Higher Education is one of the instruments that can be used right away. Power engineering represents one of such fields of study. Universities opening Bachelor Degree or Master Degree studies in this field of study may be provided with additional financial support. It is recommended that studies in power engineering are covered by this priority.

Failure to perform the above mentioned activities will pose a serious threat to meeting the deadlines specified in the Program schedule.

Chapter 12. Technology, science and research base of the Polish nuclear power sector

According to IAEA guidelines and experience of countries developing nuclear power, it is very important to ensure that the nuclear supervision authority and government agencies have adequate scientific and research support, with special focus on secure operation of nuclear power facilities.

European and global experience, research and intellectual potential and the above-mentioned IAEA guidelines indicate that the use scientific, research, communication and education capabilities of institutions dealing with nuclear physics and chemistry, will be the most suitable solution for the Program. Consolidation of existing institutes seems to be the ideal solution from the perspective of the Program implementation and co-operation with the government administration. The consolidation will streamline the implementation of the basic task of the scientific and research base: to ensure the best possible and growing nuclear security. Carrying out tasks for the nuclear supervision authority and other government agencies would require the scientific and research base to play the role of a Technical Support Organisation (TSO). Finally, a large scientific and research institution equipped with a research reactor would have better capabilities of carrying out scientific and research work in the area of nuclear security. The institution would be also an interesting partner in international cooperation in this area with EU member states and with other countries.

The final method of transformation of the existing scientific and research base into a new entity will be defined by the team appointed by the Minister of Economy pursuant to Articles 7 and 8 of the act of 30 April 2010 on research institutions (Journal of Laws No. 96, item 618).

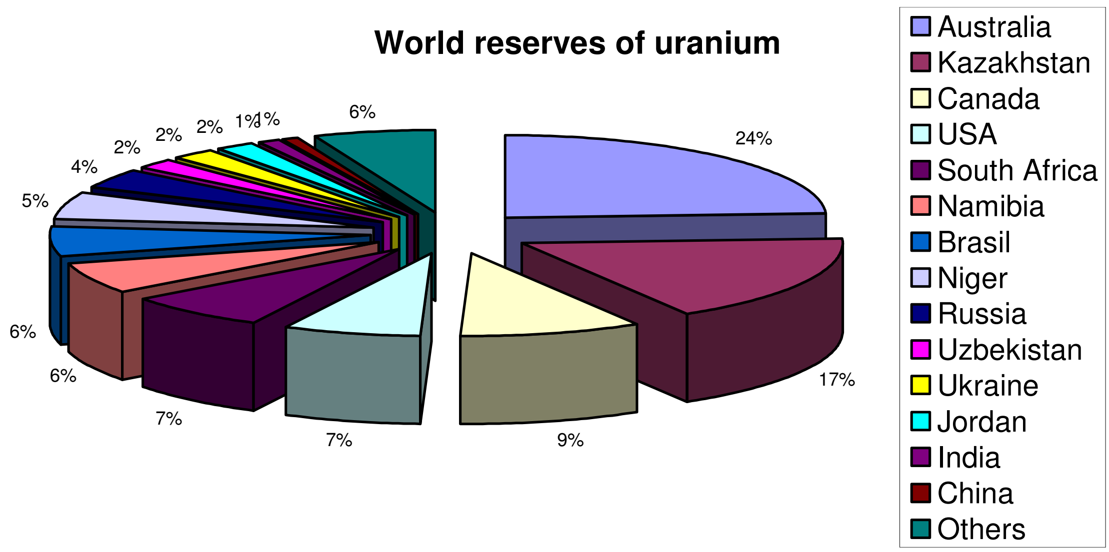
Chapter 13. Security of nuclear fuel supplies

13.1. World uranium market

The only one practical use, in terms of economy, of uranium occurring in nature is the production of nuclear fuel for reactors. Unlike petroleum, it is not suitable to be used for chemical purposes. Moreover, in uranium fuel there is accumulated such a big amount of energy that for one year's operation of a 1,000 MW nuclear power plant, only about 25 tons (640 kilograms of U-235) of nuclear fuel is required. Such an amount of fuel can be easily imported from any country and its reserve can be easily stored for a few years' operation of a power station.Fluctuations of the uranium price do not affect the production costs of electricity in nuclear power plants significantly, due to the low share of the fuel cost in the total cost of energy production. According to the AREVA, the increase of uranium price by 100% causes an increase in the electricity production costs in a NPP by 5%. According to the British government, the influence of an increase of the price of uranium on the electricity costs in a NPP is even smaller (Energy Challenge 2006[2]).
Thanks to that, an operating nuclear plant supplies electricity generated at stable costs, almost independently on the fluctuations of prices on the global uranium market. This helps keep the electricity prices stable which creates favourable conditions for sustainable development.

Deposits of uranium ore are globally dispersed, most of them located in politically stable countries, so the risk of becoming dependent on one source (supplier) is negligible.
Amount of uranium suitable for mining depends mainly on its price on the global market. For many years, the price of uranium had been low causing stagnation in exploration of new deposits. Currently, uranium price has grown which resulted in more intense uranium exploration, while at the same time made it possible for some formerly unprofitable and closed mines to be re-opened and exploited. The phenomenon of an increase in the number of discovered resources should be considered normal. This is typical for all mineral raw materials and uranium is not an exception here. The amount of economically feasible resources is growing with each passing year[3].

Fig. 13.2. World reserves of uranium, according to OECD (Uranium 2005).



[2] HM Government, BERR: Meeting the Energy Challenge, a White Paper on Nuclear Power, January 2008, para 3.23.
[3] http://nuclearinfo.net/Nuclearpower/WebHomeAvailabilityOfUsableUranium.

Progress in uranium ore extraction and purifying technology caused that low-grade and very low-grade uranium mines are now operational and highly profitable, e.g. Rossing (Namibia) mines ore with 0.0276% U_30_8[4].
Moreover, Trekkopje mine, (Namibia) which started operation in 2008, extracts ore with only 0.0126% U_30_8, and despite this, the output of the mine is 16 tons of U_30_8 per day[5], i.e. 5,400 tons per yr, which places it in the top 10 world U mines.

Current technological achievements, such as, e.g. increased burn-up ensures much more efficient use of uranium. At the same time, many reactors use MOX fuel (a mixture of uranium and plutonium oxides reprocessed from spent nuclear fuel, (MOX – mixed oxide) which substantially increases the amount of energy possible to be obtained from every mass unit of uranium. Another option is the U-Th and Pu-Th cycle (thorium is ca. 3 times more abundant in nature than uranium).

In the perspective of subsequent 40-50 years, with the introduction of Fast Breeder Reactors (FBR) currently under development as Ge. IV reactors, it will be possible to use both spent fuel from the reactors being operated today and the depleted uranium (DE) remaining from enrichment (enrichment tails). This will extend the use of nuclear power based on existing conventional resources for thousands of years.

13.2. Uranium reserves in Poland

Identified uranium ore deposits in Poland contain from 250 up to 1,100 ppm[6] of uranium, whereas much profitable very low-grade mines (e.g. Rossing, Namibia) exploit ore of 300 ppm, and even 126 ppm (Trekkopje, Namibia). The uranium deposits mined in Poland in the 1950's contained typically of around 2000 ppm.

Nowadays, the mining of Polish low-grade uranium ore would be unprofitable since much more cheaper uranium can be purchased abroad, but while discussing the strategic aspects, it should be kept in mind that **Poland has its own uranium deposits and it may use them in future.**

A comparative table of the magnitude of Polish identified uranium reserves[7] [8] is shown below.

Table 13.1. ***Reserves are estimated at the depth more than 1,000 metres,*** **according to OECD NEA Red Book, 2008**

Region in Poland	Identified reserves [tons of natural U]	Ore grade [ppm]	Estimated reserves [tons of natural U]
Rajsk (Podlasie Region)	5,320	250	88,850
Peri-Baltic Syncline			10,000
Okrzeszyn (Wałbrzych Coal Basin, the Sudety Mts.)	940	500-1,100	
Grzmiąca at Głuszyca Dolna (the Sudety Mts.)	790	500	
Wambierzyce (the Sudety Mts.)	220	236	2,000

[4] Rossing: Rossing working for Namibia, Report to Stakeholders, 2004.
[5] Turgis Consulting (Pty) Ltd: Report of the Environmental and Social Impact Assessment, Trekkopje Uranium Project, Erongo Region, Draft for Public Review November 2007, Namibia.
[6] 1 ppm = 1 particle per million = 1 gram per ton.
[7] Piestrzyfiski, A., Uranium and thorium in the Kupferschiefer formation, Lower Zechstein, Poland. Mineralium Deposita 25(1990)2, pp. 146-151.
[8] Oszczepalski, S., Blundell, D., 2005, Kupferschiefer Copper Deposits of SW Poland. in: J. Ore Geology Reviews (2005) p. 271.

Although our Polish deposits are low-grade category, some of them (e.g. Wambierzyce, Grzmiąca or Okrzeszyn) have a special advantage: they represent bedded deposits, showing a relatively homogeneous nature, thus can be regularly mined for decades.[9]
Furthermore, uranium can be obtained as a by-product of the process of extraction of other minerals. The largest uranium mine in the world is Olympic Dam in Australia, where uranium is an admixture to copper ore of the content of 0.02% in the ore, i.e. 200 ppm[10]. In Poland, it is also possible to recover uranium which occurs as an admixture to copper beds in the region of Lubin-Sieroszowice. The content of uranium in the ore is there ~ 60 ppm, with the copper content of 2%. Total resources of the ore are 2,400 million tons, with 48 million tons of copper and 144 thousand tons of uranium. This represents an equivalent of ~ 900 GWe-years which could be obtained of these resources in nuclear power plants with an energy input less than 5% of the energy generated in these power plants. **Reduction of radioactivity** in the waste products of copper purification process would be an additional advantage.

The current annual production output in the Lubin-Sieroszowice Basin is ~ 569 thousand tons of Cu, whereas the amount of uranium dumped at tailings dam is ~ 1,700 tons per year. **This would allow 10 nuclear power units, each of 1,000 MWe, to operate for 60 years.**[11]

Due to the lack of reliable and comprehensive studies of uranium in Poland, one of the objectives of the actions specified in *the Action Plan for the years 2009-12,* which is Appendix No 3 to *the Poland's Energy Policy to 2030*, is *the Exploration of uranium resources on the territory of Poland.* At the request of the Ministry of Economy, the Ministry of Environment ordered a proper study. It should be completed by the end of 2010.

The actions focused on the exploration of the size of domestic uranium reserves are to be continued.

13.3 Supply of nuclear fuel for the nuclear power stations planned in Poland

Two thirds of the global uranium supplies come from primary sources, i.e. from mines in Canada, Australia, Kazakhstan and Niger.

The security of nuclear fuel supplies depends on the yellowcake deliveries reliability, access to nuclear fuel cycle services and also on the dependability and reliability of nuclear fuel transport. The rules of uranium supplies for the EU member states are established by the Euratom Treaty. Nuclear materials (ores, source materials and special fissile materials) are made available to the Member States on the principles of equal access to their suppliers and fair treatment of all users – also in matters related to prices. A special body of the European Commission - *EURATOM Supply Agency* (ESA) – has the right of option on nuclear materials produced in the EU and on entering into contracts with suppliers from inside and outside of the Community, and also the right to monitor the uranium market and nuclear fuel cycle services, make recommendations, support users with respect to the contacts with suppliers and build up commercial stocks of uranium. In 2005, the ESA Advisory Committee specified recommendations related to a common policy concerning the security of uranium supplies:

[9] http://www.redbor.pl/artykuly/uran.htm.
[10] BHP Billiton outlines Olympic Dam grand plans WNN, 06 November 2008.
[11] Prasser H.M.:Are the sources of uranium big enough for the nuclear energy industry? In: NUCLEAR ENERGY IN POLAND: Opportunity or necessity? Oct. 20 – 21, 2008, Warszawa, Poland

diversification of the suppliers, maintaining a safe level of its own commercial stocks of uranium and optimal use of the uranium market to increase them - striving to meet the demand for uranium by way of long-standing and long-term contracts and securing the capabilities of fuel cycle facilities the EU. Australia and Canada account for 90 % of imports of uranium for the EU and they meet about a half of the current demand. In case of LEU (Low Enriched Uranium), the imports represent even 70 %. Only Bulgaria, Czech Republic, Romania and Hungary import nuclear fuel from other sources (mainly from Russia). In more distant future, it will be possible to satisfy the demand for uranium from deposits already discovered in Finland, Portugal, Slovakia, Spain, Sweden and Hungary.

Of extreme importance for our energy security is, as mentioned earlier, the possibility of stockpiling nuclear fuel for many years. Commercial stocks of nuclear fuel for several years of NPP operation are technically easy to establish and maintain. It is much more difficult and costly to stockpile any other kind of fuel for ten years or even for one year since the uranium energy value is at least 75,000 times higher than that of other fuels. A 1,000 MWe NPP needs for one year's operation only 25 tons of nuclear fuel which can be transported by one truck. Initially, Poland is not going to manufacture fuel, but it will buy it from one of the world suppliers. The fuel supply contracts will be connected, at the first phase of functioning of our nuclear industry at least, with reactor technology chosen. Supplying the fuel along with specific reactor type for the first 5-10 years of NPP operation is a global practice.

Due to the fact that the fuel market is well developed, the launching of nuclear power in Poland will not pose a risk of being dependent on foreign suppliers. However, Poland will consider building its own fuel cycle facilities in the future.

Chapter 14. Management of radioactive materials at various stages of the fuel cycle

14.1. Management of radioactive waste in the world

In practice, each type of activity connected with the production or use of radioactive isotopes results in generating radioactive waste. Because of their unique nature, radioactive waste needs special care and treatment. This applies to amassment, processing, vitrification, transport, temporary storage and final disposal. Therefore, the number of sources and the volume of waste must be reduced.

Radioactive waste must be adequately processed, vitrified, packaged and then safely disposed of. The main objective of these operations is to secure radioactive waste in such a way that they do not pose a threat to people or environment.

The nuclear fuel cycle consists of a system of industrial operations and technological processes including preparing fuel for nuclear reactors, burning it in a reactor and disposing of the radioactive waste products. The main stages of the nuclear fuel cycle are: mining uranium ore; production of uranium concentrates; conversion of U_3O_8 into UF_6; enrichment with U_{235} isotope; production of fuel material; production of assemblies; burning the fuel in a reactor; storage of the spent fuel; reprocessing; processing and neutralization of radioactive waste; final disposal of radioactive waste. During each front-end fuel cycle operation, from the extraction of uranium ore to the production of fuel assemblies, the radiation is very low. Operations with spent fuel, from unloading it from the reactor to the disposal of radioactive waste products in repositories (fuel cycle back-end), are carried out with high emission of radiation.

There are three types of the nuclear fuel cycle: open, open with processing or closed. In the open nuclear fuel cycle with processing, the spent fuel is reprocessed and the remaining fissile material is recovered. It can be reused to manufacture new fuel assemblies. In the open nuclear fuel cycle, spent fuel is disposed of and the expensive reprocessing is avoided. In the future, as the technological progress goes on, it will be possible to recycle the disposed of spent fuel. The closed nuclear fuel cycle requires a Fast Breeder Reactor (FBR).

Various countries have different policies of spent fuel management. Some of them use the open cycle (e.g. Sweden, Finland) while others use the open cycle with reprocessing (with the closed cycle being planned) – e.g. France and Japan.

The approach to radwaste depends on their type. Low Level Waste (LLW) and Intermediate Level Waste (ILW) are disposed of in repositories (after sorting and compacting etc.) in all countries. Such repositories are located across EU, including Poland.

High Level Waste (HLW) and spent fuel should be disposed of in deep geological repositories. As it has been already said, it is the final phase of the fuel cycle. Direct radiation from radioactive waste disposed of in deep geological repositories poses no risk because just a few metres of soil provide adequate protection from such radiation. HLW will be stored a few hundred meters deep in the ground. Therefore, the only risk is that HLW may be washed out by underground water, dissolved, transported to the surface and consumed be people with radioactively contaminated water. A system of technological barriers is used to eliminate these risks. These barriers prevent spreading of radioactive substances and absorb radiation.

Such deep repositories are only under construction across the world. Sweden and Finland have the most advanced projects in the EU. Delays in building deep geological repositories in the world are caused by low cost of storage of radioactive waste on site in temporary repositories. In addition, if funds allocated for this purpose are not spent more profit can be earned from interests.

14.2. Management of radioactive waste in Poland

The problem of management of radioactive waste arose in Poland in 1958 when the first research nuclear reactor EWA went critical at the Institute of Nuclear Research (INR) in Świerk. Significant progress in isotope technologies and related new applications of radioactive isotopes in various sectors of the country's economy in the early 1960ies resulted in an urgent need to solve the problem of radioactive waste disposal. The problem was addressed when a decision was made to locate a repository in Różan. The repository was commissioned in 1961.

In Poland, the head of an organizational unit where radioactive waste products are generated is responsible for its proper management including temporary storage, accounting and treatment. So far, the Radioactive Waste Management Plant (RWMP), a state owned utility company responsible for proper management of radioactive waste from its collection from the producer, has been the only organisation in Poland authorised for management of radioactive waste.

RWMP collects solid and liquid low and intermediate radioactive waste, spent sealed sources and smoke detectors. About 90% of all liquid LLW comes from MARIA reactor. Liquid Intermediate Level Waste (ILW) is generated during production of radioactive sources and in some cases during decontamination of contaminated areas.

A significant portion of radioactive waste (about 40%) comes from the Świerk Facility, i.e. from the Maria reactor and from the radioactive isotope fabrication plant operated by the Radioisotope Centre of the Institute of Atomic Energy POLATOM. Radioactive waste from reactors include, among the others, filters (from the air and refrigerant purification systems), post-decontamination waste, used up components of devices and reactor equipment. The other 60% come from hospitals, clinics and other institutions using isotope techniques from all over Poland. Radioactive waste generated in the process of using radioactive substances for medical purposes include, first of all: radioactive preparation ampoules and also syringes, cellulose wadding, foil, protective clothing, worn up elements of equipment and decontamination waste.

The amounts of waste collected for treatment in the years 2000-2008 are shown in Table 14.1. As illustrated in the table below, the amount of solid and liquid waste collected is consistently decreasing as new technologies of isotope fabrication are implemented, nuclear equipment is correctly operated and application of radioactive isotopes is reduced.

RWMP is also the operator and user of the National Radioactive Waste Repository - Różan (NRWR - Różan). The NRWR is located in the village of Różan upon Narew, about 90 km North-East from Warsaw. The site is situated within a former fort and occupies the area of 3.045 hectares (7.524 acre). The NRWR has been in operation since 1961 and according to the classification of the International Atomic Energy Agency, is a surface repository. The repository is located in one of a former military forts built by Russian authorities in the years 1905-1908.

The repository is designed for storage of short-lived low and intermediate level waste and for temporary storage of long-lived waste. The waste is stored in concrete fort facilities which are partly covered by soil (facilities No. 1, 2, 3 and 3a) and in a section of the western moat (No. 8).

The layout of facilities at the National Radioactive Waste Repository is shown in Fig. 14.1.

Fig. 14.1. Layout of facilities at the Różan National Radioactive Waste Repository

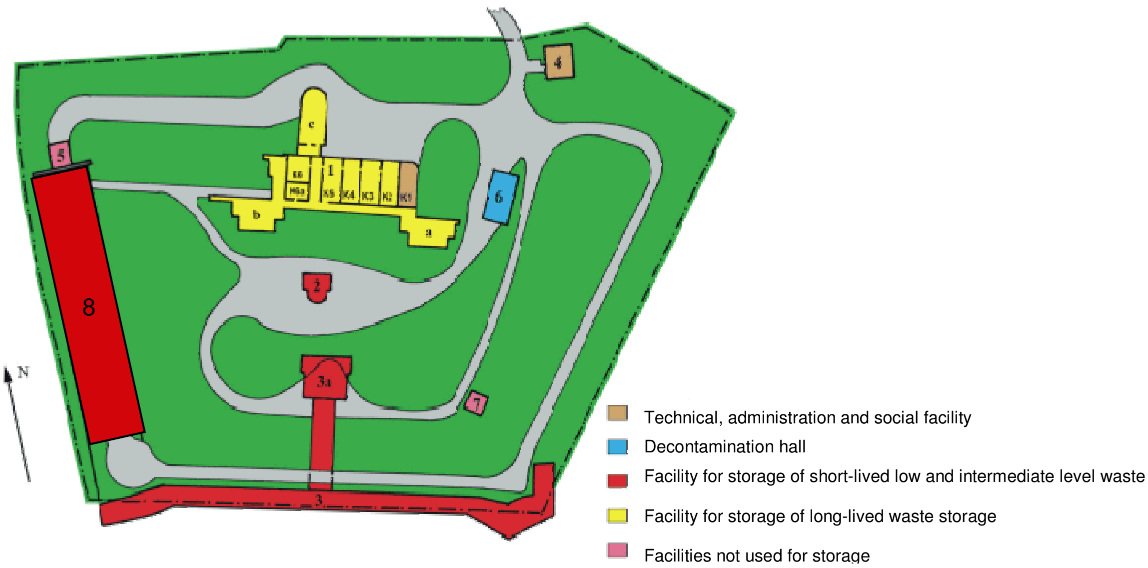


Table 14.1. Amounts of collected waste to be neutralised in the years 2000-2008

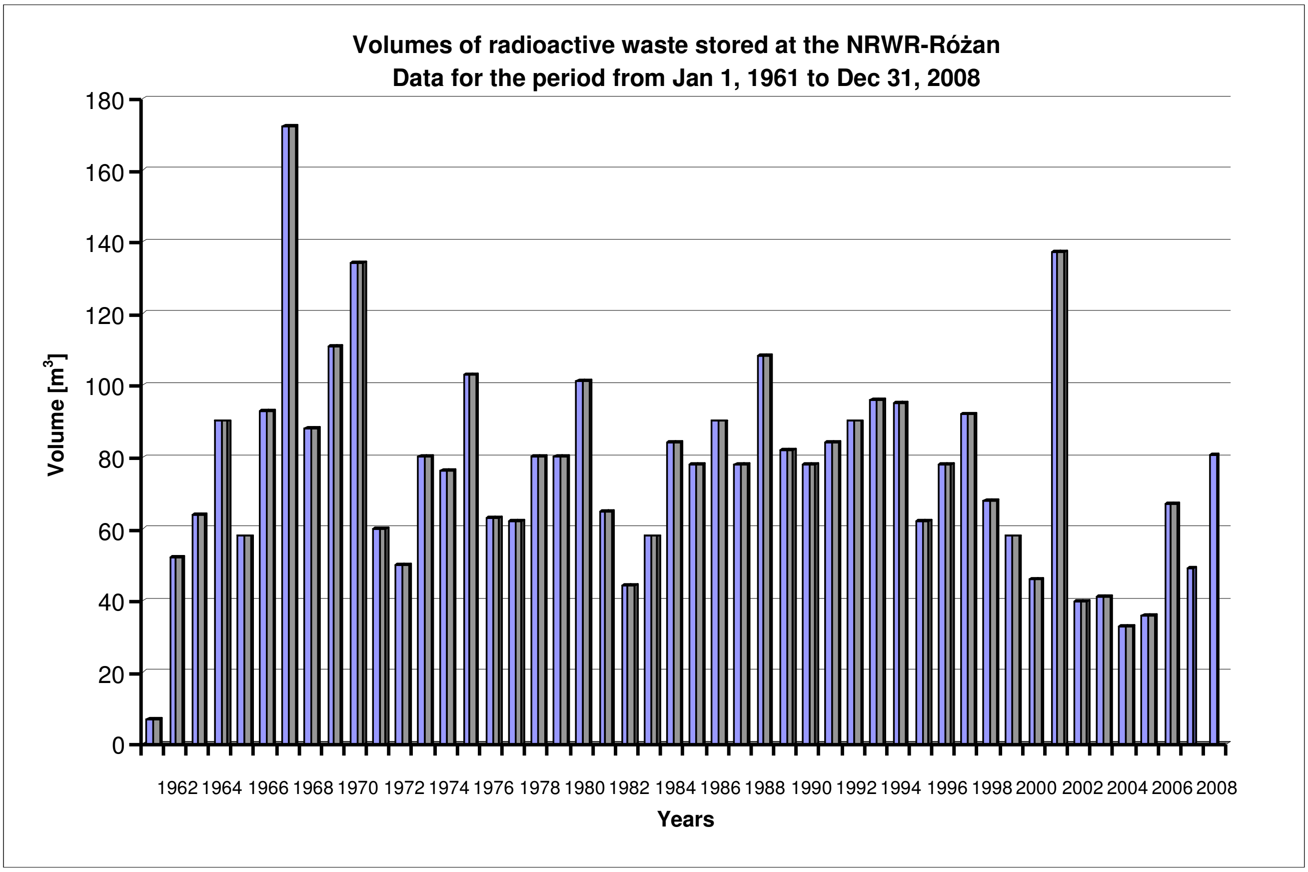
Specification	2000		2001		2002		2003		2004		2005		2006		2007		2008	
	solid	liquid	solid	liquid	solid	liquid	solid	liquid	solid	liquid	solid	liquid	solid	liquid	solid	liquid	solid	liquid
Radioactive waste sources																		
MARIA reactor (m^3)	16.55	265.00	14.60	110.00	8.00	95.00	6.00	30.00	6.00	98.21	5.030	21.00	12.92	152.09	5.50	84.00	6,76	29,00
EWA reactor (m^3)	4.65	-	1.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
POLATOM Radioisotope Centre (m^3)	11.85	0.41	10.75	0.34	7.200	0.26	7.80	0.23	8.03	0.13	8.60	0.02	7.75	0.03	6.20	0.02	-	0,05
RWMP (m^3)	5.89	8.50	76.95	8.00	3.10	4.00	18.95	8.00	7.06	-	2.56	4.00	0.33	0.00	1.51	0	3,35	6,00
Institutions outside the Świerk Centre (medical, industrial, scientific) (m^3)	45.83	1.30	41.98	1.39	29.73	1.59	26.79	145	31.39	2.88	2.13	1.66	21.17	0.6	17.27	0.48	12,68	2,59
Total	***84.76***	***275.20***	***145.48***	***119.73***	***48.03***	***100.85***	***59.54***	***39.68***	***52.48***	***101.22***	***42.32***	***26.68***	***42.17***	***153.08***	***30.48***	***84.50***	***22,79***	***37,64***
Radioactive waste categories																		
LLW (m^3)	63.22	274.81	128.14	119.40	39.77	100.64	47.62	39.66	40.17	28.19	31.26	26.68	41.57	153.08	29.92	84.48	22,38	37,63
ILW (m^3)	-	0.40	-	0.33	-	0.21	1.88	0.02	1.35	73.03	0.65	-	0.60	0.02	0.60	0.02	0,40	0,01
Alfa-emitting (m^3)	3.74	-	1.66	-	5.07	-	2.16	-	0.79	-	1.90	-	2.46	-	0.45	-	0,08	-
smoke detectors (units)	24,367		20,490		10,148		9, 995		12,211		14,101		19, 394		16, 425		25,053	
sealed sources (units)	898		875		1,235		1,195		619		825		1 397		1,508		2675	
Waste collected for storage at the DRWR Różan																		
volume (m^3)	44.87		137.16		40.72		40.99		33.03		36.30		67.95		48.88		73,41	
activity (decay as of Dec. 12 in a given year) (TBq)	1.40		1.57		2.41		1.24		0.52		1.87		1.74		1.37		1,26	

The amount of processed radioactive waste for temporary storage or final disposal is about 45 m³ per year. This amount includes solid and vitrified waste products. The total weight of the waste is 70 tons and the volume is some 80 m³ including 35 m³ of binding materials – mainly concrete. Vitrified waste is transported to the National Radioactive Waste Repository at Różan, the only such facility in Poland.

Unfortunately, according to the estimates made by the Radioactive Waste Management Plant (RWMP), the NRWR-Różan will be completely full as early as about 2020-2022.

The Minister of Economy, by way of the Regulation of 27 August 2009, set up a Team responsible for drafting the *National plan of management of radioactive waste and spent nuclear fuel*. The Team was made up of representatives of government agencies and institutions responsible for the management of radioactive waste and spent fuel. Its basic task, in addition to defining methods of management of radioactive waste coming from different types of activities, is to define the method of management of spent nuclear fuel and guidelines and recommendations on further work in this area (recommendations on using the open cycle or closed cycle with reprocessing in Poland). The Team has already started its work and it commissioned, among others, studies on evaluation of real costs of adopting various methods of the management of radioactive waste and spent fuel. These studies will form a basis for the recommendations on the approach to spent fuel. The recommendations will be issued with consideration of the costs and benefits of the two possible solutions (reprocessing the spent fuel or, ultimately, final disposal of all the spent fuel in deep geological repositories within the territory of Poland).

Fig. 14.2. Volumes of radioactive waste accepted for storage in the years 1961-2008



14.3. Activities in the radioactive waste management in Poland in connection with the development of nuclear power sector

The Plan should be adopted by the Council of Ministers in 2011, after approval of the *Polish Nuclear Power Programme.*

The Team's activities are not directly related to the construction of the deep geological repository of high level radioactive waste and spent fuel. At present, Poland does not face the problem of spent fuel from a research reactor. In 2009, an agreement was signed with the United States of America and the Russian Federation for the permanent removal and shipment of this fuel to Russia (in the frames of GTRI Program). However, as it appears from experience of other countries, the necessity of building such a repository will arise in about **30-40 years** from commissioning the first nuclear power plant, i.e. about 2050 at the earliest. By that time, spent fuel will be stored on-site.

The most urgent task with respect to the radioactive waste management, due to the NRWR-Różan being filled up, is the construction of a new Low Level Waste (LLW) and Intermediate Level Waste (ILW) repository. As regards to the siting process of a LLW and ILW repository, a motion was put forward to the National Fund for Environmental Protection and Water Management to include this project in the Fund's Plan, starting from 2010. A company responsible for the project implementation will be selected in 2010. An analysis of the results of the existing studies will be carried out as a part of the project. Historical geophysical papers for these locations will be re-interpreted. On the basis of the above-mentioned analyses, three optimal locations for a radioactive waste repository will be short-listed. Detailed studies for these locations will finally lead to the selection of one location for a LLW and ILW repository in 2013. After the selection of the site, a design and construction work will be carried out and the new repository should be ready by 2020. It is important to keep this schedule because launching the nuclear power will require an increased scale of activities related to LLW and ILW storage.

Chapter 15. Participation of the domestic industry in the Polish Nuclear Power Program

Engagement of the Polish industry to the greatest possible extent is one of the key concepts of the Polish Nuclear Power Program. Firstly, it means that an adequately prepared technological offer for the participation of the Polish industry must be submit. Secondly, Poland will need companies with adequate human, organisational, technological and quality resources to manufacture products and provide services for the nuclear power sector.

Pre-conditions of the domestic industry involvement

This objective can be achieved only if proper preparatory, training and organisational efforts are taken mainly by Polish enterprises supported by a minister competent for the economy and an investor backed up by a company offering the technology.

A minister competent for the economy will develop an effective system to support the preparations of Polish enterprises for taking part in the construction of a NPF. The minister will be able to evaluate the functioning of the system on the basis of data provided by the investor and Polish enterprises.

Involved enterprises will have to demonstrate high technology competencies and adequate capabilities in terms of human resources, organisation and quality assurance and control to become suppliers of products and services for the nuclear power sector. This can be ensured by an accreditation system providing objective and measurable evaluation of competencies. Accreditation may be granted by individual investors or technology suppliers, or by an accreditation body (e.g. the Polish Centre for Accreditation).

The PNP Program is a program of construction of high-tech nuclear power plants according to statutory or contractual requirements. The design, manufacturing, assembly and maintenance works performed in the framework of a nuclear power plant project must meet requirements provided for in international (IAEA) and domestic regulations, as well as the requirements of the investor. All these requirements are categorised depending on the safety level of both the nuclear power plant itself and components, products, equipment or services considered to be used in the construction. The safety requirements have been specified, for example, in the following documents and standards:

- ISO 9001:2008 – Quality management;
- IAEA GS-R-3:2006 – IAEA Safety Standards: The Management System for Facilities and Activities;
- ASME NQA-1-2008 – Quality Assurance Requirements for Nuclear Facility Applications;
- RCCM A5000-2008 – Quality Assurance Principles.

Domestic subcontractors will be also required to observe detailed rules of occupational and health safety, as specified for example in OHSAS 18001, and of environmental protection – for example according to ISO 14001.

Activities aimed at involving the Polish industry

a) Evaluation of needs

The investor and/or its vendor will draw up a list of products and services that can be commissioned from domestic companies. The list will be based on the knowledge of the objective environment and local conditions (location, weather conditions, geology, subcontractor competencies, etc.).
Orders placed with domestic companies will not be limited to technical areas. They may also include legal, regulatory, organizational, design, transport and logistic services, etc.

b) Evaluation of the potential of the domestic industry and service providers

The investor or its vendor will announce the above mentioned list of products and services that can be commissioned from domestic companies in order to get domestic enterprises' declarations of their participation in the construction of a NPF. Then, they will verify the submitted applications for the technology, competence and organizational level of the companies. The next step will be an analysis of the enterprises that have shown their interest in the project in order to determine their manufacturing or service potential. Companies with adequate capabilities will be able to start the process of obtaining accreditation through introducing necessary changes in their organization, implementation of quality control systems, acquiring new technologies, increasing their manufacturing potential, reducing prime costs, etc. The analysis should also indicate the costs of the changes which are necessary to be implemented.

c) Accreditation

Companies interested in the project, upon completion of the adaptation process, will receive accreditation from the investor. The scope of the accreditation will depend on the implemented adaptation process and the proposed area of the company's involvement. The accreditation will be valid for a defined period of time. Cascaded accreditation is also possible: the contractor authorises its key subcontractor (an accredited company) to accredit other sub-suppliers. The investor may also choose one domestic partner that will be authorised to select its subcontractors. Observing the most severe rules of safety is the key principle of accreditation. This is why obtaining accreditation, e.g. for the production of components to be installed within the nuclear part of a power plant *("the nuclear island")* is a difficult, time-consuming and expensive process.

d) Final analysis

A complete collection of data concerning the needs and domestic enterprises constitutes a basis for the final analysis of the possibilities of engaging domestic industry in the PNP Program. The analysis will provide the investor with the following information:

- List of companies interested in the Program capable of providing the required quality of products and services;
- Schedule of accreditation activities related to employing specific suppliers of products and services;
- Guidelines for hiring selected domestic manufacturers and service providers.

In order to provide a valid evaluation of the scope of involvement of the Polish industry in individual nuclear technologies, an index of the Polish industry involvement would be useful. The index should quantitatively describe the level of the involvement of domestic sub-suppliers. The index could be based on the total number of orders, employment, development of company competencies and employee skills, possibility of hiring these companies for future nuclear projects, and the share of the state-owned enterprises. Therefore, the possibilities of involvement of companies bidding in public procurement procedures should also be analysed.

Benefits resulting from the participation of the Polish industry

Positive outcomes in macro-scale can be expected in industries engaged in the nuclear power sector projects. The involvement of Polish companies in a nuclear power facility (NPF) project to the maximum possible extent should have a positive effect on the Polish economy and industry. The Polish economy will benefit mainly from increased employment related to the construction of a NPF. The size of the growth will depend on the size of the nuclear power program itself. For each nuclear power plant, sub-suppliers will employ thousands of Polish employees directly or indirectly involved in implementation of the investment project. More jobs means increased revenue from (direct and indirect) taxes, growth of supply and demand and other related positive effects.

Enhanced competencies of companies will help them to make successful bids on international nuclear power projects and will make it easier for them to win contracts from the nuclear power industry and from other sectors.

In addition to advantages in terms of technology, organisation and competency, enterprises involved in the construction of a NPF will also be better equipped to partner with similar enterprises offering required competencies or technologies by establishing *joint ventures* or similar equity or organizational links. It would help the Polish industry to integrate with the international nuclear power industry. Such partnerships and relationships would be important not only for the construction of nuclear power plants, but also in other areas including for example the nuclear fuel cycle or radioactive waste management. The latter is especially interesting for Poland in view of the necessary construction of a new LLW and ILW repository in Poland by 2020.

Generally, it may be ascertained that business activities of Polish enterprises associated with the construction of a NPF should create an added value directly fuelling the GDP growth. It will be taken into consideration in the forecasts of Poland’s economic growth prepared by the minister competent for the economy in co-operation with the World Bank.

Chapter 16. Public consultations and communication

The support of the public for nuclear power is one of the most important preconditions of the implementation of the Nuclear Power Program (NPP). Experience of Western Europe countries and the United States proves that a steady and informed support (or at least acceptance) from the majority of the public is a necessary pre-condition of the implementation of nuclear power without using the topic as an argument in political debates. However, a broad political agreement during the preparation and implementation of the NPP Program as well as adequate regulations in this area are required.

16.1. Current status

At present, 40-50% of the Polish society supports nuclear power, according to different surveys. However, it should be pointed out that the support is unsteady and to a large extent not based on public awareness of the nuclear power option. This is illustrated by results of surveys conducted by different organisations (including the National Atomic Energy Agency) carried out to research the level of knowledge and self-assessment of the respondents' awareness. Poles know very little about nuclear power but at the same time they are aware of their ignorance. It is a positive fact since it means that people are open to information, education and dialogue. The low level of knowledge among the Polish society about nuclear power has its source in over 20 years of educational negligence.

16.2. Required activities

In order to build the public awareness of the nuclear energy option (including nuclear power) it is necessary to carry-out continuous education and information activities. Both types of activities should be aligned, coordinated and pursued simultaneously. The responsibility for education activities should be distributed between departments (ministries) responsible for education, training and promoting science co-operating with the Minister of Economy who will work together with the Nuclear Power Agency. The education activities should be also pursued by other government agencies that will be appointed for these tasks by an institution responsible for the implementation of the Program. The education activities should be started from the lowest levels of the education system – at least from primary schools. They should be also supported by the investor(s), both as a part of their CSR (Corporate Social Responsibility) policy and liaison with institutions responsible for training staffs for the nuclear power industry.

A detailed specification of the educational activities will be provided in the *Human Resources Development Plan* discussed in Chapter 11.

The second component is represented by information activities including a dialogue with stakeholders. The Minister of Economy supported by the NPA (and by investors on the local level) will be responsible for the information activities. These activities must be carried-out on two levels:

- national
- local – at possible and approved locations of nuclear power facilities.

The dialogue (bidirectional flow of information) must be based, first of all, on the feedback from the stakeholders (i.e. communities, opinion leaders, etc.). The organisation responsible for information activities must use the feedback to prepare further communication. Tools that are easily accessible for the public – for example the Internet – should be used to collect the feedback.

Both the education and information activities should be funded by the government. However, organisations carrying out individual activities should, in co-operation with the Minister of Economy, search for alternative, additional source of financing, including especially the EU funds, to relieve the burden from the state budget while maintaining the continuity of information and education operations and ensure their effectiveness.

Some education and information activities on the local level should be co-financed by the investors because of the importance of these activities for building the acceptance among local communities for investments in the nuclear power.

16.3 Proposed activities

16.3.1. Information campaign

In the process of the creation and operation of the nuclear power industry, the key issues will include: social communication, information and education activities and involvement of the public in making decisions about matters related to the nuclear power option. They will be addressed according to the *Act on nuclear power industry* and *Act on provision of information about the environment and its protection, on participation of the society in environmental protection activities and on assessment of the environmental impacts*.

In the Act on nuclear power industry, the responsibilities of the Nuclear Power Agency, the operator and investor (project owner) of a Nuclear Power Facility (NPF), will be established with respect to collection, publication and provision of data and information about the nuclear power. The Act will also define methodologies of information activities and govern issues related to a referendum on the construction of a NPF and the scope of educational responsibilities, including social education. Responsibilities of the National Atomic Energy Agency (NAEA) (later CNSRP) in this respect are defined in the Atomic Energy Law.

The society will be entitled to obtain information on the functioning of nuclear power industry. All information will be made available, provided it is not information legally protected pursuant to the applicable regulations on information security, information covered by intellectual property laws, information considered as sensitive information by the Investor/Operator of a NPF, information about the physical protection and security of nuclear materials as well as information that cannot be disclosed without a risk for public safety. The Nuclear Power Agency (NPA) will be obliged to protect the data and information received by the Investor/Operator of a NPF from access by unauthorised persons and entities.

The Nuclear Power Agency (NPA) will be obliged to collect data and information on the nuclear power in Poland and in the world, process and publish them as well as to make them available to interested natural and legal persons. The scope of the data and information to be collected by the NPA will depend on the demand for them.

Each investor and operator of a nuclear power facility (NPF) will be obliged to pass to the NPA adequate amount of reliable data and information on the NPF free of charge and on a regular basis. Also, the national nuclear regulator will have to immediately provide the NPA with the information made available and published by it, so that they can be processed, made available and published.

The NPA will process the received data. Depending on the degree of their importance, it will publish some of the data and information, on its websites and in the NPA's newsletter or make them available at the Agency head office and at Local Information Centres.

A Local Information Centre (LIC) will have an important role to play in the social communication on the local level. Each investor will be obliged to set up a LIC located within the municipality with jurisdiction over the site of a Nuclear Power Facility (NPF). The investor will have to establish a LIC not later than on the day of obtaining the decision on approval of the NPF location and operate it until decommissioning of the NPF.

A LIC will be an enquiry desk and a centre where the NPF investor and operator will carry out their local information, education and promotion strategy with respect to the nuclear power. The NPA and the national nuclear regulator will be able to execute their tasks related to the provision of information and data and education activities through a LIC.

The tasks of an investor/operator running a LIC will include: publishing current information on the NPF operations; publishing information on the current status of nuclear safety and radiological protection around the NPF; liaison with the Nuclear Power Agency (NPA) with respect to the dissemination of solid knowledge about the nuclear power in the Poland and in the world; and working together with the national nuclear regulator with respect to making information and data on nuclear safety and radiological protection available and to social education in this area. The information will by published by LIC in an electronic form, at least on its website, and in the printed form, as a local newsletter.

The Municipality Council competent locally for a NPF location, at the request of the local community, has the right to establish a Local Committee for Information (LCI) that will play a role of a link between the local community and the investor/operator of a NPF. A representative of the municipal authorities and representatives of the local community will be members of the committee. A LCI will be responsible for the social monitoring of the NPF operation and representing the local community in contacts with representatives of the NPF. A LCI will have the right to enter the premises of the NPF, view the NPF's documents (except for the documents containing legally protected confidential and sensitive information, including documents concerning the physical protection and security of nuclear materials), appoint external experts and ask the investor/operator of the NPF for explanations about issues, in which the committee may be reasonably interested.

The Municipality Council on the territory of which a NPF is planned to be built or operated will have its right to set up a Municipal Information Centre (MIC) responsible for the implementation of the Municipality's information, educational and promotional strategy with respect to the nuclear power. Detailed tasks and the operation model of a MIC will be defined by the Municipal Council. The Nuclear Power Agency (NPA) and the Local Information Centre (LIC) will be obliged to make the data and information as specified in the Act on Nuclear Power available to the MIC.

Public consultations will be conducted exclusively with respect to obligating decisions. Therefore, there will be no consultations about a decision on the approval of a NPF site. However, with respect to a decision on the site of a NPF, the investor, in the framework of

public consultations, will have the right to organise additional consultations apart from those provided in the *Act on provision of information about the environment and its protection, on participation of the society in environmental protection activities and on assessment of the environmental impacts*.
However, the consultations will have to meet the following conditions:
1. Equal access of all interested natural and legal persons to this form of consultation is ensured;
2. All interested natural and legal persons are provided with the possibility to express their views;
3. The investor's and the province governor's rights to take a stance on the statements of the participants of the consultations is guaranteed;
4. A report recapitulating the questions and motions from natural and legal persons and replies of representatives of the investor, the province governor (*voivode*) and other bodies invited to take part in the consultations must be drawn up. The report will be enclosed with the application for a decision on approval of the NPF site.

A referendum among the local community on a NPF or a complex of a NPF planned to be built in a given location will be one of the important elements of a local public information campaign. The referenda will be held according to applicable provisions of the *Act* of 15 September 2000 *on a local referendum*. The referendum should be carried out by the authorities of the municipality locally competent for the planned NPF, at the request of the investor, before the investor submits an application for a general decision on the NPF site. The referendum on the construction of a NPF should be preceded by information campaigns carried out by the investor and other stakeholders. The decision in a referendum will be made by a simple majority votes and is valid irrespective of the attendance.

16.3.2. Education campaign

The recent surveys of the society have shown that the public knowledge of matters related to nuclear power, ionizing radiation and nuclear physics is very limited. This is why a continuous education campaign is necessary. Its purpose is to raise the level of knowledge about nuclear power among the public to ensure that decisions expressed about nuclear power – whether positive or negative – are based on relevant information rather than on myths and false beliefs, and that they are immune to populist, ideological or irrational arguments.

Teaching physics and nuclear power engineering and integrating these matters in school curricula at educational institutions in Poland should be a fundamental initiative. Moreover, the national nuclear regulator will educate the society as a whole in the nuclear safety and radiological protection, according to the ***Atomic Energy Law***, and the Nuclear Power Agency (NPA), in co-operation with the investor/operator, will educate in the nuclear power industry. The educational offer designed for primary, junior and senior secondary schools will be an important component of the education campaign carried out at Local Information Centres (LICs). The educational offer will include activities designed for schools as well as exhibitions and interactive presentations. In addition to the educational activities of LICs, also the NPA and the national nuclear regulator will carry out educational activities with the use of all available forms of communication (the Internet, television, radio, daily press, magazines and industry journals).

The educational activities carried out by the NPA and the national nuclear regulator will be financed from their respective budgets. The NPA will work together with the Minister of

National Education with respect to the education of primary and secondary school students in nuclear power. The NPA will also disseminate knowledge of nuclear power among university students, in cooperation with the Ministry of Science and Higher Education.

16.4. Drafting the information campaign

In the framework of its *Framework Time Schedule for Nuclear Power Activities,* the Ministry of Economy commissioned drafting a project of information and education campaign aimed at *presenting the society with valid and reliable information about the nuclear power industry and raising the knowledge of the subject among the public through education activities.*

According to the Schedule, the information and education activity (Stage One, Activity 6) should start by 31.12.2010. Some initiatives within the activity were started in May 2009. It is interesting to note that the information and education activities had already been carried out earlier independently by the National Atomic Energy Agency (NAEA) (information brochures on the radiological protection; "scientific picnic" events), by scientific and research institutes (Institute for Nuclear Studies, Institute of Atomic Energy POLATOM, Institute of Nuclear Chemistry and Technology – a series of education initiatives and activities on the Internet) and universities (conferences, symposia).

Information and education activities will be continued beyond 2020. As it is not possible to plan specific activities in a detailed way with such a long perspective, the plan of the campaign drawn up for the Ministry of Economy covers the first phase of the campaign till 2012.

The complete information campaign draft was consulted with experts who have knowledge and experience in the public communication and education, and with the most important circles invited to participate in the campaign. During these consultations, numerous changes were implemented, many new proposals of activities were added and the content of the campaign was significantly extended. The campaign is designed in such a way that it is possible to modify and adapt it to changing conditions on ongoing basis. However its main objectives will remain unchanged until the end of the first phase of the campaign.

The segmentation of the target groups is based on the results of the surveys conducted in the past 3 years. Specific groups have been determined within the society, including, opinion-leader circles, municipal authorities and young people.

The most important groups covered by the campaign have been defined according to their level of approval (or lack of approval) of nuclear power.

Communication objectives have been specified, both on the national and regional levels. The forms and contents of communication planned for the regional level slightly differs from what have been prepared for the nation-wide campaign. Inhabitants of municipalities, districts and provinces interested in the construction of a nuclear power station in their area will expect information concerning any impact of nuclear power plants on their most immediate environment – in terms of safety and environment protection and the effects on the economy of the region.

As a part of the educational activities, education in nuclear power is planned to be introduced to school curricula with attractive teaching methods. Establishing an association of teachers interested in spreading the knowledge about nuclear power is planned as one of the initiatives to help the teachers who have taken up such education efforts independently and without adequate support.

Activities on the local level and active partnership with the Ministry of Economy and media are planned in the framework of the campaign.

Internet initiatives will also be extended. Dedicated websites will be launched to provide both basic information about nuclear power and more detailed information for those who have deeper interest in the subject. Online discussions will be held with dedicated Interned forums.

A particular emphasis in the campaign will be placed on a debate. The decision about launching the Program of Nuclear Power can be made only if the public gets complete and reliable information about the nuclear power. Public debates will be held all over Poland, and the most important of them should be transmitted in media – so that everyone could know the reasons of the supporters and the opponents of the peaceful use of atomic energy, as well as the responses to these reasons. A similar strategy has been successfully used and approved by the public in Western Europe countries (UK, France) and in United States. In addition a debate planned to last for several days will be held to ultimately resolve any doubts about the reasons to build nuclear power plants in Poland.

The information and education campaign will provide answers to the fundamental questions asked about the nuclear power:

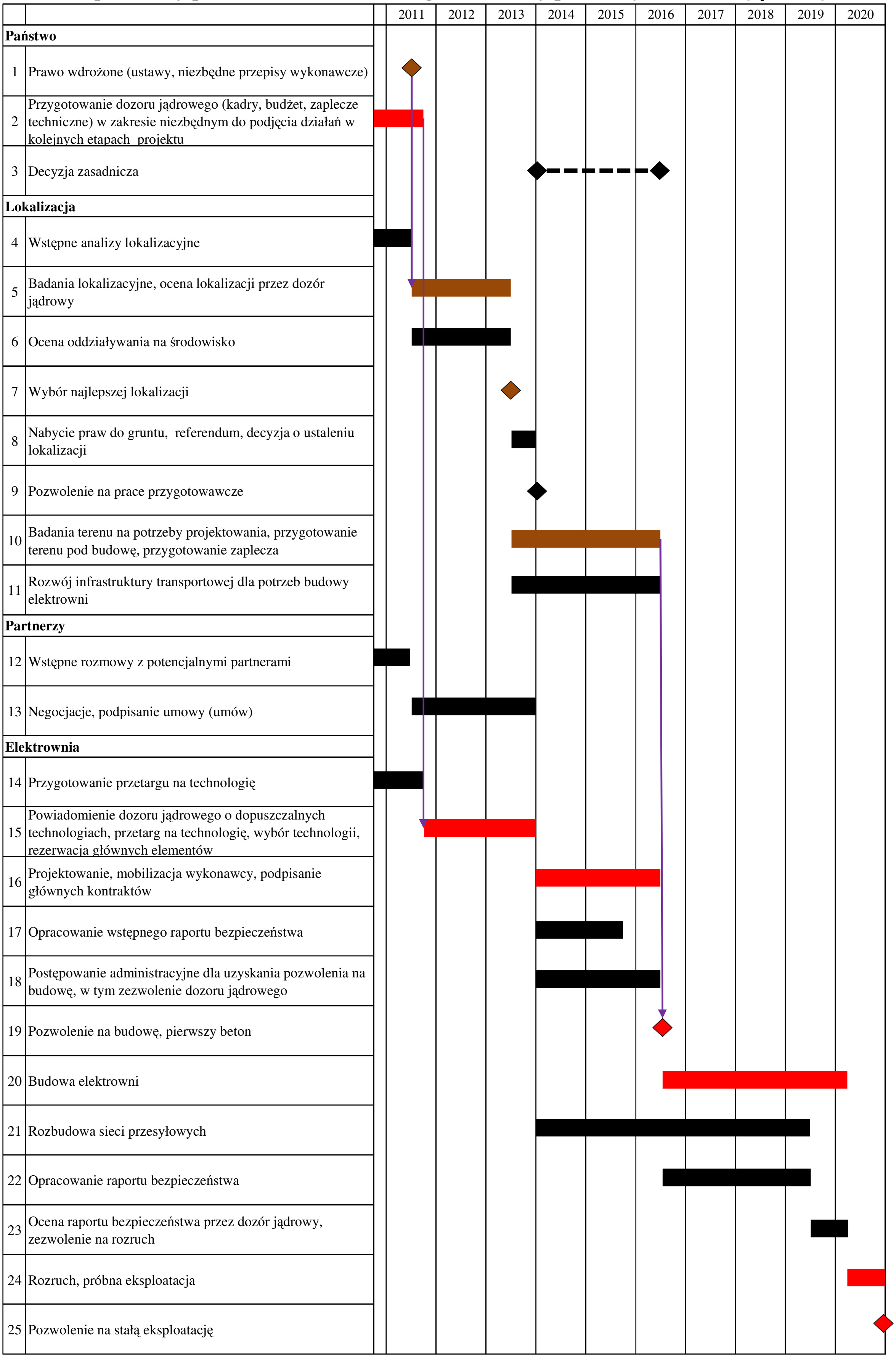
- Is the operation of nuclear power plants safe? Would an accident like the one in Chernobyl be possible in a Polish nuclear power plant?
- Are nuclear power plants competitive in terms of economy in comparison with other sources of electricity?
- Are renewable sources of energy an alternative to nuclear power plants?
- Is radioactive waste a problem and what can be done about it? What is going to happen to a decommissioned nuclear power plant?
- Could imports of nuclear fuel make Poland economically dependent on other countries? Can Poland use its own uranium reserves?
- What is the position of other governments on nuclear power and what is the European Union position to this matter?

Financial resources for the information campaign have been allocated in the state budget for 2010 and planned in the budgets for the years 2011 – 2012.

According to results of the tender procedure carried out under the *Act* of 29 January 2004 *on public procurement*, the information campaign should commence in Q4 of 2010 and is expected to be continued till the end of 2012. Then, the campaign outcomes will be summed up and lessons learned from the first stage will be used to continue the campaign beyond 2012.

Appendix 1

Proponowany przez Inwestora harmonogram budowy pierwszej elektrowni jądrowej



SCHEDULE DESCRIPTION

The entry into force of the bills and executive regulations related to the nuclear energy sector (**item 1**) is of key importance for launching operation of the nuclear supervision authority (**item 2**) and for taking capital-consuming activities by the project owner.

From the project owner's perspective, a nuclear supervision authority is operational when the competent authority equipped with a relevant budget, as well as sufficient and experienced staff has initiated its operations. It has been assumed in the schedule that the nuclear supervision authority will start its activities immediately after the relevant regulations enter into force, which means that the work aimed at establishing the authority has to be carried out in advance.

Until the legal regulations are passed and operation of the nuclear supervision authority is operational, the project owner will be only capable of carrying out the less costly preparations for the construction of the nuclear plant: preliminary location-related work (**item 4**), preliminary negotiations with the potential business partners (**item 12**) and preparation of the tender for the technologies to be applied (**item 14**).

Once the legislation has been passed, at the initial stage, it will be of particular importance for the project owner to have regulations in place on the principles of certification of the (first) power plants, as well as regulations related to the selection of the location.

Effective legal regulations will form a base for selecting a partner, holding relevant negotiations and signing an agreement (**item 13**), as well as for initiating location research (**item 5**). Commencement of the operation of the nuclear supervision authority will enable the launch of the tender procedure (**item 15**) and evaluation of the location research results (**item 5**) from the point of view of the nuclear supervision authority.

The tender will end with signing a contract (contracts) with the technology supplier and the general contractor. Prior to that, detailed location research will be performed for the two or three most promising locations (**item 5**), and an environmental impact assessment for the construction site and for the power plant operation will be performed for these locations (**item 6**). Finally, the target location will be selected (**item 7**). Once the location has been chosen, detailed land surveying will begin for the purposes of the power plant design (**item 10**), and once the rights to the site have been acquired and a permit for preparatory work has been obtained (**items 8 and 9**) (it is assumed that the local referendum on the construction of the power plant will bring about positive results) preparations will be commenced (cutting down trees, land levelling, drainage, reinforcement, relocation of infrastructure systems) and construction back-up facilities will be started.

Selection of the target location will allow commencing work related to the preparation of the transportation infrastructure: construction of roads and railways for transporting oversized and excessive weight loads, along with necessary flyovers, bridges (or by-passes), ports, etc. (**item 11**).

Tender procedures are time-consuming. They will be completed at the turn of 2013 and 2014 (**item 15**). Therefore, some slots in the production schedules at various manufacturers will be reserved prior to the conclusion of the tender (it is not ruled out that production slots for the same plant's major elements will be reserved with several manufacturers). The design work, signing of engineering, supply and construction contract(s), mobilisation of the contractor's (contractors') resources (**item 16**), drawing up and evaluation of the preliminary safety report – power plant design licensing (**item 17 and 18**) and the administrative proceedings required to obtain the construction permit will be completed by mid-2016 (**item 19**).

The construction of the power plant will take 45 months (**item 20**). During the construction stage it will be necessary to obtain commissioning and test run permits, upon submission of the safety report and its approval by the nuclear supervision authority (**items 22, 23, 24**). Positive results of commissioning try-outs and test runs (**item 24**) will allow commencement of normal operation, subject to obtaining the relevant permit (**item 25**).

During the construction stage the highest voltage transfer grid will be modernised and expanded (**item 21**). At the same time a transfer contract will be signed by the power plant operator and the transfer system operator.

The primary decision, expressing the approval of the government agencies for the construction and operation of the nuclear power plant, will be issued no sooner than upon prior selection of the final location, operational technology and the investment partner, and no later than prior to the issuance of the construction permit. Therefore, in line with the suggested schedule, the general decision should be made between the beginning of 2014 and mid-2016 (**item 3**).

The graph does not provide for training the power plant's staff, as the process is of a continuous nature and will commence once the technology has been chosen and will continue until the facility is decommissioned. Its milestones will include obtaining, by the future operators, licenses for operating the facility. The licenses will be issued by the nuclear supervision authority. The first licenses will be issued as early as during the construction stage, so that the future operators may fully participate in the loading of fuel, commissioning and test runs.

KEY FINDINGS AND RISKS

<u>The project owner will be able to reach its highest activity level once the regulations providing for the issues of primary importance for the development of the nuclear power sector have been passed</u> in the form of relevant bills and executive regulations. Delays in passing such regulations will result in the postponement of the entire time schedule.

<u>For the plant to be launched in 2020, the nuclear supervision authority should commence its operation immediately after the law has been passed (mid-2011),</u> so that it is able to assume a standpoint concerning the project owner's proposals related to the potential locations and standard nuclear power plant construction designs accepted for the tender procedure. Any delays will pose a risk for the power plant construction completion deadline and may result in financial losses incurred by the project owner.

In order for the construction schedule to be met, it is necessary that the project owner conducts the relevant preparatory work (construction of back-up facilities, drainage, relocation of the infrastructure, cutting down trees, land levelling, replacement/hardening of soil) and expands the transportation infrastructure in the power plant's vicinity <u>prior to obtaining the construction permit. It means that there is a considerable risk of significant expenses if the construction permit is not granted</u>. If the aforementioned work were to be performed upon obtaining the construction permit, the entire schedule would be postponed by approximately 2.5 years.

The schedule presented herein indicates that technologies with short construction lead times should be preferred in the terms of reference. This solution provides a greater freedom in terms of the following:

- time required for site preparation work,
- time required for drawing up and evaluating, by the nuclear supervision authority, of the preliminary safety report, and thus the time at which the nuclear supervision authority is ready to license the suggested solutions,
- time required for the appointed contractor to mobilise its resources and conduct more in-depth preparations for construction of the nuclear power plant,
- time required for making the primary decision with the government's approval for the construction of the nuclear power plant.

COMMENTS TO THE SCHEDULE

It is assumed that the three stage approach to the nuclear power regulation process will consist in obtaining (i) the location decision, (ii) the construction permit and (iii) the commissioning / test run / operation licence for the power plant, all issued as separate administrative decisions. <u>If the US model is adopted – with a single, integrated permit for the construction and operation of the nuclear power plant – the project could not be launched before 2020.</u> In order to issue an integrated permit it would be necessary to submit, to the nuclear supervision agency, a detailed design of the power plant, along with a full description of the organisational aspect of the facility construction process for certification. This would mean that the preparation stage would be extended by a few years and no other activities could be performed in parallel. As Poland lacks hands-on experience in constructing nuclear power plants, and due to the fact that the nuclear power sector regulations are in the making, adoption of the US certification model would result in a number of risks on the part of the project owner, co-financing institutions, and the nuclear supervision authority as well. Therefore, the traditional approach with separate construction and operating permits is fully justified.

<u>The location decision may be obtained only based on an environmental impact report and following a consultation process performed on the national and international level</u>. It takes usually approximately two years to draw up and consult the environmental impact report. The process should be completed by mid-2013. Once the location decision has been issued, the project owner will be able to apply for the power grid connection conditions. Only after the application is submitted, the transfer system operator will be able to include the nuclear project into its development plans. It is important to apply for such power grid connection conditions as early as practicable in order to avoid a problem with "blocked" transfer capacities "reserved" for other projects (e.g. wind farms).

<u>The final location decision should be issued in the end of 2013 at the latest.</u> This means that the administration bodies have six months to issue the location decision.

Preparation of the site (cutting down trees, levelling, drainage, construction of back up facilities, etc.) and the primary construction work should be subject to two separate permits. Both of them should be issued by the province governor. Adhering to the current practice consisting in commencing preparatory work only upon the construction permit has been granted would result in delaying the entire project by approximately 2.5 years. The final permit for constructing the major facilities related to the nuclear part of the plant must be issued by mid-2016 at the latest. Components of the power plant with long construction lead times, such as the reactor tank, for instance, should be ordered well ahead of this deadline, however.

For the nuclear supervision authority to be able to approve the power plant construction (which is required for issuing the construction permit) in due time, the technology assessment process needs to be shortened. This may be achieved, without compromising the nuclear safety, by applying a two-stage process. As the first step, the Polish nuclear supervision authority would certify the standard nuclear power plant solutions based on the result reviews that have been already performed by other countries' nuclear authorities. As the second step, the Polish nuclear supervision authority would only review the modifications to the power plant's design specific for the conditions at the site. Such a procedure should not last longer than 2.5 years. A full power plant design review carried out by the Polish nuclear supervision authorities, prior to issuing the construction permit, would take considerably longer, thus delaying the entire project.

The suggested first nuclear power plant construction schedule is quite challenging. It is assumed that the partner and the technology will be chosen within 2.5 years, preparation for the construction stage will be completed within 2.5 subsequent years and the construction (until the facility is commissioned for commercial use) will last another 4.5 years; it means the total of 9.5 years from passing the relevant legal regulations.

Appendix 2

Information

on the Team for the Polish Nuclear Power Sector and the Social Team of Advisors at the Government Commissioner for Nuclear Power

The Team for the Polish Nuclear Power Sector was appointed under *Disposition No. 70 of the Chairman of the Council of Ministers of 9 September 2009 on establishing a Team for the Polish Nuclear Power Sector.* Its tasks include, in particular, the following:

- propose motions related to the share of the nuclear power sector in the national power engineering system;
- carry out analyses of the regulations in force and formulate opinions with respect to the adaptation of the law to the requirements and needs resulting from the nuclear power implementation;
- propose solutions related to the organization of the construction and operation of nuclear power facilities;
- present opinions, findings and proposals related to the strategic technical and technological aspects of nuclear power, including the nuclear fuel cycle.

The Team is made up of the following: the Government Commissioner for Nuclear Power, the Chief Adviser to the Prime Minister for energy security, representatives of the Office of Competition and Consumer Protection, the National Atomic Energy Agency, the Energy Regulatory Office and the Ministry of Infrastructure, the Ministry of Finance, the Ministry of Health, the Ministry of Foreign Affairs, the Ministry of State Treasury, the Ministry of Environment, the Ministry of Science and Higher Education, the Ministry of Education, the Ministry of Interior and Administration, and the Ministry of Economy. The regulation was amended recently to include also the Chairman of the Internal Security Agency and the Chairman of the Office of Technical Supervision in the Team.

The Chairman of the Team shall submit, by 31 March of each year, an Annual Report to the Prime Minister (the 2009 Report is enclosed).

The Social Team of Advisors at the Government Commissioner for Nuclear Power was appointed pursuant to *the Disposition of the Minister of Economy of 21 July 2009 on the establishment of the Social Team of Advisors at the Government Commissioner for Nuclear Power.* The Team is composed of:

- Prof. **Janusz Lewandowski,** PhD, Eng**.** – Chairman of the Team, professor of the Warsaw University of Technology, expert in power engineering, Director of the Institute of Thermal Technology;
- **Artur Bartoszewicz** - European fund expert at "Lewiatan", the Polish Confederation of Private Employers, member of Operational Program Monitoring Committees in the years 2004-2006, member of working groups at the Ministry of Economy and Labour and the Ministry of Regional Development; involved in the process of consulting the new programming period for the years 2007-2013, advisor in the process of acquisition, management and settlement of co-financing by the European Social Fund and the European Regional Development Fund;

- Prof. **Andrzej Chmielewski,** PhD, Eng**.** – Director of the Institute of Nuclear Chemistry and Technology, Chairman of the Atomic Energy Council at the President of the National Atomic Agency;
- Prof. **Antoni Dmowski** PhD, Eng. **–** Warsaw University of Technology, Head of the Power Station and Electrical Power Engineering Management Unit;
- **Jacek Kaniewski,** PhD, Eng. – former long-time employee of the National Atomic Energy Agency and the International Atomic Energy Agency in Vienna;
- Prof. **Julian Liniecki,** PhD – Medical University in Łódź, expert in nuclear medicine, Head of the Diagnostics and Radiological and Isotopic Therapy Unit;
- Prof. **Tadeusz Skoczkowski,** PhD, Eng**.** – Chairman of the National Energy Efficiency Agency S.A.;
- **Tadeusz Wójcik**¸ PhD – long-time employee of the International Atomic Energy Agency in Vienna, Honorary Chairman of the Polish Learned Society, Vice-Chairman of the Association of Environmentalists for Nuclear Power Engineering;
- Prof. **Andrzej Ziębik** PhD, Eng**.** – professor of the Silesian University of Technology in Gliwice, former Director of the Institute of Thermal Technology;
- Prof. **Mariusz Dąbrowski,** PhD, Eng. – professor of the Szczecin University, Head of the Institute of Physics.

Prior to being nominated the Minister of Environment, Prof. **Andrzej Kraszewski,** PhD, Eng., professor of the Warsaw University of Technology, expert in environmental engineering, with extensive experience in social negotiations, was also a member of the Team.

The Team's task is to submit proposals of system solutions for the nuclear power sector, determine directions of its development, draw up expert opinions and conclusions, as well as review documents prepared by the Commissioner.

Appendix 3

Expected expenditures in the years 2011-2020 related to the implementation of nuclear power in Poland

No.	TASK	Expenditures by 2020 kPLN	Including the expenditures in the years 2011 – 2014			
			2011	2012	2013	2014
	1	2	3	4.	5	6
1	Operation of the entity coordinating the nuclear power development – the Nuclear Power Agency. Target employment: 50 people	75,760		5,160	6,900	7,476
2	Preparation of necessary expert opinions and analyses related to the legal framework defining the operation of the nuclear power sector.	2,900	600	250	200	200
3	Performing analyses related to the implementation and updating of the nuclear power program.	2,000	200	200	100	200
4	Implementation of the staff training program for nuclear power sector organisations.	40,000*	9,000	9,000	9,000	8,000
5	Conducting the information and education campaign related to the nuclear power sector.	50,000*	8,000	8,000	6,000	5,000
6	Preparing the NAEA to perform the role of the nuclear and radiological regulator for the needs of the nuclear power sector. The funds will be spent on: - increase of employment by 2014: 39 full-time jobs and related costs, - development of the necessary technical infrastructure.	175,717	2,581	6,408	10,011	13,206
7	Location analyses for the radioactive waste repository, along with the design and construction of the deposit and implementation of the National Plan for Radioactive Waste and Spent Nuclear Fuel Management.	260,000	5,000 incl. ME: 1,000 NFEPWM: 4,000	28,000 incl. ME: 21,000 NFEPWM: 7,000	22,000 ME budget	25,000 ME budget
8	Adopting the scientific and research base for the needs of nuclear power engineering.	160,000*	8,000 incl. ME (subsidy NCNR): 8,000	20,000 incl. MSHE: 15,000 ME (NCNR subsidy): 5,000	20,000 incl. MSHE: 15,000 ME (NCNR subsidy): 5,000	20,000 incl. MSHE: 15,000 ME (NCNR): 5,000
9	Seeking uranium resources in the territory of Poland (including the NFEPWM: PLN 8m)	10,000	-		-	-

10	**Preparing the participation of the Polish industry in the Polish Nuclear Energy Program.**	**4,000**	**200**	**200**	**400**	**300**
11	**Costs of participation in international organisations and research programs.**	**10,000**	**1,000**	**1,000**	**1,000**	**1,000**
	TOTAL	**790,377** **incl. state budget: 771,377**	**34,581** **incl. state budżet: 30,581**	**78,218** **incl. state budżet: 71,218**	**75,611** **state budget funds only**	**80,382** **state budget funds only**

ME = Ministry of Economy
MSHE = Ministry of Science and Higher Education
NAEA = National Atomic Energy Agency
NNRC = National Centre for Nuclear Research
NFEPWM = National Fund for Environmental Protection and Water Management

* - It is also expected that from 2014 (the new financial perspective) the Community funds will be used to the maximum for the implementation of this task, which will allow to reduce the use of budgetary funds.

Due to the absence of provisions on nuclear power in the National Strategic Reference Framework, the current financial perspective (2006-2013) offers no possibility of financing the implementation of the PNPP out of EU funds and an amendment to the NSRF seems today groundless, considering the significant duration of the procedure and the distribution of costs. As a result of what was agreed with the Ministry of Regional Development in 1010, it has been decided that measures pertaining to nuclear power will be integrated into the National Strategic Reference Framework in the new financial perspective. A special working team has been appointed, consisting of representatives of the MRD and the ME. Its task is to analyze the National Strategic Reference Framework with regard to facilitating the most intense possible use EU funds for financing the activities associated with implementing the PNPP.

Appendix 4

Basic assumptions for the comparative analysis

1. For the purpose of the analysis, individual components of the electricity production cost have been estimated based on experience and forecasts of renowned world research centres. **A conservative approach** has been adopted for the technologies with initial indicators suggesting their competitiveness. The above applies mainly to nuclear plants which are often the subject of emotional evaluations and require exercising caution when it comes to assumptions adopted for their comparisons with other technologies.

2. The analysis compares the discounted costs of electricity generation, averaged for the lifecycle of each technology. Technologies to be implemented in the 2020, 2030 and 2050, as well as those being introduced at present have been compared – to form a base for the forecasts of costs for later periods. Forecasts for 2050 are, by nature, burdened with a considerable amount of uncertainty and should be treated with great caution.

3. The methodology adopted to determine electricity generation costs from the point of view of the domestic economy and the society has been used for the comparisons. Average values of economic and technical parameters concerning the technologies in question have been used. For a given real discount rate and parameters of a given technology, including the economic life cycle of a facility, the following real (expressed in monetary units having the purchasing power of the year chosen) values have been compared:
   - average ***annual*** cost of energy generation related to a unit of power and
   - average ***unit*** cost of energy generation related to a unit of the generated energy.

4. ***2005*** was chosen as the currency year, since the majority of data in the literature refers to this year. The currency year is of no significance for the results the technology comparison.

5. In the analysis, the following taxes were not included: income tax, VAT and excise duty, as they depend on the government's fiscal policy and affect the prices of energy rather than the comparable costs of its generation. However, the internalised external costs generated by the individual technologies have been taken into account, including CO_2 emission costs resulting from the obligation to purchase emission allowances at auctions, pursuant to the climate and energy package adopted by the European Council and the European Parliament in December 2008.

6. In the production costs, the investment costs – constituting the total of fixed asset balance sheet depreciation and capital costs – have been taken into consideration. In the case of the balance sheet depreciation, unlike with fiscal depreciation, the total depreciation period is equal to the facility's economic operation.

7. A real discount rate was applied in the calculations, which was determined as the average cost of capital (ACC) for infrastructure investments, with the proportion of equity capital and external funding typical of this kind of projects. The actual ACC value was assumed conservatively for the reference variant of the calculations concerning capital-intensive investment at 7.5%. In the sensitivity analysis, the impact of the lower and higher ACC

values (5 and 10%) was examined. The escalation (more-than-inflationary increase) of the individual components of the production costs, including the escalation of primary energy carrier costs, related to the condition of the global or local market of these carriers, has been taken into account.

8. For the comparisons, technical and economic parameters of the sources under consideration were assumed as based on a wide range of data quoted in reference materials, including forecasts made by the world's leading analytical centres. Capital expenditures covering current expenditures and the cost of capital, incurred by the project owner in the course of the construction process, have been included.

9. The annual costs, related to the unit of the source's power rating, as well as the unit energy generation costs, related to the unit of energy produced, have been averaged for the period of the source's economic operation, worked out based on experience and on global forecasts. For nuclear power plants, it was conservatively assumed that their lifecycle will be 40 years, although most nuclear power plants are granted operational license extensions for 60 years, and such a period is ever more widely adopted in corporate analyses. It is not of great significance for the results of the analysis in question, as the discount-based calculations have been used, in which the differences in the energy generation-related capital expenditures for facilities with the life-cycle prolonged to 60 years do not affect the analysis' results when it comes to the comparison of the individual technology effectiveness.

10. In the case of variable costs, the forecasted costs of fuel have been taken into account, together with the costs of waste storage and neutralization, as well as the costs of CO_2 emission for sources powered by organic fossil fuels.

11. The costs of nuclear power plant decommissioning have been taken into consideration as write-offs for the power plant decommissioning fund included in the fixed costs of operation and maintenance (*O&M*).

12. Relatively low prices of CO_2 emission allowances have been assumed; from €20/tCO_2 in 2010 to €30/tCO_2 in 2020 and €60/tCO_2 in 2050. It is a conservative assumption with respect to zero-emission power plants including, first of all, the nuclear power plants. The costs of fuel for nuclear power plants include the costs of spent fuel storage.

13. For wind power stations, an allowance was made for the fixed costs of reserve sources in the system, which must be provided irrespective of the reserve capacity needed for the safe operation of the system. It was assumed that power stations with gas turbines would be used as such reserve sources. Wind power stations with energy accumulation systems have been considered as alternative solutions.

Appendix 5

OPINION OF THE MINISTER OF REGIONAL DEVELOPMENT
Compliance Program with the country's medium-term development strategy

MINISTER
ROZWOJU REGIONALNEGO
Elżbieta Bieńkowska

Warszawa, dnia 15 grudnia 2010 r.

OPINIA
O ZGODNOŚCI PROJEKTU PROGRAMU ROZWOJU
ZE ŚREDNIOOKRESOWĄ STRATEGIĄ ROZWOJU KRAJU
sporządzona w celu realizacji art.19 ustawy z dnia 6 grudnia 2006 r.
o zasadach prowadzenia polityki rozwoju
(Dz. U. Nr 227, poz.1658, z późn. zm.)

Nazwa dokumentu:
Program Polskiej Energetyki Jądrowej

Ministerstwo przygotowujące dokument:
Ministerstwo Gospodarki

Dokument jest częściowo zgodny ze średniookresową strategią rozwoju kraju z uwzględnieniem wymogów ustawy z dnia 6 grudnia 2006 r. o zasadach prowadzenia polityki rozwoju (Dz. U. Nr 227, poz. 1658, z późn. zm.). **W świetle dokonanej analizy, której wyniki przedstawia załączona „Karta zgodności projektu programu rozwoju ze średniookresową strategią rozwoju kraju", dokument wymaga dostosowania i uzupełnień.**

MINISTER ROZWOJU REGIONALNEGO

Appendix 6

Institutions that declared their participation in the Project and Quality Management (ZPIJ) and conducted a self-assessment indicating their roles in the process of implementing nuclear power in Poland.

1. Chief Inspectorate of Environmental Protection
2. General Directorate for Environmental Protection
3. National Atomic Energy Agency
4. Energy Regulatory Office
5. Office of Technical Inspection
6. AGH University of Science and Technology
7. Poznań University of Technology
8. Silesian University of Technology
9. Warsaw University of Technology
10. Wrocław University of Technology
11. University of Silesia
12. University of Łódź
13. Maria Curie-Skłodowska University
14. Institute of Nuclear Physics of the Polish Academy of Sciences
15. Institute of Atomic Energy POLATOM
16. Institute for Nuclear Studies
17. Institute of Nuclear Chemistry and Technology
18. Central Laboratory for Radiological Protection
19. Institute of Power Engineering
20. PGE Polska Grupa Energetyczna S.A.
21. Polskie Sieci Energrtyczne – Operator S.A.
22. Radioactive Waste Neutralisation Unit

Furthermore, the following institutions have declared their intentions to prepare the INIR mission:

1. Gdańsk University of Technology
2. University of Szczecin
3. Welding Institute
4. Institute of Plasma Physics and Laser Microfusion

Appendix 7

International and community conventions to which Poland is a party

- Convention on Early Notification of a Nuclear Accident drawn up in Vienna on 26 September 1986 (Journal of Laws of 1988, No. 31, item 216) (INFCIRC/335);
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency drawn up in Vienna on 26 September 1986 (Journal of Laws of 1988, No. 31, item 218) (INFCIRC/336);
- Convention on Nuclear Safety drawn up in Vienna on 20 September 1994 (Journal of Laws of 1997, No. 42, item 262) (INFCIRC/449);
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, drawn up in Vienna on 5 September 1997 (Journal of Laws of 2002, No. 202, item 1704) (INFCIRC/546);
- Convention on the Physical Protection of Nuclear Material together with Appendixes I and II opened to the signature in Vienna and New York on 3 March 1980 (Journal of Laws of 1989, No. 17, item 93) (INFCIRC/274/Rev.1);
- Amendment to the Convention on the Physical Protection of Nuclear Material, adopted in Vienna on 8 July 2005, (GOV/INF/2005/10-GC(49)/INF/6);
- Treaty on the Non-Proliferation of Nuclear Weapons, signed in Moscow, Washington and London on 1 July 1968 (Journal of Laws of 1970, No. 8, item 60) (INFCIRC/140) and the following acts resulting therefrom:
- Agreement between the Kingdom of Belgium, the Kingdom of Denmark, the Federal Republic of Germany, Ireland, the Republic of Italy, the Grand Duchy of Luxemburg, the Kingdom of the Netherlands and the European Atomic Energy Community and the International Atomic Energy Agency concerning the enforcement of the article III sections 1 and 4 of the Treaty on the Non-Proliferation of Nuclear Weapons, signed in Brussels on 5 April 1973 (Journal of Laws of 2007, No. 218, item 1617);
- Additional Protocol to the Agreement between the Republic of Austria, the Kingdom of Belgium, the Kingdom of Denmark, the Republic of Finland, the Federal Republic of Germany, the Republic of Greece, the Republic of Italy, the Grand Duchy of Luxemburg, the Kingdom of the Netherlands, the Republic of Portugal, the Kingdom of Spain, the Kingdom of Sweden and European Atomic Energy Community and the International Atomic Energy Agency concerning the enforcement of the article III sections 1 and 4 of the Treaty on the Non-Proliferation of Nuclear Weapons, signed in Vienna on 22 September 1998 (Journal of Laws of 2007, No. 156, item 1096);
- Vienna Convention on Civil Liability for Nuclear Damage, drawn up in Vienna on 21 May 1963 (Journal of Laws of 1990, No. 63, item 370) (INFCIRC/500);
- Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention (on Liability for Nuclear Damage), drawn up in Vienna on 21 September 1988 (Journal of Laws of 1994, No. 129, item 633) (INFCIRC/402);
- Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage (INFCIRC/566) – under the process of ratification.

Appendix 8

Key factors to be taken into consideration by the project owner in selecting the locations nuclear power plants

1. The Plot

A single power unit occupies relatively small space. However, depending on the designed number of units, chosen technology and cooling system (open vs. closed), the size of the plot needed for the construction of a power plant may vary considerably.

Third generation nuclear power plants, i.e. ones which are expected to be constructed in Poland, can be built in a modular system. Some modules (e.g. components of the security lining at the reactor building) may be too large to be transported. Therefore, they will have to be fabricated in direct vicinity of the construction site.

The construction of a power plant requires co-operation with a large concrete factory, large machinery park, capacious warehouses for materials and equipment, as well as facilities for numerous and mobile staff.

For the above mentioned reasons, the plot allocated for the construction of a power plant may have the area of up to 150-200 hectares, i.e. much more than it would result from the contour of the area enclosed by a fence of the future power plant.

2. Cooling water

Cooling water for turbine condensers used in electricity generation must be provided. Cooling will be provided with one of the two methods. Cooling water may be taken from sea, lake or river and after the condenser has been cooled down, it is returned to where it was taken from. The use of cooling towers for evaporation of cooling water is an alternative solution. The first solution is less expensive. However, it requires significant amounts of water (tens of tons per second for each nuclear power unit). The other solution is less demanding in terms of water consumption (a few tons per second). However, it implies the necessity of building some cooling stacks (additional area, higher capital expenditures) and increases the power plant's internal load, thus lowering its efficiency. It is up to the project owner to choose the cooling method.

Special attention will be focused on taking heat away from the reactor to the environment during a potential power plant failure. A possibility of severe design and non-design failures will be taken into account. Emergency cooling systems for the reactor or its housing must operate in a reliable way.

3. Generator power evacuation

Generator power evacuation at a nuclear power plant will not be restricted to the connection of the facility to a power transmission system. Interference in the existing stations and transmission lines, in terms of their expansion and modernization, as well as in the principles of controlling the domestic transmission system will be required. These issues have been discussed in a separate chapter of this document.

4. Geology, tectonics, seismology, geotechnical engineering

The assessment of soil conditions will be of great importance for designing the foundations of the power plant and for its protection against damage by potential seismic shocks. Evaluation of the soil's mechanical strength will cover load capacity, shear strength, compressibility, displacement and other tests involving various parameters. The most restrictive tests will concern potential geological faults in the area. The acceleration value for the Maximum Computational Earthquake expected in the analyzed locations will be evaluated. Seismic analyses with a varying degree of range and accuracy will cover different levels: regional (up to 150 km), adjacent to the power plant (up to 25 km), vicinity of the power plant (up to 5 km) and the area occupied by the power plant itself.

Although modern nuclear power plants are resistant to medium strength earth crust quakes, the preferred locations should be in seismically stable areas. In such areas, the risk of possible facility stoppages resulting from seismic shocks and required for conducting the necessary inspections is minimised.

The territory of Poland is largely seismically stable so it can be expected that seismic factors will not substantially limit the choice of locations for the nuclear power plant.

5. Population

Location of nuclear power plants far away from densely populated areas is a part of the method of „inland protection" promoted by the International Atomic Energy Agency. The sheer distance is an effective protection barrier for ionizing radiation, and adequately prepared contingency plans deployed in the case of a nuclear power plant failure with radioactive substances being released will additionally contribute to reducing absorbed doses and damage to property of the local population.

6. Environment

The impact of the construction process and the operation of a nuclear power plant on the environment will be subject to a thorough analysis. The influence of the power station on national parks, nature reserves, special protection areas of the Natura 2000 network, landscape parks, areas of protected landscape, natural monuments, etc., will be determined.

Due to the deep drainage during the construction work and constant drainage during operation, a nuclear power plant may affect groundwater levels. Therefore, the impact of the facility on the level of groundwater and (as required) on the main groundwater reservoirs will be examined. Apart from environmental aspects, also sites of special character due to their historical legacy will be taken into consideration, including historical monuments and archaeological excavations.

Environmental issues may turn out to be essential factors that affect the location decision.

7. Natural threats

The operational security of a nuclear power plant will be reviewed, among others, with respect to the threats from the nature. Apart from extreme weather conditions (see below), flood-related threats will be taken into account, including inundation, rain water flooding, or effluxes (raised level of subterranean water and groundwater) or high level of surface water. The assessment will cover threats resulting from potential damage to natural and artificial water reservoirs or other hydrotechnical systems. For coastline locations, storms, tsunami waves and a hypothetical rise of the level of the Baltic Sea due to the Earth's climatic changes will be taken into consideration as well.

8. Anthropogenic threats

Accidents or other unpredictable events in nearby industrial plants or other facilities may adversely affect the operation and security of the power plant. That is why hazards of this kind will be carefully examined. In particular, such factors will be analyzed as location, type and impact directions of chemical plants, refineries, explosive material factories, mines, pipelines and tanks for gas, oil and liquid fuels, water reservoirs (of retention type and belonging to hydroelectric power plants), airports, air corridors, military training grounds and others.

9. Transportation routes

Access to transportation routes (roads, railways, ports of appropriate quality) is a matter of key importance that streamlines the process of construction of a power plant. Numerous components of the power plant will be transported in one piece from the place of manufacture, despite their non-standard sizes and weights (e.g. reactor casings, steam generators). Moreover, some technical processes involved in the construction of a third generation power involve on-site fabrication of the facility modules. An appropriately prepared transport system will allow prefabricating components of the power plant a long way from its location, thus contributing to economic development of more distant regions of the country. Therefore, the condition of the transport infrastructure is an essential factor in the construction of a nuclear power plant and it is taken into account in the location research.

10. Land development and infrastructure

The construction and operation of a power plant will have a tremendous impact on the local community. Acquisition of grounds for the construction of the power plant, cooling water ducts, power transmission grid and traffic routes, heavier traffic during the construction phase, temporary accommodation for thousands of construction workers, and then for hundreds of families of the permanent power plant staff will irreversibly change the manner, in which the adjacent areas are used.

Some existing components may hamper the possibility of locating the power station. These include mainly heavy tourist traffic, a extensive recreational and holiday facilities, industrial plants situated within the potential location and in zones of limited use, fragmented ownership of land required for the power station and for the related infrastructure (ducts, lines, stations).

Each such case requires an in-depth consideration.

11. Meteorology

A nuclear power plant will be designed in a way that guarantees optimal operational parameters in the typical range of weather conditions. However, a power plant must be fully safe also under extreme conditions, i.e. at extreme temperatures, exceptionally high snowfall and rainfall, hurricanes, tornados, and others.
The location will have appropriate properties in terms of dispersion of substances potentially released in the result of an accident. Concentration of radioactive substances will be strictly monitored.
Therefore, a careful examination of meteorological factors which are significant for proper drafting of the power plant design will be required, along with an evaluation of parameters of atmospheric transportation and diffusion of substances.

12. Radiological threats resulting from operation of a nuclear power plant

In case of a failure, a nuclear power plant may pose a potential threat to its surroundings. That is why such threats will be carefully analyzed, and an evaluation of direct and indirect threat dispersal routes will be prepared. In particular, threats caused by effluxes of radioactive substances and emissions of radioactive substances to the atmosphere will be considered.
Normal operation of the nuclear power plant will be subject to a critical analysis concerned with the release of radioactive substances and a potential level of threat for the personnel and the surroundings.
Conditions at the power plant's location (configuration of land, geological structure, hydrogeological and meteorological factors, density and distribution of population, and others) can be of fundamental significance for the results of threat assessment, both in emergency situations and under normal operating conditions.

Appendix 9

INFORMATION

Information on new initiatives aimed at promoting education and atomic research in Poland

Atomic Research Centre

1. Key objectives of the Consortium:
   a) conduct scientific research and development work in the area of atomic physics, in accordance with the research program of the Consortium which constitutes an Appendix to this agreement;
   b) create, upgrade and maintain the research infrastructure for research in the area of atomic physics and use nuclear techniques for research in other areas including in particular research on materials, biological, medical and environmental research and research on safety and security systems;
   c) ensure safe operation of the Nuclear Centre in Świerk and the centres in Bemowo (IPPLM) and Żerań (INCT);
   d) support the development of the Polish nuclear power sector through research and development work in this area, expert opinions, and also by promotional activities, social education and personnel training;

2. The Consortium accomplishes its objectives through:
   a) pure research, development and prototyping, implementations and production;
   b) promotion of innovation and development of science and technology in the field of nuclear physics and its applications;
   c) breaking technology and non-technology barriers hindering development and practical applications of elementary particle physics, nuclear physics, plasma physics and radiochemistry;
   d) initiation of development of modern technologies based on nuclear techniques, experience and know-how acquired during research in the field of atomic physics;
   e) participation in designing programs for the development of atomic physics and related sciences;
   f) providing support for government authorities in drawing up development strategies for modern nuclear technologies;
   g) involvement in drawing up forecasts of the development of science and technology in the fields associated with atomic physics;
   h) involvement in the implementation of EU programs (e.g. The 7th Framework Programme of the European Union, so-called program-related initiatives, Euroatom, structural funds, non- EU funds compliant with the principle of combining aid from EU and non-EU sources);
   i) promotion and lobbying for nuclear power;
   j) broadly understood social education on nuclear power;
   k) education of personnel for the Polish nuclear power sector, research and development establishments and the economy.

3. Composition of the Consortium:

1. Institute of Nuclear Chemistry and Technology (INCT) in Warsaw;
2. Institute of Atomic Energy (IAE) in Świerk;
3. Institute of Plasma Physics and Laser Microfusion (IPPLM) in Warsaw;
4. Andrzej Sołtan Institute for Nuclear Studies (INS) in Świerk;
5. Henryk Niewodniczański Institute of Nuclear Physics (INP) in Cracow
6. Central Laboratory of Radiological Protection (CLRP) in Warsaw.

Polish Nuclear Technology Platform

1. Objectives:
   a) engage in the key activities of the Sustainable Nuclear Energy Technology Platform (SNE-TP);
   b) co-operate in the creation of policy and legislation supporting the development of nuclear technologies;
   c) integrate key economic and research partners interested in the development of nuclear technologies;
   d) build a bridge between the industry and scientific establishments by initiating research, development and study work and by commercialization of innovative solutions based on nuclear technologies;
   e) improve the competitiveness of the Polish economy by applying nuclear technologies;
   f) build and upgrade the national research, educational and industrial infrastructure used by and for the benefit of nuclear technologies;
   g) optimise the use of national and foreign funds allocated for the development of nuclear technologies;
   h) promote the development of nuclear technologies

2. PNTP objectives will be accomplished, among others, by:
   a) participation in European initiatives related to nuclear technology;
   b) organising conferences, seminars, training sessions and workshops to share information and experience with respect to research and development initiatives;
   c) drawing up documents concerning trends in the development of nuclear technologies in Poland and worldwide as well as ways to break the barriers in the development of new technologies;
   d) initiating joint research and implementation projects concerning nuclear technologies;
   e) publishing information materials related to nuclear technologies;
   f) providing support for social and scientific and technical organizations active in the field of nuclear technologies.

3. Composition:
   1. Institutes of the Atomic Research Centre:
      - Institute of Nuclear Chemistry and Technology in Warsaw;
      - Institute of Atomic Energy in Świerk;
      - Institute of Plasma Physics and Laser Microfusion in Warsaw;
      - A. Sołtan Institute for Nuclear Studies in Świerk;

2. Companies of Polska Grupa Energetyczna:
   - Polskie Sieci Elektroenergetyczne S.A. in Warsaw;
   - BOT Górnictwo i Energetyka S.A. in Łódź;
3. AGH University of Science and Technology;
4. CAPITAL – European Investment Consulting in Warsaw;
5. Institute of Nuclear Physics of the Polish Academy of Sciences in Cracow;
6. KGHM Polska Miedź S.A. in Lubin;
7. Warsaw University of Technology;
8. Pomeranian Special Economic Zone;
9. University of Warsaw;
10. Wrocław Technological Park.

"Human Resources for the Nuclear Power Sector and Nuclear Technologies in Industry and Medicine" Consortium

1. Objectives:

Prepare the research and technology infrastructure for the Polish nuclear power sector by:

1. development of human resources and technical facilities for medical therapies based on nuclear techniques and for nuclear technologies, including:
   - 1.1. research of new radiopharmaceuticals;
   - 1.2. development of accelerator sources of radiation and imaging methods required in medical diagnostics;
   - 1.3. development of material technologies;
   - 1.4. activities related to environmental protection;
2. launching training courses and research programs for the nuclear power sector including:
   - 2.1. introduction (reintroduction) of nuclear topics to physics, chemistry and engineering curricula;
   - 2.2. introduction (reintroduction) of university faculties (majors) related to nuclear power;
   - 2.3. introduction of postgraduate and doctoral studies in nuclear power, including studies for candidates who represent engineering specializations (metallurgy, heating, electrical, mechanical, environmental engineers, etc.);
   - 2.4. educating nuclear supervision officers, etc.;
   - 2.5. starting appropriate scholarships and international internship programmes;
   - 2.6. educating teachers and research personnel;
   - 2.7. participation in international atomic research projects selected with consideration of the country's needs and possibilities;
   - 2.8. launching a comprehensive program of education and social information with respect to the foundations of, use of and threats posed by nuclear technologies.

2. Composition:
1. Institute of Nuclear Chemistry and Technology in Warsaw;
2. Institute of Atomic Energy in Świerk;
3. Institute of Plasma Physics and Laser Microfusion in Warsaw;
4. A. Sołtan Institute for Nuclear Studies in Świerk;
5. Warsaw University of Technology,
6. Maria Curie-Skłodowska University in Lublin;
7. Wrocław University of Technology;
8. University of Warsaw.