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National Action Plan for the Development of the Nuclear Energy Sector in the Czech Republic

Compiler: Ministry of Industry and Trade of the Czech Republic, Ministry of Finance of the Czech Republic

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Executive Summary

The document "National Action Plan for the Development of the Nuclear Energy Sector in the Czech Republic" (NAP NE) follows the updated State Energy Policy (SEP)[1] and within the limits of its strategic task (with a final opinion from the environmental impact assessment process – SEA), transforms any sub-targets of this document into particular implementation steps. Implementation steps and the roles of the state are described in areas such as regulation in the field of nuclear safety; ensuring a long-term sustainable infrastructure necessary for construction; the long-term safe operation of nuclear installations and their decommissioning; the disposal of nuclear waste of all categories, both from nuclear power and from nuclear research, medicine and industry; research in the field of nuclear power or learning and education.

The document is based on the knowledge that the state plays a fundamental role in the energy sector. The most important role of the state is to establish a clear long-term policy in the field of the economy, energy and the environment with an adequate base in the field of legislation and the institutional framework.

Specifically, as regards the construction of new nuclear facilities in the territory of the Czech Republic in accordance with the strategic task defined in SEC, it is desirable, in view of ensuring the energy security of the Czech Republic and the overall social benefit, **from the perspective of the state, to immediately begin preparations for the siting and construction of one nuclear unit at the Temelin site and one unit at the Dukovany site, while protecting the potential risks by obtaining the necessary permits/licences for the possibility of the construction of two units at both sites.** In particular, to maintain the continuation of production at the Dukovany site, the **construction of a unit at the Dukovany site and its commissioning by 2037 are crucial** in order to ensure the continuity of the operation of a nuclear facility and human resources at the site until 2037, when the shutdown of the existing NPP is expected.

From the perspective of the state, the investment through the existing owner and operator of the nuclear power plants ČEZ, a. s., or its 100% owned subsidiary is clearly the preferred option of the investment model for the construction of new nuclear facilities (NNF). This first option is based on the assumption that ČEZ will draw up the relevant investment plan following the approved SEP defining the intended structure of electricity production in the Czech Republic, including targets for the construction of new nuclear facilities within a defined timeframe.

In the event that the investor plan drawn up by ČEZ would not be implemented through ČEZ, for any reason whatsoever, in line with the procedure according to the first option, the state may ensure the construction of new nuclear facilities in accordance with the time schedule defined in SEC, through the selection of two alternative options.

The second option is a private investor consortium, i.e. an association of investors in order to achieve a certain goal (ČEZ, financial investor, large customer, contractor of nuclear unit, etc.). The composition of the consortium and the percentage distribution of shares depend on the willingness

[1] The NAP NE document is based on and follows the updated State Energy Concept. Thus, this document will be submitted to the government for approval not earlier than following the approval of SEP and the formulation in the text therefore already refers to the approved document.

of individual investors to enter the project. In light of the experience from other projects in Europe, it could however be presumed here that in the existing market situation, such a consortium will expect some form of guarantees from the government.

The **direct construction by the state through the newly established state-owned enterprise** is the last hypothetical possibility. However, because of a large number of negative aspects and mainly because of the high impact on the state budget and the increasing national debt relating thereto, this option is the least likely and it is therefore mentioned only for the sake of completeness.

Recommended procedure for the preparation of a new nuclear facility

Due to the high uncertainty regarding the future situation on the electricity market, it is recommended to continue with the process of preparation and construction of a new nuclear facility in two stages.

In the first stage, it is absolutely crucial for the Czech Republic to maintain all necessary capacities for the future construction of new facilities, i.e. it is needed to continue immediately the preparatory work leading to construction, including obtaining all necessary licences/permits and concluding contracts with contractors, the effectiveness of which will be limited to the activities required to ensure the project preparation needed for processing the licensing and permitting documents, and for commencing construction after obtaining a building permit. ČEZ should continue to carry out this work. The timeframe up to obtaining a building permit is roughly around 2025.

Subsequently, at the latest before issuing a building permit (estimate around 2025), at the time when there will be a real need to decide to build new facilities and issue a notification of the full effectiveness of a supply contract with a contractor, and real capital expenditures in the amount of approximately CZK 250 – 300 billion (during the construction of two units), an assessment would be made based on the market situation whether the need for the construction of a new nuclear facility is still present and whether:

a) the market situation has been stabilised enough to allow construction of new nuclear facilities without any state guarantees and ČEZ would build new facilities on a commercial basis;
b) market deformations are still present and new nuclear facilities cannot be built without providing any guarantees. In such a case, the state has to decide whether it will provide guarantees to an investor and what form they will take[2].

The above options also have some differences in the opportunity to influence the share of domestic contractors in the overall supply. While in the first two options the state only disposes of indirect instruments for promoting a greater share of Czech companies (through the exercise of their shareholder rights or, where appropriate, by defining the form of guarantees), in the third option the state may influence the share of Czech companies more effectively (provided that an exemption from the public procurement law – PPL has been obtained). **The way of business organisation is the key factor for the possibility to influence the share of domestic contractors** – in the case of the

[2] Any form of state guarantee would constitute public aid within the meaning of Article 107, para. 1 of the Treaty on the Functioning of the European Union and would be subject to approval by the European Commission

selection of the power plant turnkey contractor (EPC (Engineering, Procurement, Construction) contractor) pursuant to the PPL, the amount of the share of domestic contractors cannot be evaluated and the instruments to motivate the EPC contractor to use domestic contractors are, therefore, very limited. In the case of obtaining an exemption from the PPL, the share of domestic contractors can be efficiently influenced (evaluation criterion, determination of the minimum share of domestic contractors, price preference, etc.).

Summary of recommended actions for the construction of new nuclear facilities in the Czech Republic:

a. **Given that some of the options of the investment model require the establishment of a special purpose vehicle (SPV), into which all the relevant assets shall be brought in order to complete the construction of nuclear units at both existing sites, it is advisable to start preparing this process at the level of the company ČEZ. At the same time, the preparations for the selection of the EPC contractor should be started in accordance with the selected business model.**
b. **At the same time it is crucial to avoid irreversible steps within the ČEZ Group, which would lead to the reduction of human capacities required to implement this NAP NE. Furthermore, it is necessary to build up the competences for the project team.**
c. **Initiating contacts with strategic partners for the construction of a nuclear unit in the Czech Republic.**
d. **Negotiations with the European Commission on how to select a contractor, financing method and ensuring a return on investment.**
e. **Immediate continuation of the project preparation in the option of two units with the subsequent construction of one unit (and with the possibility of extension to two units) at the Temelin site.**
    a. SPV – preparation for allocation to allow the accession of a partner.
    b. Environmental Impact Assessment (EIA) – compliance with the conditions.
    c. Preparation for the selection of a contractor – technical documentation.
    d. Licence for siting - for SPV.
    e. Continuation of the site preparation for the construction of NNF.
    f. Continuation of the acquisition of necessary lands.
    g. Continuation of the activities leading to the obtainment of the necessary licences and permits.
    h. Preparation and calculation of related and induced investments (implementation following the decision on the investor and business organisation model).
f. **Immediate continuation of the project preparation in the option of two units with the subsequent construction of one unit (and with a possibility of extension to two units) at the Dukovany site.**
    a. SPV – preparation for allocation to allow the accession of a partner.
    b. EIA – preparation and submission of documents.
    c. Preparation for the selection of a contractor – technical documentation.
    d. Licence for siting - for SPV.
    e. Continuation of the site preparation for the construction of NNF.
    f. Continuation of the acquisition of necessary lands.
    g. Continuation of the activities leading to the obtainment of the necessary licences and permits.
    h. Preparation and calculation of related and induced investments (implementation following the decision on the investor and business organisation model).
g. **Beginning the preparation of legislative changes in order to simplify the permitting and licensing process and minimise the associated risks of impacts on deadlines and costs.**

h. Not later than before issuing a building permit, to assess whether the need for construction of a new nuclear facility is still present and whether the market situation has been stabilised, which would allow construction on a commercial basis, i.e. without the need of state guarantees.

1 Purpose of the Document, Basis and Objectives of the Development of the Nuclear Energy Sector

The document "National Action Plan for the Development of the Nuclear Energy Sector in the Czech Republic (NAP NE)" follows, in the field of nuclear energy, the updated State Energy Policy (SEC), which defines the corridors for the intended share of individual primary energy sources in the total consumption as well as in electricity generation. Within the limits of such corridors and specific strategic visions and goals to achieve them under SEC, for which the Ministry of Industry and Trade (MIT) received a final opinion of the Ministry of the Environment (ME) from the strategic environmental assessment (SEA) process and in line with the individual strategic objectives contained in SEC, NAP NE develops, inter alia, the following:

- Safe operation of existing and new units of nuclear power plants (NPP),
- Ensuring the entire fuel cycle, including spent nuclear fuel management,
- Sufficiency and appropriate educational structure of human capital,
- Science, research and the application thereof in practice,
- Industrial base of the Czech Republic for the needs of nuclear energy, etc.

NAP NE should be evaluated and updated at least once every 5 years on an as needed basis. It is approved by the government and constitutes a partial implementation plan of the State Energy Policy for the field of nuclear energy.

In the sector of nuclear energy, it, therefore, outlines how priority I of SEC[3] will be fulfilled for the balanced mix of primary energy sources as well as electricity generation sources, including maintenance of the strategic reserves available and the associated strategic objectives of SEC:

- Nuclear generation will gradually replace coal energy in the role of the pillar of electricity generation.
- Strengthening the role of the nucleus in electricity generation and the maximum utilisation of waste heat from NPP (construction of 1-2 new units of NPP depending on the prediction of the generation and consumption balance; the long-term extension of the operation of the current four units in the Dukovany NPP and the potential construction of another unit in the time span covered by the shutdown of the Dukovany NPP; territorial delineation of the sites for the possible future development of NPP after 2040).

Furthermore, NAP NE addresses priority II of SEC, specifically the field of support for research, development and innovations ensuring the competitiveness of the Czech energy sector and support for education, aimed at generational change and quality improvement of technical intelligence in the field of energy.

[3] Balanced mix of primary energy sources as well as electricity generation sources based on their broad portfolio, efficient use of all the domestic energy sources available and coverage of the consumption of the Czech Republic by electricity generation to EC with sufficient reserves. Maintenance of the available strategic reserves of the domestic forms of energy.

For the field of electrical energy, it develops the way of meeting the partial objectives for the field of nuclear energy, i.e.:

- Support the development of the nuclear energy sector as one of the pillars of electricity generation. With the target share of nuclear energy in electricity generation ranging around 50% and with the maximisation of heat supplies from nuclear power plants.
- Support and speed up the process of negotiation, preparation and implementation of new nuclear units at the existing sites of nuclear power plants with the total capacity of up to 2,500 MW or the annual generation in the amount of approximately 20 TWh over the years 2030 – 2035 including the necessary steps within the international negotiation.
- Create the conditions for Dukovany NPP life extension to 50 years[4] and, if possible, up to 60 years (having regard to technologies, safety, economy and EU rules).
- Target the potential construction of another new unit at the existing sites of nuclear power plants around the possible shutdown of Dukovany NPP, i.e. after 2035, depending on the prediction of the generation and consumption balance.
- Ensure the legislative, administrative and social conditions for construction, and the safe and long-term operation of radioactive waste repositories and the rules for the management of spent fuel as a potentially valuable secondary raw material.
- Finding and safeguarding the territorial defence of another suitable site for the development of the nuclear energy sector.
- Deciding on the nuclear waste repository by 2025.

The NAP NE document fulfils, at the same time, the task assigned to the Ministry of Industry and Trade (MIT) and the Ministry of Finance (MF) in the Resolution of the Government of the Czech Republic No. 243 of 9 April 2014. Its purpose is to ensure that even with the current fragile situation on the electricity market it is possible to continue in the future to contribute to the further development of the nuclear energy sector, i.e. not to take irreversible steps, which would make it impossible to build other nuclear units in the Czech Republic in the future, and where appropriate, to avoid the loss of key know-how in the field of human resources and industry.

NAP NE is based on the knowledge that the state plays (and should continue to maintain or strengthen in the future) a fundamental role in the energy sector in general and in the electrical energy and nuclear energy sectors separately, particularly in the context of the privatisation and liberalisation of energy sectors. Instruments are direct and simpler in the states where the energy sector is centralised and owned by the state, since the energy policy is implemented both by the legal framework and directly by energy management. Where the energy sector was privatised and liberalised, the state instruments shall be much more sophisticated and challenging, since their action is indirect, their effect is related to the action of a number of external factors, which can strengthen and weaken the efficiency of instruments and, last but not least, the effect is typically visible with a delay compared to direct management. Therefore, state policies and strategies shall be far more predictive in relation to the effect of external and internal conditions of the country concerned. Where the objectives of energy policy cannot be achieved by traditional legislative-regulatory instruments, a greater involvement of the state may be considered for the development of sources.

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[4] i.e. until 2035 – 2037

The most important role of the state is to establish a clear long-term policy in the field of the economy, energy and the environment with an adequate base in the field of legislation and the institutional framework. The policy and the legal and institutional framework shall create a clear and predictable environment for the long-term, transparency and equality of conditions as well as generate the long-term trust of investors in the stability of such a framework. Only this way may the inflow of private capital into the energy sector be ensured.

Nuclear energy figures prominently among fields, in which the role of the state is irreplaceable, namely due to the long-term aspect both in the preparation and construction of nuclear installations, and in their operation, requirements for state supervision and control mechanisms and, last but not least, complexity and overlap to any other fields and spheres of state engagement (research, education). The specific outputs of facilities require coherence between the development of transmission grids and the instruments of reliability and balance management of the electrification system. The nuclear source is characterised by, on the one hand, stable and low generation costs and a long lifetime and, on the other hand, extremely high capital intensiveness and thus a long payback period. The life cycle of a nuclear power plant is approximately 100 years (preparation and construction 15 – 20 years, new generation unit operation 60-80 years and decommissioning 20 years) and the life cycle of the necessary infrastructure is even longer (decision on the end of a fuel cycle, and the construction and operation of a deep geological repository).

The orientation on nuclear energy is therefore a strategic choice of the state, which - if made - constitutes a long-term commitment and leading role of the state in creating stable conditions. With a stable comprehensive and long-term framework, the state may substantially reduce regulatory risks and requirements of private capital for its return, which play a significant role in the total costs of nuclear generation.

The basis of the framework of the utilisation of nuclear energy is, in accordance with the recommendations of the International Atomic Energy Agency (IAEA)[5], a clear long-term and stable energy strategy, particularly with the long-term strategy in the nuclear energy segment (standing on three segments: the state's role, the role of the independent supervisory authority and owner/operator of nuclear power plants), adopted by the state, accepted across the political spectrum and fulfilled, including a clear identification of all entities (the state, industry and other "stakeholders") with the adopted strategy. The legislative framework and state administration shall then meet this strategy in all aspects and create such an environment, which does not present any risk of the reversal and frustration of investments for the investors entering this sector under the conditions set out by this framework.

The utilisation of nuclear energy was and is not possible without international cooperation and this applies particularly to the Czech Republic. **The vision of the development of the nuclear energy sector in the Czech Republic is based on the need for long-term international cooperation and anticipations of geopolitical changes over the next century, and anchoring shall be therefore sufficiently robust to be stable in today's increasingly less stable international situation.**

[5] Draft revision of the IAEA document "Milestones in the Development of a National Infrastructure for Nuclear Power. IAEA Nuclear Energy Series No. NG-G-3.1. IAEA 2007" of 2014.

The regulation in the field of nuclear safety remains the key role of the state. The state shall ensure a strong and independent regulatory authority with sufficient competences, sufficient financial resources and expertise. The regulatory authority shall be prepared to provide surveillance of the operated nuclear installations and nuclear material management including the disposal of radioactive waste, and ensure licensing procedures in case of new nuclear facilities, nuclear waste management facilities as well as the life extension of existing installations and the decommissioning of nuclear facilities following the end of their operation. Legislation shall set high requirements for nuclear safety complying with international standards and compliance with these standards shall be, at the same time, uncompromisingly enforced by the regulatory authority.

The **state's role in ensuring the long-term sustainable infrastructure needed for the construction, long-term safe operation and decommissioning of nuclear installations is also** irreplaceable. The infrastructure involves a number of fields including international commitments, the disposal of radioactive waste, the provision of reliable services in the field of fuel cycle, long-term sustainable industry, associated research, education and training, etc. A comprehensive view of the role of the state and the necessary infrastructure is provided in a number of IAEA guides and recommendations including potential missions to assess its compliance.

The **state's role in the field of the disposal of nuclear waste of all categories, from both nuclear energy and nuclear research, medicine and industry is** important. With regard to the long-term aspect of disposal, this role cannot be replaced in its entirety by a commercial entity. The state ensures the safety and long-term disposal of all kinds of radioactive waste and provides for the creation of funds to cover future costs associated with the decommissioning of nuclear installations and safe waste disposal.

Research in the field of nuclear energy is extensive, extremely expensive and exceeds the capacity of individual states. Moreover, its outputs serve not only for nuclear energy but also for a number of other fields including basic research. Therefore, it is carried out in a number of international consortia under international projects and conventions. Although such projects are participated in by private entities, the top coordination of participation, the contractual framework and funding shall be ensured by the state including a number of bilateral interstate activities.

The state plays a crucial role in the field of education and training. It takes more than 10 years to train a specialist in highly specialised fields such as nuclear physics and a number of technical fields necessary for the nuclear energy sector. Therefore, the state shall provide for not only the basic framework for technical education from financing to assuring the quality of teaching but also sufficient capacity of the relevant fields, and the quantity and quality of graduates meeting the needs of the future development, i.e. a certain degree of planning for the needs with respect to the long-term energy strategy, demographic trends and external factors including the brain drain, professional development and changes on the labour market.

Public acceptability forms an integral part of nuclear energy. If the state intends to continue to build new nuclear facilities, it shall be ready to communicate openly on a long-term basis about all aspects with the population as well as pay attention to the transparency of all procedures and the behaviour of all key actors and systematically maintain the credibility of this field. Regular reporting on the state of the nuclear energy sector forms a part of transparency.

Nuclear power plants would hardly be safely and reliably operated without high-quality engineering and technical support and quality services provided by the supply system during operation. International commitments in the field of liability for nuclear damage clearly make the operator of a nuclear installation responsible for nuclear safety. This responsibility cannot be contractually passed on to the contractor of a nuclear installation and it is therefore of paramount importance that during the construction of a NPP or any other nuclear installation, *know-how* and *know-why* be entirely transferred to the operator's organisation. Certain guarantees from the state in this field require an independent supervisory authority for nuclear safety to indicate any deficiencies in this field in time to avoid drastic measures with adverse economic impacts.

The Czech Republic has built up its nuclear energy sector within Czechoslovakia since the mid-fifties. However, change in the political system, the splitting-up of Czechoslovakia, change in the geopolitical situation, the transition to market economy, accession to NATO, EU and globalisation led to changes as a result of which it was necessary to formulate a new long-term vision of nuclear energy in the Czech Republic under the approved State Energy Policy, where NAP NE specifies only the individual partial steps to implement the strategic objectives contained in SEC.

2 Vision of the Development of the Nuclear Energy Sector

In a long-term vision of the energy industry of the Czech Republic, nuclear energy is a key element:

To ensure the transition to low-carbon energy by the end of 2050 in the context of meeting the Czech international obligations – taking into account the fact that virtually no domestic fossil sources will be available after 2050/60 to the extent that would allow their use for electricity generation while including the entire infrastructure for separation and mainly storage of CO_2. In low-carbon energy without domestic fossil sources, a combination of electricity from renewables and nuclear energy is assumed on the side of sources and, at the same time, a high proportion of electricity consumption within the total final energy consumption, in accordance with the assumption that electricity will have to, with a high probability and depending on the availability of fossil fuels, replace to a significant extent the consumption of liquid fuels in transport and fossil sources in heat supply, gradually over the period from 2040 to 2060.

To ensure energy security (the ability of long-term electricity supplies in the event of failure of external supplies of sources) – in terms of security of supplies, nuclear energy is an essential component of security, assuming the maintenance of sufficient strategic reserves of uranium concentrate and separation enrichment and fabrication works. With the extent of nuclear energy and its expected long-term share, it is advisable to ensure fabrication works in their own plant in the territory of the Czech Republic or in any Central European premises in the context of a multilateral international agreement. According to the development of the world uranium market (balance, variability of supplies, trade openness and territorial structure of mining), reserves of uranium concentrate will then be created to the extent of consumption for four years and more. Conversion and enrichment works are assumed to be ensured under international agreements, guaranteeing their availability on a long-term basis. Under these assumptions, nuclear energy is, in terms of energy security, the safest source, even compared to the generation from renewable energy sources (RES), which may be affected by natural changes on a short-term or long-term basis.

To ensure industrial production and export potential – past construction and operation of nuclear facilities in the territory of the Czech Republic were mainly ensured by domestic industry, providing it with the opportunity to supply to the foreign markets at the same time. The share of nuclear industry and infrastructure in the employment rate is approximately 15,000 persons and the share of GDP is approximately 2%. For the further development of the nuclear energy sector, the share may be considered up to twice the level of the current state.

To provide the knowledge base of the economy (driving force for hi-tech industrial production, organisational and design skills) – nuclear energy, as one of the most complex and most sophisticated fields of human activity, requires a very high level of qualification and provides a high added value but involves other fields at the same time (material research and development, mechanical engineering development, etc.).

The State Energy Policy assumes that nuclear energy together with renewable energy sources will play a key role in the energy sector, in particular in electricity generation. As regards the complexity of nuclear energy, the long-term strategic development task shall specify the vision of all components of the life cycle of nuclear power plants, taking account of the expected (and specified in SEC) extent of nuclear energy in the future – the decommissioning of Dukovany NPP Units 1-4 between 2035-37, and if applicable, 2045-47, operation of Temelin NPP Units 1,2 approximately until 2060, construction of up to three new nuclear facilities (NNF) by the end of 2040 and any further construction after 2040.

It should be also noted that the development of electricity consumption in the context of SEP may be undervalued if the whole range of expected savings is not implemented and, in contrast to this, the massive deployment of electricity occurs in the transport (higher than as expected by SEC) and heat sectors in order to achieve the objectives of climatic policy. This could necessitate other NNF by 2050 if this increased need could not be replaced by RES.

For the above reasons, the field of nuclear energy requires a clear decision on the long-term nuclear energy utilisation to generate electricity. This decision shall also include a commitment to ensure the long-term sustainable national infrastructure needed to ensure the vision of the development of the nuclear energy sector, which includes commitments on the part of the government, legal framework, regulation, material assumptions, technological assumptions, human resources and, last but not least, support for industry and public opinion throughout the life cycle. The demonstration of compliance with international legal instruments, internationally acceptable safety standards, recommendations for nuclear safety and safeguard mechanisms in terms of preventing the proliferation of nuclear materials is fundamental to creating and maintaining an acceptable nuclear programme. IAEA summarised these requirements in its report "*Milestones in the Development of a National Infrastructure for Nuclear Power*[6]", updating the former version thereof[7].

IAEA defines the necessary infrastructure to nuclear energy in the points below:

1. National position
2. Nuclear safety
3. Management
4. Funding and financing
5. Legal Framework
6. Safeguards
7. Regulatory Framework
8. Radiation protection
9. Electrical grid
10. Human resource development
11. Stakeholder involvement
12. Site and supporting facilities
13. Environmental protection
14. Emergency planning
15. Nuclear security
16. Nuclear fuel cycle

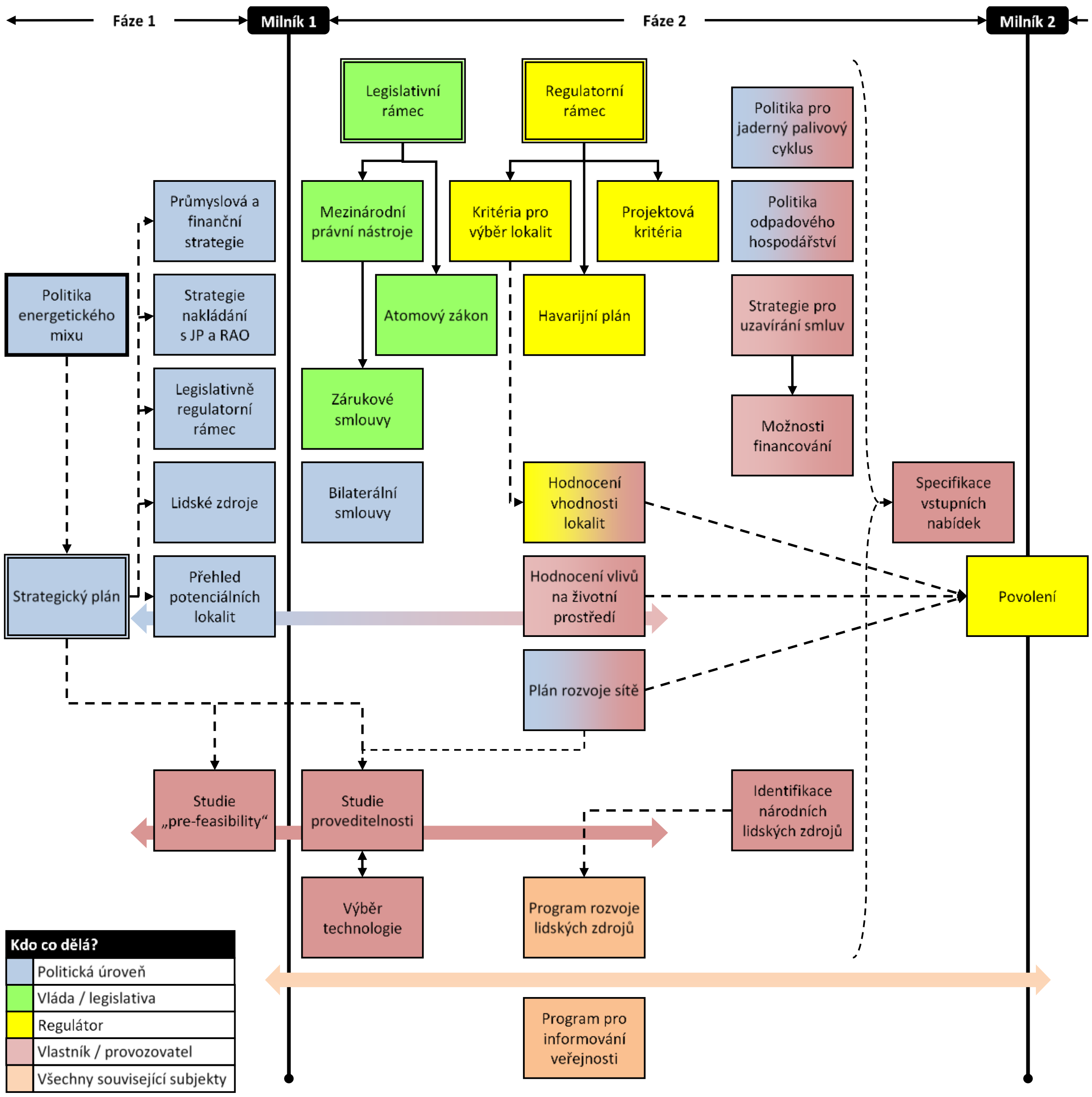
[6] Milestones in the Development of a National Infrastructure for Nuclear Power. IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 2). International Atomic Energy Agency, Vienna, 2014. Draft.
[7] Milestones in the Development of a National Infrastructure for Nuclear Power. IAEA Nuclear Energy Series No. NG-G-3.1. International Atomic Energy Agency, Vienna, 2007.

17. Radioactive waste management
18. Industrial involvement
19. Procurement

From the viewpoint of IAEA, there are <u>three main entities</u>, which can ensure this infrastructure and the requirements imposed thereon (in accordance with the financial resources and enforcement instruments available): <u>the government</u>, <u>the owner/operator of nuclear power plants,</u> and a <u>sufficiently independent supervisory authority for nuclear safety</u>.

The roles of individual entities are shown in Fig. 1:

Fig. 1: *Roles of individual entities*



Fáze 1	Stage 1
Milník 1	Milestone 1
Fáze 2	Stage 2

Milník 2	Milestone 2
Legislativní rámec	Legal Framework
Regulatorní rámec	Regulatory Framework
Politika pro jaderný palivový cyklus	Nuclear fuel cycle policy
Průmyslová a finanční strategie	Industrial and financial strategy
Mezinárodní právní nástroje	International legal instruments
Kritéria pro výběr lokalit	Site selection criteria
Projektová kritéria	Design criteria
Politika odpadového hospodářství	Waste management policy
Politika energetického mixu	Energy mix policy
Strategie nakládání s JP a RAO	Nuclear fuel and radioactive waste management strategy
Atomový zákon	Atomic Act
Havarijní plán	Emergency plan
Strategie pro uzavírání smluv	Contracting strategy
Legislativně regulatorní rámec	Legal-regulatory framework
Zárukové smlouvy	Safeguard contracts
Možnosti financování	Financing options
Lidské zdroje	Human resources
Bilaterální smlouvy	Bilateral contracts
Hodnocení vhodnosti lokalit	Site suitability assessment
Specifikace vstupních nabídek	Specification of entry offers
Strategický plán	Strategic plan
Přehled potenciálních lokalit	Overview of potential sites
Hodnocení vlivů na životní prostředí	Environmental Impact Assessments
Povolení	Permit/licence
Plán rozvoje sítě	Grid development plan
Studie „pre-feasibility“	Pre-feasibility study
Studie proveditelnosti	Feasibility study
Identifikace národních lidských zdrojů	Identification of national human resources
Výběr technologie	Selection of technology
Program rozvoje lidských zdrojů	Human resources development programme
Program pro informování veřejnosti	Public information programme
Kdo co dělá?	Who does what?
Politická úroveň	Political level
Vláda / legislativa	Government/legislation
Regulátor	Regulator
Vlastník / provozovatel	Owner/operator
Všechny související subjekty	All related entities

3 Conditions for Ensuring the Sustainable Development of the Nuclear Energy Sector

3.1 Nuclear Safety at the Top Level

From the viewpoint of the state, nuclear safety over the entire fuel cycle is of the highest priority of the nuclear sector. Ensuring nuclear safety constitutes a commitment for all entities, the government, the owner/operator of the nuclear power plant, the supervisory authority for nuclear safety, suppliers of nuclear technologies and facilities, and any other organisations and shall be implemented in all segments of the nuclear energy development programme. Requirements for nuclear safety are defined by IAEA and Nuclear Energy Agency (NEA).

The Czech Republic has created the required system, belongs among the top in the overall rating in Central and Eastern Europe and is above average within NEA countries. This is facilitated by the established legal framework and the existence of an independent supervisory authority in the form of the State Office for Nuclear Safety (SÚJB). Also, operators of nuclear installations (ČEZ, a. s., ÚJV Řež a.s., CV Řež, s.r.o.) meet the requirements imposed on them by law and international commitments of the Czech Republic.

The role of the government in the field of nuclear energy is represented by MIT. It is responsible for the field of radioactive waste management through the Radioactive Waste Repository Authority (RAWRA), provides supervision of DIAMO s.p., which carries out, inter alia, the mining of uranium and ensures the removal of consequences of past mining or facilitates international cooperation in the field of nuclear energy (NEA and bilateral cooperation agreements with a number of states).

The supervision of nuclear safety in the Czech Republic is provided by SÚJB, while it is necessary, within a well defined legislative framework, to continue to maintain its highly qualified staff and develop international cooperation in order to share the most updated information and the so-called *best practices* (Western European Nuclear Regulators Association – WENRA, European Nuclear Safety Regulators Group – ENSREG, etc.).

It is appropriate to consider the possibility of a different approach to nuclear power plant life extension, which, in the Czech Republic, is currently associated with the 10-year periodic safety assessment usual in the EU. It is obvious that extending the working life by 20 years, as practised in the USA and as is also applied by Finland, Hungary and Russia to VVER 440 reactors, is much more beneficial from the point of view of nuclear safety, since it allows for higher one-off investments in enhancing safety with a guarantee of return for operators.

In addition, the owner/operator of reactors in the Czech Republic, ČEZ, a. s., has a functional system of the quality assurance of nuclear safety. It has a good design, technical and research base in the UJV Group. ČEZ is involved in the World Association of Nuclear Operators (WANO), which was formed following the nuclear accident at Chernobyl with the aim of working together to assure operational nuclear safety and following the nuclear accident at Fukushima NPP, expanding the view of the field of safety by design. ČEZ and UJV Group participate in research cooperation within the

Electric Power Research Institute in USA and the Nuclear Generation II & III Association (NUGENIA)[8] in the EU.

Critical prerequisites for ensuring a long-term high standard of nuclear safety

In the area of the Government of the Czech Republic

Continuously support the role of SÚJB in the field of nuclear energy in order to continue to ensure the long-term fulfilment of IAEA recommendations in the field of nuclear safety.

In the area of the State Office for Nuclear Safety (SÚJB)

Ensuring nuclear safety throughout the working life of NNF depends primarily on the quality of licensing procedure, which affects the quantity and quality of such adopted know-how and know-why. For quality preparation, it is highly desirable that the Czech Republic participates in the Multinational Design Evaluation Programme (MDEP).

In the area of the operator

Create the conditions necessary for the maintenance and further development of the required domestic staff and knowledge infrastructure to ensure nuclear safety, in respect of all entities involved in ensuring nuclear safety.

In the area of technical support

Ensure quality and continuous technical support (Technical Support Organization – TSO) without the coherence of assets to the NPP operator.

In the area of research

Ensuring financing in the field of nuclear safety is necessary:

- for the supervisory authority for nuclear safety to ensure the availability of necessary knowledge as well as training of own staff,
- for the support, particularly for operators and other entities, in the field of nuclear energy.

Ensuring financing in the field of science and research (S&R) in nuclear energy is necessary to optimise the operation of NPP and strengthen the role of the Czech Republic in the research of other generations of NPP (GenIV, fast reactors, closed fuel cycle, etc.).

3.2 Minimum Environmental Impact in All Stages of the Life Cycle of Nuclear Energy

From the perspective of the Czech Republic, nuclear energy constitutes a key instrument to ensure a gradual decarbonisation of the Czech energy sector and thus contribute to achieving our European and international commitments in the field of climate protection. However, further development of nuclear power plants as well as all stages of the fuel cycle shall meet strict legal commitments to environmental protection.

[8] http://www.nugenia.org

Sustainability in the field of environmental protection with respect to nuclear energy[9] may be divided into several basic groups. These are health protection, air protection, pollution with regard to noise, water management and water systems, the protection of agricultural land resources and forest management, nature protection and landscape conservation, radioactive waste management and the prevention of severe accidents.

In particular, adequate legislation indicating limit values of individual substances with a potentially adverse impact on human health and air, monitoring the network and periodic evaluation of deviations from measured and permitted values is the condition to ensure the protection of health and protection of the population. In this respect, the main legislative background is formed by Act No. 18/1997 Coll., Act No. 201/2012 Coll., Act No. 100/2001 Coll., and Act No. 258/2000 Coll. Therefore, evaluation and, where appropriate, the adequacy of the emission monitoring network and ensuring not to exceed the maximum permitted values in accordance with the applicable legislation are particularly the condition of sustainability. With respect to the monitoring of the radiation situation, the condition is primarily a multi-stage monitoring in the form of territorial monitoring, the monitoring of the nuclear facility operator and independent monitoring.

In view of the negative impacts caused by increased noise level, it is particularly necessary to ensure an adequate distance of the nearest residential area and residential agglomerations, which is mainly applicable to new potential sites. The project is always assessed by an acoustic study and where the distance separation, which in the case of nuclear energy is determined relatively strictly in the form of safety zones, does not meet the hygienic limits, other effective noise reduction measures are proposed. The above applies primarily to the "non-participating" population; however, the exposure to increased noise level is mainly related to the staff of nuclear facility. In this respect, it is necessary to strictly comply with the safety of work requirements, which in the case of nuclear energy are scrutinised as a result of the special statute of this field. The risk of increased exposure to noise, in respect of staff, is then primarily related to the construction of a new facility rather than the operation of existing facilities.

With regard to agricultural land resources, we can talk about so-called "cumulative effects". From the viewpoint of agricultural land resources, cumulative effects occur mainly where new investment projects of a construction nature are proposed on a "greenfield site" in the context of the already existing or proposed urbanised areas and where there will be a significant use of agricultural land resources or an increase in the proportion of hard surfaces. It then may be reflected, for example, in the increase of unabsorbed stormwater, the acceleration of surface runoff and in a potential threat to the territory particularly in periods of abnormal occurrences such as torrential rains. However, in case of buildings at the existing sites, the impacts on land resources and forest management should be negligible.

While the use of agricultural land resources at a time when it is approved by the competent authorities is very difficult to compensate, the increase in the proportion of hard surfaces or the reduction of area retention may be regulated, to a certain extent, by means of technical solutions to the stormwater management system under each specific project. The principle must also be

[9] The purpose of this Chapter is not to give an exhaustive description of individual groups but rather an indication of basic theses with respect to sustainability issues. Some theses are also of a more general nature and are not only linked to nuclear energy.

respected of not building up in floodplains, in particular where no appropriate flood-protection measures are taken in hydrologically related areas. In this context, it is necessary, at the level of specific projects, to prefer construction of any energy infrastructure in an already urbanised area to construction on a greenfield site and appropriately design the stormwater management system. In relation to the water management, the sustainability of the operation of a nuclear facility is mainly conditioned by ensuring the sufficient quantity of available water primarily for technological processes, utilising natural conditions to avoid any additional intervention at the site concerned. Of course, any contamination of surface and ground water should be consistently evaluated while maintaining the stability of the whole aquatic ecosystem.

In case of the identification of new sites for the construction of NNF, nature protection and landscape conservation should be conditioned by a fitness assessment of the area concerned for the construction of nuclear facility. The identification and designation of protected landscape areas and nature reserves, etc., should prevent the construction of not only energy projects with potentially negative impacts. In this context, it can be stated with respect to the two existing sites that there is no special protection area in the area concerned and the area concerned is not part of any special protection area. The area concerned is also not situated in a national park or a protected landscape area; no national nature reserves, nature reserves, national natural monuments or natural monuments are designated in the area concerned. Furthermore, there are no elements of the territorial system of ecological stability in the area concerned (on the area of intended construction); both elements of the territorial system of ecological stability and significant landscape features are present in the vicinity. Last but not least, the area concerned is not part of a natural park or the Natura 2000 system.

At a very general level, closing the fuel cycle and thus minimising the resulting waste are the condition for sustainable radioactive waste management. However, in case of unclosed fuel cycle, it is crucial to ensure disposal capacities and high safety standards in transportation, disposal and handling of radioactive materials.

The potential severity of the radiation consequences of accidents is related to the level of radioactive fission product activity in the reactor and to the extent of damage to barriers preventing the release of radioactive substances into the environment. In this respect, the assessment of the so-called “design accidents” and the so-called “severe accidents” is the prerequisite. Assessment of the probability of their occurrence as well as possible development and severity. Therefore, it is necessary to ensure the use of the latest safety features and the enforcement thereof.

Last but not least, the importance of legally relevant regulations should be noted, which take into account the environmental impacts of individual designs in their entirety and their strategic importance. In this respect, it is the environmental impact assessment within the meaning of Act No. 100/2001 Coll., on Environmental Impact Assessment, specifically the so-called SEA and EIA procedures.

3.3 High Competitiveness of Electricity Generation in the Nuclear Energy Sector

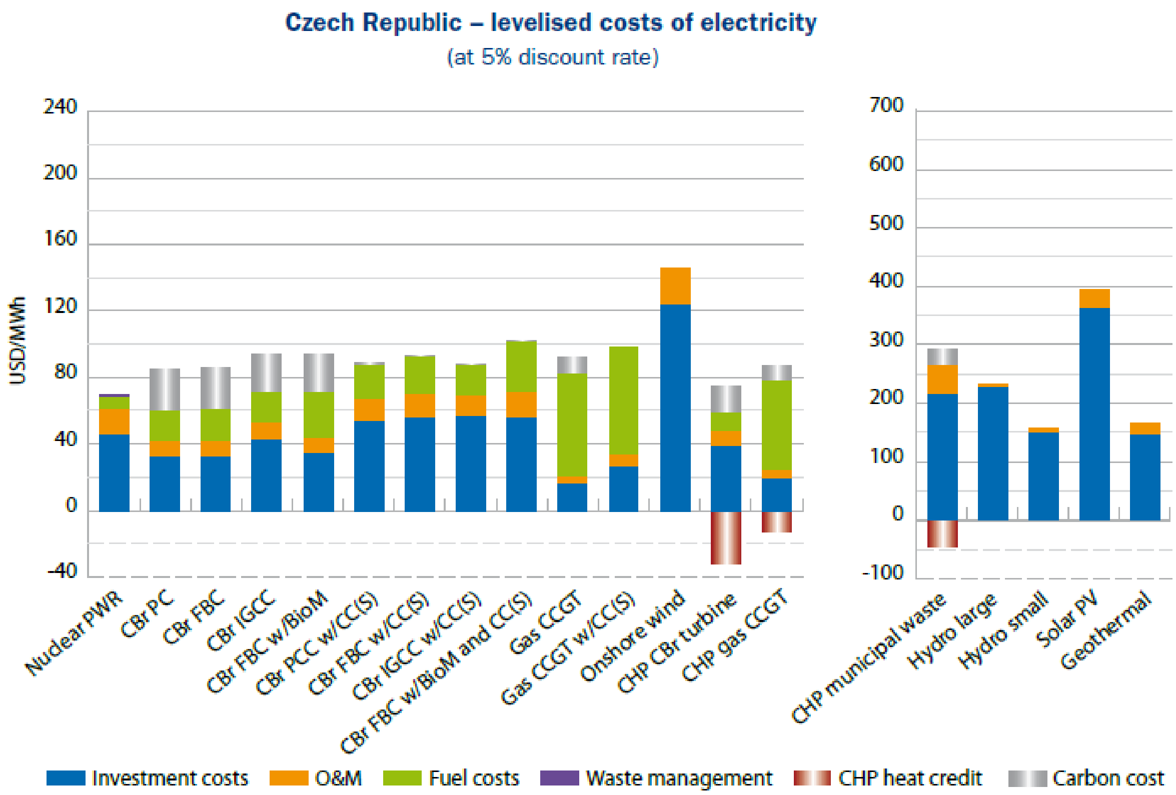
From the viewpoint of economic effectiveness or competitiveness of generation, the following three factors should be taken into account: (1) total costs of construction and operation of a new facility attributable to the generated MWh, (2) the stability and amount of operational costs, even in crisis situations, and (3) the impact on the Czech economy.

Ad 1) The total costs of the construction and operation of the nuclear facility, attributable to the generated MWh, are one of the lowest costs among low-emission facilities generating at basic load. This is due to low operational costs and the fact that large initial investments are dissolved in costs over the long life durability.

Ad 2) The amount and stability of operational costs are important due to the connection of facilities to the system: in the deregulated environment of the energy market, facilities are connected according to the amount of variable/operational costs (the so-called “merit order effect”). For a nuclear facility, these are basically only at the level of fuel costs, which are around 10 EUR/MWh. Even with low scenarios of the development of the energy market, it can hardly be assumed that the long-term electricity price would drop to this level. However, with the prices at such low levels, the facility would not cover its fixed costs and primary investment.

Ad 3) Construction and operation of a new nuclear facility may have significant effects on Czech economy: in case of the construction of a new nuclear facility, up to 70% of the investment will remain in the Czech Republic. The impact of the operation of the nuclear facility on the regional economy is important due to the contracting of local and Czech companies in investing in operation and maintenance.

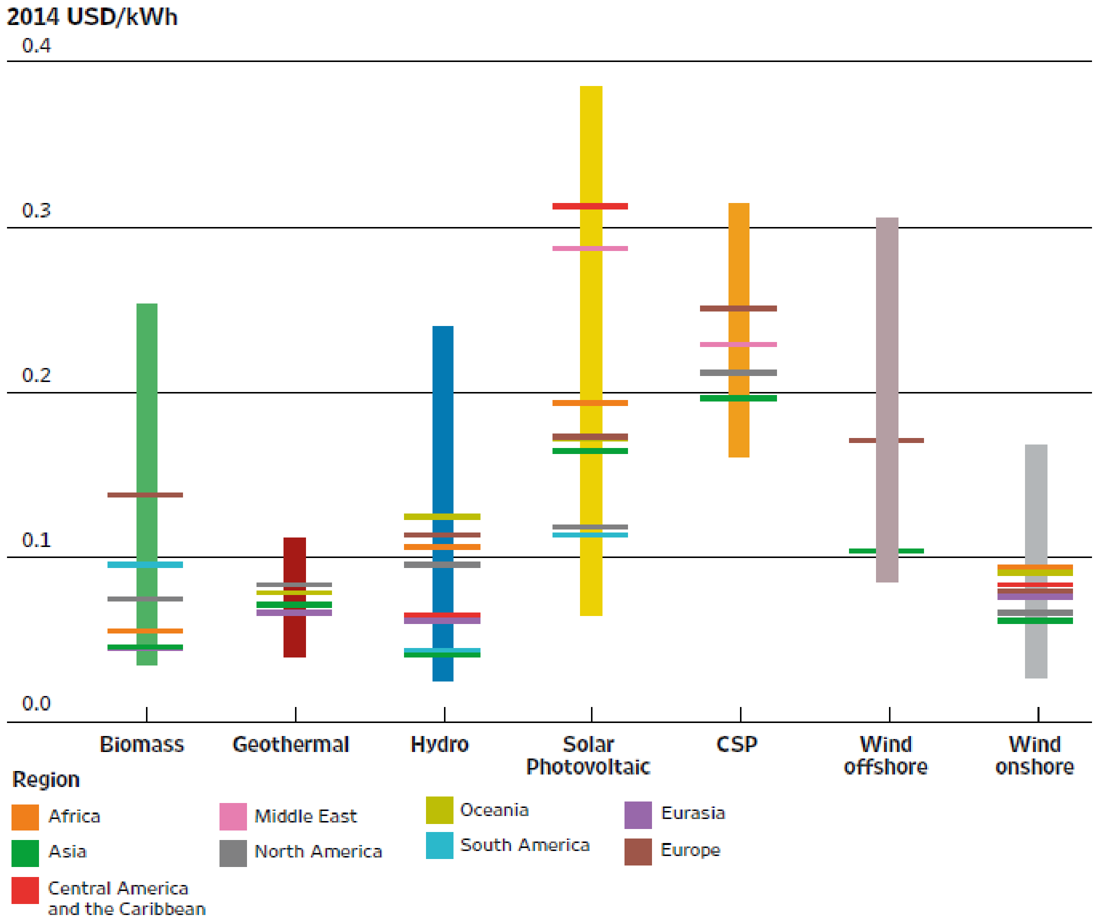
Graph no. 1: *Specific costs of generating electricity for individual types of power plants in the Czech Republic*



Source: IEA (Projected costs of generating electricity, 2010)

The graph above shows the comparison of specific costs of the individual sources of electric power intended to cover their operation in the Czech Republic. In terms of the timeliness of the data, it can be stated that the data set out for the facilities utilising non-renewable forms of energy remain unchanged on a long-term basis. The amount of specific costs for renewable energy sources, on the other hand, still develops, particularly with regard to the prices of individual technologies reflected in the amount of investments in their construction. More recent data for these sources are provided for in the following graph indicating the range of specific costs of generating electricity for individual types of renewables, and weighted averages of such costs for individual world regions including Europe as a whole, containing countries with very different meteorological conditions. However, this graph does not show the specific value for the Czech Republic and therefore, the data should be taken with a good margin. The two graphs indicate that although the trend of the gradual reduction of specific costs of generating electricity in renewables is still maintained, their values still exceed the generating costs achieved by conventional technologies, in particular in the meteorological conditions of the Czech Republic.

Graph no. 2: *Specific costs of generating electricity from renewables in the world*



Source: International Renewable Energy Agency (Renewable power generation costs in 2014, 2015)

3.4 Transparency and Acceptability for the Population

Public acceptance is one of the preconditions for the construction and operation of a nuclear facility. Awareness is essential to achieving it, which is ensured by both the government and the State Office for Nuclear Safety and the operator, and is provided through various channels, and concerns operation as well as further development, advantages and disadvantages of its utilisation. Acceptance changes over time due to a number of factors, part of which is beyond the control of communication channels – including political, economic, social and psychological. Although the probability of severe accidents is at a minimum level, nuclear safety is the main pillar of communication, in addition to security, disposal of radioactive waste and the potential diversion of radioactive materials.

According to the statistics, the majority of the population of the whole Czech Republic as well as both Temelin and Dukovany sites supports the operation of the existing nuclear installations and their development. It can be stated that a transparent communication policy of an operator has proven to be effective to the maximum extent on a medium- and long-term basis. It should objectively be noted that in the case of the Temelin power plant, the so-called "Melk Protocol" was concluded to set up a transparent communication policy, which established the sending of an information report. The subsequent decision of an operator to send the same report to all stakeholders and interested parties may be one of the reasons for the very high rating of transparency in independent surveys at the sites of both Czech NPP. The programme of the meeting of the representatives of the population and the management and staff of both NPP also contributes to the very high rating of the credibility at the NPP sites.

Almost 70% of the population is currently interested in nuclear energy in the Czech Republic. A total of 96% of survey respondents believe that the Czech Republic should remain self-sufficient as far as generating electricity is concerned in the future; 51% of respondents strongly agree. The support of nuclear energy is at the forefront across Europe (surveys in the Czech Republic and Eurostat) and is around 65% - 70% with fluctuations depending on external influences (e.g. Fukushima NPP accident, long-term perspective and clear attitudes - government's attitude).

A similar high rate of transparency and communication shall also be given to the field of nuclear fuel management throughout the fuel cycle. It is obvious that radioactive waste (RAW) and spent nuclear fuel (SNF) must be disposed of in a safe and economic way as well as in a way acceptable to the public. Therefore, the selected solutions shall be not only safe and environmentally friendly, but also generally accepted both at sites where such installations are or should be situated and by the general public. A transparent approach is required for a decision on a certain solution, which includes the opportunity for the public not only to comment on the selected solution, but also actively influence the solution. This necessitates the creation of an adequate institutional and legal framework, reflecting the importance and uniqueness of the repository design.

The basic principle should consist in creating a partnership and finding a balance between interests of the state and interests of municipalities. The three areas mentioned below are significant to such a public involvement process, which need to be fulfilled all at once.

- Availability of information concerning the end of the fuel cycle, and RAW and SNF management.
- Motivation of municipalities forms a standard part of the nuclear installation siting procedure. Advantages for municipalities affected by the siting of a RAW storage facility or repository are usually represented by measures in three areas: monetary support, social benefits and strengthening of the competences of the affected municipalities.

- Involvement of all affected municipalities and other entities in the decision-making process is an important element to make progress in preparing any major project. The “Working Group for Deep Geological Repository Dialogue”, which includes the representatives of both parliament chambers, representatives of non-governmental organisations in addition to the representatives of the state, has been working since 2011 and was transformed into a standing working group of the Government Council for Raw Material and Energy Strategy in 2014. The concept assumes that the long-term partnership programme will be guaranteed by the Government of the Czech Republic.

3.5 Ensuring a Long-term Nuclear Fuel Cycle

Regarding the strategy of the fuel cycle of the Czech Republic, the following applies to its individual areas:

3.5.1 Natural Uranium

Supplies of uranium for the needs of nuclear power of the Czech Republic in accordance with the SEP until 2100 should not cause any problem and its market security is fairly reliable.[10]

In the open fuel cycle option, the demand for natural uranium will stabilise at the level of 1,600 tU/year after 2060. The long-term security of natural uranium supplies after 2100 would then depend on the availability of conventional resources; a switch to non-conventional resources or extraction from seawater is possible as a last resort. The Czech Republic should be involved in research in the field of the utilisation of non-conventional resources in order to provide for access to their stocks on a basis more favourable than a market basis.

Utilisation of domestic uranium should be considered in the light of its potential contribution to the economy of the Czech Republic. In the extreme and unlikely case of disintegration of the global uranium market, domestic uranium may be utilised, using the latest environmentally friendly technologies.

In closed fuel cycle options, the demand for natural uranium shall be gradually reduced after commencement of the substitution of pressurised water reactors for fast reactors. After the transfer has been completed and the equilibrium fuel cycle has been achieved, the demand for uranium shall be reduced to the consumption itself (i.e. fission) and shall drop to the level of 6 tU/year, and uranium in spent fuel or possibly depleted uranium shall be sufficient to cover it for a very long time (a thousand years). The implementation of this option requires involvement in cooperation in developing a fast reactor.

3.5.2 Uranium Conversion to UF_6

As with the supplies of natural uranium, the provision of conversion services for the vision of the development of the nuclear energy sector of the Czech Republic until 2100 should not cause any problem and its market security is fairly reliable.

The need for conversion services for the Czech Republic at the level of 1,500 tU/year is nearly of an order less than the size of plants providing such services (5,000 – 15,000 tU/year). In the event of substantial growth in installed capacity in the region (in particular in Poland and Ukraine), a commercial unit could be taken into account where the installed capacity in the region exceeds approximately 50,000 MWe.

[10] Current forecasts aside from resources, production and demand for natural uranium are provided for in the document "Uranium 2014 Resources, Production and Demand" (2014, OECD; NEA), available from http://www.oecd-nea.org.

3.5.3 Separation (Uranium Enrichment)

Ensuring separation work for the vision of the development of the nuclear energy sector of the Czech Republic until 2100 should not cause any problem, with the need of approximately 800 tSWU/year, which is far below the optimal capacity of 5,000 – 15,000 tSWU/year.

From this perspective and in the current market situation, building a regional capacity is not advisable to consider.

However, the Czech Republic, unlike many states operating VVER reactors, comprehensively contracting the fuel supply with other services of the front end of the fuel cycle, has already diversified the purchase of separation services with the relevant economic impacts.

3.5.4 Nuclear Fuel Fabrication

Fuel for reactors operating today in the Czech Republic is supplied by the TVEL company; Temelin NPP (VVER 1000) was commissioned with Westinghouse fuel.

3.5.5 Interim Spent Fuel Storage Facility

Insufficient interim nuclear fuel storage capacity could potentially cause a temporary shutdown of NPP and therefore, it is crucial to make a timely extension of a storage facility or to implement forced transport of SNF for reprocessing as a last resort, regardless of the economic aspects of that action.

3.5.6 Transport of Spent Nuclear Fuel

Any early deployment of fast reactors or MOX fuel (or advanced fuels with other nuclear elements than only uranium) requires ensuring SNF transport to the state, in which reprocessing would take place. France, Russia and Great Britain are currently under consideration in Europe (others cannot be expected).

The Czech Republic shall ensure these transport routes on a long-term basis, with Austria and Germany being risky from this perspective. The Czech Republic should ensure close cooperation with Poland, SR, Belarus and Ukraine to have a reliable transport route for spent fuel to the state possessing reprocessing capacities.

3.5.7 Nuclear Fuel Reprocessing

Fuel reprocessing for pressurised water reactors makes sense in case of an open fuel cycle only when there is a shortage of natural uranium; from this perspective, premature processing is undesirable for NNF and it is appropriate to have the potential for MOX recycling if necessary.

As regards the closing of a fuel cycle with fast reactors, MOX fuel recycling in light water reactors makes sense; capacities shall be reprocessed only when there is a threat of a shortage.

However, both the volume of glazed waste from reprocessing and the fact that reprocessing with MA separation is not in sight must be carefully considered in both cases.

3.6 Long-term Security of Fuel Supplies

With regard to the long-term security of supplies, the need to diversify nuclear fuel supplier must be accented, in line with the Corfu Declaration and in line with the energy-security strategy of the Czech Republic of 2014. The European Commission has also undertaken to place increased emphasis on the diversification of fuel supplies when assessing new investment projects. In this regard, it must be noted that the current import dependency on one nuclear fuel supplier may pose a risk to the energy security of the Czech Republic. Attention given to the security of nuclear fuel supplies is not an end in itself and is not only a response to the current political situation in Ukraine. This has long been addressed both by international organisations – IAEA, International Energy Agency (IEA), NEA, and the EU itself, as well as countries in which nuclear energy forms an important part of their energy policy.

The European strategy for energy security of May 2014, which has emerged in response to the crisis in Ukraine, states that the Commission shall systematically take the issue of the diversification of fuel supplies into account when assessing new investment projects in the field of nuclear energy and new draft agreements or contracts with third countries.

As to the potential for safe long-term security of fuel supplies for NPP, there are basically the following options (see study of the Pacific Northwest National Laboratory – PNNL[11]):

A. Reciprocal agreement between suppliers relating to the mutual supply of specific fuel quantities.

B. Other specific standby fabrication capacity for nuclear fuel.

C. Formation of nuclear fuel reserves for the given reactor types.

D. Formation of reserves of components for fuel (fuel rods and assemblies), which could be economically stored for the given reactor types.

For Option B, i.e. the construction of a nuclear fuel fabrication plant with the capacity sufficient to cover the VVER fuel market (maximum capacity in three-shift operation 400 t HM/year) supplying the market in normal conditions with approximately 100 t HM/year, the construction process can be divided into two stages - stage 1 (without reconversion from UF_6 to UO_2 powder, i.e. powder production) and stage 2 with UO_2 powder production, which may not necessarily occur. The investor of such a construction project could be a private business entity funded from the state budget. This option shall be further analysed.

From the perspective of the state, a reciprocal agreement between suppliers relating to the mutual supply of specific fuel quantities (Option A) goes beyond the scope of possible measures (this is at the discretion of the manufacturers themselves). Option B, i.e. the construction of a fabrication plant, is highly economically challenging and associated with a number of risks within the permitting procedures. The formation of nuclear fuel reserves for the given reactor types (Option C) is today more or less a used alternative (it has its own economic costs as well as other negative impacts on operators), but it does not secure long-term failure and in case of a crisis, it requires the starting of preparing and licensing the alternative fuel immediately. Option D is a more reduced version of the nuclear fuel fabrication plant.

[11] Redundancy of Supply on the International Nuclear Fuel Market: Are Fabrication Services Assured? PNNL-20861. October 2011.

3.7 Long-term Design of Fuel Cycle Back End and RAW Management

The international community through the IAEA had established the universal principles for the safe utilisation of nuclear energy and ionising radiation, which also apply to the field of RAW management. The fundamental principles are applicable to all countries and all RAW and SNF types, regardless of their physical or chemical characteristics or their origin. The Czech Republic, as a Member State of the IAEA, shall carry out RAW and SNF management in accordance with the following principles:

- **Responsibility for safety:** The primary responsibility for the safety rests with the person or organisation who is responsible for facilities or activities that give rise to radiation risks.
- **Role of government:** An effective legal and governmental framework for safety shall be established and maintained, including an independent regulatory body.
- **Safety management and assurance:** An effective safety management and assurance system shall be introduced and maintained in organisations having relation to facilities or activities that pose radiation risks.
- **Reasons for facilities and activities:** Facilities or activities that give rise to radiation risks shall generate overall benefits.
- **Protection optimisation:** Protection shall be optimised to ensure the highest level of safety that can reasonably be achieved.
- **Individual risk reduction:** Measures to control radiation risk shall ensure that no individual sustains an unacceptable risk of injury.
- **Protection of present generation and future generations:** People and the environment shall be protected against radiation risks today as well as in the future.
- **Accident prevention:** All practical measures shall be implemented to prevent nuclear or radiation accidents.
- **Emergency preparedness:** Emergency preparedness shall be ensured for the case of a nuclear or radiation accident.
- **Protective measures to reduce existing or unregulated radiation risks:** Protective measures to reduce existing or unregulated radiation risks shall be justified and optimised.

Other related measures include:

- **Public participation in the decision-making process:** Decisions that may have a potential impact on health, society or the environment should be made with the participation of those concerned.
- **Sustainable development:** Due to the long time, for which radioactive waste shall be disposed of in a safe manner, all aspects of sustainability should be taken into consideration. Therefore, it is necessary to ensure that the needs of the present generation are satisfied, without restricting the possibilities for future generations to satisfy their needs.

Radioactive waste is defined as “substances, objects or equipment containing or contaminated with radionuclides, for which no further use is foreseen”. Radioactive waste materials are classified as gaseous, liquid and solid. Solid radioactive waste materials are classified into three basic categories - transition, low- and intermediate- and high-level RAW:

- Transition radioactive waste is waste that has a radioactivity level lower than clearing levels after long-term storage (maximum 5 years);
- Low- and intermediate-level radioactive waste is classified into two subgroups - short-term waste, containing radionuclides with a half-life less than 30 years (including ^{137}Cs) and long-term waste that is waste not included in the subgroup of short-term RAW;
- High-level waste is waste that shall be stored and disposed of taking account of heat release from the decay of the radionuclides contained therein.

Spent nuclear fuel from nuclear power plants is not radioactive waste. Until the spent nuclear fuel is declared to be a radioactive waste by its producer or SÚJB, its producer is obliged to ensure its management so as not to make the possibility of its further conditioning harder. The SNF contains over 90% of the volume quantities of material that can be further used for generating electricity in next-generation reactors after processing.

In the Czech Republic, the responsibility for safe RAW and SNF management is shared between producers who ensure its collection, sorting, processing, storage and transport, and the state that is responsible for the safe disposal of waste; the state also creates conditions for the activity of an independent regulatory body (SÚJB, CMA, ME).

The major producers of radioactive waste in the Czech Republic include the following companies: ČEZ, a. s., operating the Dukovany NPP and Temelin NPP, Research Centre Rez, Ltd, operating research nuclear reactors, and ÚJV Řež, a. s., processing and conditioning into a form suitable for disposal more than 90% of all institutional RAW. In addition, there is a large number of minor producers who use ionising radiation sources in the industry, health sector or research.

The Radioactive Waste Repository Authority was established by the Ministry of Industry and Trade as an organisational body of the state to ensure activities linked to radioactive waste disposal. The RAWRA carries out various activities under a licence issued by the SÚJB.

3.7.1 Estimate of Future Quantities of RAW and SNF

About 30 to 50 m^3 of institutional waste per year is currently produced. It is envisaged that its production in the future will be about the same size as in the present, apart from a short period of increase in its quantity over the following five to ten years as a result of the removal of environmental damage in ÚJV Řež, a. s., (100 to 200 m^3/year). In the longer term, waste resulting from the decommissioning of research facilities of ÚJV Řež, a. s., should be taken into account. As a result of decommissioning of nuclear installations, a relatively large quantity of waste will be produced.

<u>Estimate of future quantities of low- and intermediate-level waste (LLW and ILW) meeting the acceptance conditions for near surface repositories</u>

For an estimate of the future quantities of LLW and ILW including estimate of waste that could result from new nuclear facilities see Table 1.

Table 1: *Balance of low- and intermediate-level conditioned waste meeting the acceptance conditions for near surface repositories (conservative estimate)*

Waste designation	Volume [m³]
Operational waste from NPP	
60 years of life of operated NPP	18,300
60 years of life of NNF	10,200–23,200 *)
Low- and intermediate-level radioactive waste from the decommissioning of nuclear power plants	
60 years of life of operated NPP	10,800**)
60 years of life of NNF	7,200**)
Institutional waste	
operational waste (60 years)	2,000
waste as a result of environmental damage and the decommissioning of nuclear installations	1,500 ***)

**) The estimate of waste production from NNF is based on a general requirement for Generation III advanced reactors to produce less than 50 m³ of conditioned RAW per 1 GW of installed capacity and on data stated by potential contractors for NNF in their offered type projects.*

***) The estimate of waste production is comparable for all decommissioning options.*

****) This includes waste resulting from the decommissioning of all organisations holding a licence for RAW management; the balance of waste as a result of environmental damage is considered on a conservative basis, without possible release into the environment.*

Estimate of future quantities of intermediate- and high-level waste destined for a deep geological repository

This waste group includes mainly activated process material and objects that are stored at the NPP throughout the operation. This waste shall be disposed of during decommissioning of NPP (e.g. activated measuring transducers, thermocouples, inserted rods, surveillance specimen assemblies, absorbers). RAW will arise during the decommissioning of NPP, which shall be disposed of in a deep geological repository (DGR) due to exceeding the limit values of concentration of reference radionuclides activated in reactor components following the end of operation.

Table 2: *Balance of waste unacceptable to near surface repositories*

Waste designation	Weight [t]
Operational waste, operated NPP and NNF (60-year life)	140
Waste as a result of NPP decommissioning (operated NPP and NNF)	4,200
Institutional waste: • as a result of decommissioning of an experimental reactor • stored in the Richard repository	20 64 (189 drums)

Estimate of future quantities of SNF from nuclear power plants

The estimate of future quantities of SNF was made in the updating of the reference project in 2009. The data in Table 3 include an overall production of SNF (including already stored SNF) and considered SNF for the operation of existing NPP for a period of 40 and 60 years, and for NNF for a period of 60 years. In the case of NNF, three units with the same capacity are envisaged.

Table 3: *Balance of SNF to be placed in a deep geological repository*

Operating time	Dukovany NPP 1 - 4 [t TK]	Temelin NPP 1,2 [t TK]	NNF (2 + 1) [t TK]	**Total [t TK]**
40 years	1,740	1,750	---	3,490
60 years	2,430	2,470	5,010	9,910

The strategy for SNF management on the basis of a techno-economic assessment does not exclude the possibility of further recycling SNF in the form of MOX fuel in light water reactors or using plutonium from the reprocessing of SNF in Generation IV fast reactors, if commercially available. High- and intermediate-level waste will have to be placed in a deep geological repository.

Estimate of future quantities of SNF from LVR-15 research reactor

Low-enriched IRT-4M spent nuclear fuel (enrichment 19.7%) will further result from the operation of the LVR-15 reactor. Until the planned end of reactor operation (2018), 136 fuel assemblies of IRT-4M will be produced. In the event of the extension of reactor operation until 2028, the total quantity of SNF will be 286 fuel assemblies. About 2 m^3 in total of vitrified waste containing fission products and minor actinides will be produced as a result of reprocessing.

3.7.2 Management of Low- and Intermediate-level Waste from Nuclear Power Plants Destined for Near Surface Repositories

The reactor coolant is a crucial source for the activity of liquid media. The processing of contaminated liquid media is driven by both efforts to concentrate the activity in the smallest possible volume and necessity to take account of further steps in the management of this RAW, in particular conditioning into a form, which meets the acceptance criteria of the given radioactive waste repository (RAWR). Solid RAW is produced particularly during regular reactor outages, during maintenance and cleaning operations, decontamination of facilities and rooms, in laboratories, etc. Its composition depends on the mode of reactor operation. The basic operation in the solid waste management process is the sorting of inactive proportion, which can be released into the environment after radiochemical control. Solid or solidified RAW compacted in 200-litre steel drums is characterised and subsequently transported to the Dukovany RAWR for disposal. Operational waste from nuclear power plants is placed in the Dukovany RAWR, which has been continuously operational since 1995. The total volume of the disposal rooms of 55,000 m^3 (approximately 180,000 drums) is sufficient for the disposal of all low- and intermediate-level waste from the existing Dukovany and Temelin power plants. The current capacity of the Dukovany RAWR could be exhausted around 2050. The missing capacity for the disposal of LLW/ILW will be provided after the consideration and evaluation of several alternatives, e.g. by expanding the Dukovany RAWR, building a repository on a new site or depositing LLW/ILW in the complex of a deep geological repository for high-level waste (HLW) and SNF under development. The existing technologies for RAW conditioning and processing also have the ability to process the foreseeable quantities of RAW from a radiation accident. At the end of 2013, the Dukovany repository was 17% filled and there will always be sufficient free capacity in the coming decades. It will be possible to use storage facilities of RAW producers for the storage of RAW not meeting the acceptance criteria and, where appropriate, reserve some sumps in the Dukovany RAWR for temporary storage.

The basic concept of SNF management is deep geological disposal in a repository built in the territory of the Czech Republic. However, it is not excluded that we will choose to reprocess SNF in the future. The use of reprocessed SNF for fuel in fast reactors would result in a significant reduction in the quantity of waste to be deposited in a deep geological repository**. As regards storage capacities and the strategy for final disposal, it is necessary to put a deep geological repository into operation around 2065. The site should be selected by the end of 2025. Construction should start after 2050**, when the clarification of the issue of using SNF for fuel in Generation IV reactors is expected, i.e. specification of the quantity of high-level waste for final disposal.

3.7.3 Storage of SNF from Power Reactors

In the Czech Republic, the responsibility for the storage of SNF from power reactors lies with ČEZ, a. s. In the basic option of ČEZ, a. s., the spent nuclear fuel removed from the reactor is stored in a spent nuclear fuel pool (approximately 7–10 years) and then in dry storage facilities (approximately 40–60 years), which are primarily situated at power plant sites. In its strategy, ČEZ, a. s., has declared its intention to hand over SNF to the RAWRA for disposal after 2065. The operated storage capacities for SNF from the existing units of the Dukovany NPP are sufficient for 45 years of operation. In the case of the operated Temelin NPP Units 1 and 2, the storage capacity covers about a 30-year operation. An additional storage facility will have to be built for the period of operation under consideration in the basic option of 50 years. To extend the operation to the planned 50 years, the storage capacity needs to also be expanded for the existing units of the Dukovany NPP. In the case of the 60-year operation of existing units, other storage capacities of approximately 1,580 t TK would have to be provided.

In the updated reference project of 2011, the deep geological repository is designed so that its facilities can hold SNF from the operated NPP, i.e. 4 units of the Dukovany NPP, 2 units of the Temelin NPP and the planned new nuclear facilities (2 units of the Temelin NNF and 1 unit of the Dukovany NNF). It is expected that the deep geological repository will also take RAW from the decommissioning of the existing NPP as well as the planned NNF and other RAW that cannot be deposited in nearby surface repositories. The site will be selected in several phases (stages) of gradual reduction of the number and areal extent of the sites. During the first stage of the selection procedure, the available data will be revised and a surface geological survey will be carried out without work involving operations carried out on parcels. This stage will result in the reduction of the number of potentially suitable sites where detailed geophysical, geochemical, hydrogeological and geotechnical measurements using deep boreholes (2–4 boreholes to depths of 500 m and 1–2 boreholes to depths of 1,000 m) will be carried out in the subsequent stage. The suitability of at least two finally selected sites will be documented by means of material to the extent of the Initial Safety Analysis Report, which shall confirm by means of arguments, at a conceptual level, the operational and long-term safety of a repository and by means of feasibility studies and environmental impact assessment for a repository siting. A systematic assessment of all potential sites for the siting of a deep geological repository will be carried out in all stages according to the following criteria:

- Safety criteria
- Design criteria
- Environmental criteria
- Socio-economic criteria

Involvement of all affected municipalities and other entities in the decision-making process for the selection of the site is taken into account at all preparation stages of a deep geological repository.

3.7.4 Waste As a Result of the Operation and Decommissioning of Nuclear Power Plants

Waste that cannot be deposited in near surface repositories is produced by the operation and decommissioning of nuclear power plants. It is a part of activated material stored throughout the operation in NPP and a certain fraction of waste from decommissioning (activated measuring transducers, thermocouples, surveillance specimen assemblies, absorbers, pressure vessel weld deposits, in-core components, serpentine concretes and backfills, etc.). This waste will be conditioned within the framework of decommissioning to be accepted in a deep geological repository. Concrete packagings with an outer and inner steel case (the so-called "concrete-containers") have been designed for its disposal. Further research and development of packagings will be undertaken on an iterative basis in cooperation with the RAWRA and producers. Conveying and handling systems will be designed at the same time as the design of packagings to allow for their receipt, inspection and placement in restricted areas.

3.7.5 Financing of RAW Disposal

Pursuant to the Atomic Act, a nuclear account was opened to cover all activities relating to the disposal of RAW and SNF in the future. This account is opened with the Czech National Bank, with the Ministry of Finance of the Czech Republic being responsible for its management. Funds collected on the nuclear account may be only used through the RAWRA to fulfil the tasks defined in the Atomic Act and included in the work plan of the RAWRA for that year. Funds are derived from several sources.

The management of funds on the nuclear account is carried out under the work plan approved by the government; the amount and methods of payment are set out by the government in its regulations. The RAWRA is responsible for the management of payments into the nuclear account and prepares documents to fix them. The value of assets on the nuclear account as of 31 December 2014 is CZK 22.7 billion. A significant part of the payments into the nuclear account shall cover the costs of activities to be carried out in the future. The methodology for the determination of the amount of payments is based on the existing price ranges and takes account of the known estimated costs, risks and other relevant factors (e.g. expected development in the national economy, interest rates, inflation) and respects the concept of RAW and SNF management. The creation of funds of the nuclear account shall be compared, in adequate, no longer than, five-year intervals, with the expected future expenses and in case of major differences, the relevant government regulation shall be amended.

<u>Costs of waste disposal in near surface repositories</u>

Costs relating to the operation and enclosure of the existing repositories shall be covered by funds of the nuclear account that are paid by the nature and quantity of the waste to be disposed of by individual producers of the radioactive waste to be disposed of. Payments to cover such costs shall be determined according to the relevant methodology and provided for in the up-to-date government regulation in the form of one-off or periodic payments. Radioactive waste repositories have been operational for some decades and no reserve funds have been created prior to the entry into force of the Atomic Act to cover future costs-relevant items (in particular, decommissioning and enclosure of repositories). Therefore, the state provides resources to cover the management of such RAW. Burdens of the state include mainly the following items:

- Maintenance of mining works and repairs of process equipment;
- Environmental impact monitoring, both during the operation of repositories and after decommissioning;
- Preparation for the decommissioning of repositories – development of the sealing technology for storage chambers and the enclosure of parts of repositories.

The costs of operation of low- and intermediate-level waste repositories (Dukovany, Richard, Bratrství) are CZK 50–60 million per year. They mainly cover the storage operations, maintenance of plots, built structures, process equipment and underground areas (Richard and Bratrství), radiation protection, physical protection, fire safety, technical safety, emergency preparedness and environmental impact monitoring. In addition, they include overhead costs incurred by the RAWRA and contributions to municipalities, in the cadastral area of which the repositories are operated. The estimated total costs of the disposal of short-term low- and intermediate-level waste in a period until 2050 are provided in Table 4 (CZK million in prices of 2013).

Table 4: *Overview of costs of low- and intermediate-level waste disposal*

Type of costs	Sum [CZK million]
Operation of repositories	2,100
Research and development	110
Enclosure of repositories	310
Institutional control after enclosure	730
TOTAL COSTS	**3,250**

Costs of spent nuclear fuel disposal and of waste non-disposable in near surface repositories

Funds to cover the costs of the preparation, construction, operation and enclosure of a deep geological repository, of conditioning the SNF into a form appropriate to disposal and of SNF or RAW disposal shall be paid from the nuclear account. Basic technical and economic information for the assessment of the costs of a deep geological repository in the Czech Republic has been provided in the reference project for a deep geological repository of 1999, updated in 2011. Table 5 provides estimates of DGR construction and operation costs (CZK million in prices of 2011).

Table 5: *Estimated costs of DGR*

Type of costs	Sum [CZK million]
Total construction costs including R&D	36,700
Operation including enclosure of the repository	42,100
Casks	32,600
TOTAL COSTS	**111,400**

3.8 Creation of a Sufficient Reserve for Decommissioning

The method of creating a reserve to ensure the decommissioning of a nuclear installation of category III or IV workplace is set out in Regulation of the Ministry of Industry and Trade No. 360/2002 Coll. This regulation imposes an obligation on licensees authorised for nuclear facility operation to create a reserve for decommissioning, where the decommissioning cost estimate pursuant to Regulation No. 185/2003 Coll., exceeds CZK 300,000. The size of the reserve for decommissioning for a taxable period is determined as the share of the estimate of the total decommissioning costs to the number of years, which elapse from the time of issuing a licence for active testing to the expected termination of the decommissioning process. In the update of the decommissioning cost estimate, the licensees create a reserve for decommissioning for a taxable period, in which the costs have been updated, as the share of the variance of updated costs and already created funds for decommissioning to the number of years remaining to the expected termination of the decommissioning process. Details of the determination of the financial reserve are provided for in this regulation.

Within the European Union, there are three basic types of reserve financial fund models adopted by Member States:

- Earmarked internal fund managed by the operator of the installation as an autonomous budget, the funds from which may only be used for the purposes of decommissioning and waste management, and which is under supervision of the national body. Funds of this type exist, for example, in France, Belgium and the Czech Republic;
- Earmarked external fund not managed by the operator of the installation. Such funds exist in Finland and Sweden, where they are independent of the state budget, and in Hungary, Romania, Slovakia and Bulgaria, where the funds in some way form a part of the state budget;
- Non-earmarked internal funds exist in Germany, where companies operating nuclear power plants are required by commercial law to create significant reserves on their balance sheets for the costs of future decommissioning and waste management.

The European Commission, together with the Nuclear Energy Agency, has drawn up and proposed the "Yellow Book" containing the methodology for calculating decommissioning costs. Although this method for calculating or comparing with reference indicators is strongly recommended, it is not a mandatory procedure. However, in some countries, it could serve as a model for the improvement of methodologies therein. The "Yellow Book" has recently been updated and replaced by the "International Structure for Decommissioning Costing", issued by the Nuclear Energy Agency in 2012. There are not yet equivalent means of the evaluation of the costs associated with nuclear waste.

The system in the Czech Republic is set to create the reserve for the decommissioning (liquidation) of a nuclear facility separately from funds earmarked to finance the future disposal of radioactive waste and spent nuclear fuel. Whilst decommissioning is financed through resources that are not removed from the balance sheet of the operator, radioactive waste and spent nuclear fuel disposal is covered from payments into the Nuclear Account. If the decommissioning cost estimate exceeds CZK 1 billion, the operator of a nuclear facility shall be obliged to pay the reserve funds into a special escrow account with a bank established in the territory of the Czech Republic. Therefore, the issue in this case is not the reserve in the accounting sense of the term, because a reserve in accounting forms an unspecified part of assets. But reserve funds here actually have the monetary meaning. The account holder is entitled to use funds on the escrow account only with the approval of the competent authority – in the case of decommissioning reserves, the RAWRA is the competent authority.

Therefore, licensees are obliged to create financial reserves to cover the decommissioning of nuclear installations or workplaces with significant or very significant ionising radiation sources. Funds must be available for the preparation and implementation of decommissioning in the required time and amount, in accordance with the schedule approved by the State Office for Nuclear Safety and decommissioning technology. The decommissioning costs shall be verified by the RAWRA and licensees are obliged to update the estimates in accordance with the relevant regulation at five-year intervals. The update specifies the cost estimate and includes the movement in the price level for the past five years.

A generally accepted deterministic approach under the "Standard List" is applied for the creation of the cost estimate in the Czech Republic. The valuation of individual activities is based on the price lists provided by suppliers, catalogue prices and expert estimates. As for expert estimates, the experience gained from the decommissioning of other nuclear facilities may be used as a basis.

The cost estimate is updated on a five-year basis. For example, the Proposal for Nuclear Installation Decommissioning Method for Temelin NPP of 2009 is drawn up in three options (in prices of 2009):

a) Immediate decommissioning - termination date of decommissioning 2065, decommissioning costs CZK 13,712 million;
b) Deferred decommissioning - safe enclosure, termination date of decommissioning 2087, decommissioning costs CZK 12,794 million;
c) Deferred decommissioning - safe enclosure of active buildings, termination date of decommissioning 2091, decommissioning costs CZK 14,579 million.

The option c) Deferred decommissioning with a termination date of decommissioning in 2091 is the preferred option provided that in the case of a change in the strategy, a sufficient reserve shall be created to cover the remaining two options.

For a summary overview of the amount of decommissioning reserves see Table 6 (in CZK million in prices of the year of drawing up an updated estimate).

Table 6: *Overview of decommissioning costs*

Decommissioning costs	Amount [CZK million]
Reserve for decommissioning of Dukovany NPP (2012)	22,355
Reserve for decommissioning of Temelin NPP (2009)	14,579
Reserves for decommissioning of SNF storage facilities (2010)	46
Other reserves for decommissioning (2012)	470

3.9 Clear Definition of the Civil Liability for Nuclear Damage

Compared with the general liability regime for damage caused by particularly dangerous operation, the liability regime for damage caused in connection with the peaceful utilisation of nuclear energy for power generation (or non-power) purposes (the so-called "civil liability for nuclear damage") has a number of specific features, of which the following features are of prime importance:

- It implies that any damage event occurred in a nuclear installation would have not only a national but mostly a regional (cross-border) impact and therefore, the international community of the states feels the need to modify the liability regime in the form of multilateral international conventions,
- The peaceful utilisation process of nuclear energy is participated in by a number of entities (technology supplier, contractor, nuclear fuel supplier, nuclear installation operator), with a clear definition to be made to determine who is liable in the event of damage,
- The liability for damage must be adequately insured or otherwise financially secured,
- Due to the cross-border nature of possible damage, it is necessary to adjust the rules on jurisdiction (i.e. to designate the courts having jurisdiction to hear actions for damage compensation),
- It is also necessary to fix the time-limit within which the injured parties shall take their claims for compensation to court,

- The state identifies the sector of the peaceful utilisation of nuclear energy as a key segment of the national economy and therefore, it enters the liability relationships by limiting the operator's liability (which ultimately protects the operator against the risk of financially destroying suits) and by providing its own guarantees (which protect injured entities against the risk of incomplete compensation for the damage suffered).

The reasons above led the international community of states to adopt a number of multilateral treaties before 1986. They are (the so-called "first-generation treaties") listed below:

- Paris Convention on Third Party Liability in the Field of Nuclear Energy of 1960, adopted under the auspices of the Organisation for Economic Cooperation and Development (OECD) as a regional convention on liability for Western Europe,
- Brussels Convention of 1963 Supplementary to the Paris Convention on Third Party Liability in the Field of Nuclear Energy of 1960, adopted under the auspices of the Organisation for Economic Cooperation and Development (OECD) as a regional convention on liability for Western Europe,
- Vienna Convention on Civil Liability for Nuclear Damage of 1963, adopted under the auspices of the International Atomic Energy Agency (IAEA) as a convention on liability, open to all states in the world,
- Convention relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material of 1971, adopted under the auspices of the International Maritime Organization (IMO).

The provisions of the international conventions listed above incorporate the following principles, which govern the liability for nuclear damage:

- **Objective liability of the operator of a nuclear installation**, i.e. the operator is held liable irrespective of fault (however, in principle, with the possibility of liberation in exceptional cases, e.g. in case of war, severe natural disaster, riots, etc.),
- **Exclusive liability of the operator of a nuclear installation**, i.e. exclusion of the liability of any other entity (technology supplier, designer, fuel carrier, etc.) for damage caused by an event which occurred in a nuclear installation,
- **Limited liability of the operator**, i.e. limitation of the maximum sum, to which the operator is liable for damage done,
- **Specific setting of objective and subjective time limit for the bringing of a claim for nuclear damage** (taking into account the fact that harmful effects of exposure may become apparent in a longer time interval),
- **Obligatory insurance** or any other financial security of the liability of the operator of a nuclear installation, aimed at guaranteeing the existence of financial resources in case of a claim for damage,
- Specific legislation on **jurisdiction**, with the exclusive court of competent jurisdiction for the resolution of claims for compensation in the territory of that state where the accident occurred.

Significant developments in the field of international legislation on the liability for nuclear damage took place after 1986. A number of new international conventions have been adopted, in particular, aimed at increasing the amount of financial resources for the sake of an accident in a nuclear installation, extending the time limit for the bringing of a claim for compensation and defining more broadly the range of damages, for which the operator is liable. The following international conventions (the so-called "second-generation treaties") were adopted in response to the Chernobyl nuclear accident:

- Joint Protocol relating to the Application of the Vienna Convention and the Paris Convention of 1988, adopted under the auspices of the International Atomic Energy Agency (IAEA) for the purpose of "connecting" both existing liability systems (Paris and Vienna),
- Protocol of 1997 to Amend the Vienna Convention on Civil Liability for Nuclear Damage, adopted under the auspices of the International Atomic Energy Agency (IAEA) for the purpose of optimising the liability system, developed under the Vienna Convention of 1963,
- Convention on Supplementary Compensation for Nuclear Damage of 1997, adopted under the auspices of the International Atomic Energy Agency (the Convention has not yet entered into force),
- Protocol of 2004 to Amend the Convention on Third Party Liability in the Field of Nuclear Energy of 1960, and
- Protocol of 2004 to Amend the Convention of 1963 Supplementary to the Paris Convention of 1960 on Third Party Liability in the Field of Nuclear Energy, adopted under the auspices of the Organisation for Economic Cooperation and Development (OECD) for the purpose of optimising the Paris Convention of 1960 and the Brussels Convention of 1963 (the Protocols of 2004 have not yet entered into force).

"Second-generation" international treaties are based on the same liability principles as "first-generation" international treaties (exclusive liability of the operator, liability limitation, obligatory insurance, exclusive jurisdiction). Their value resides in the optimisation of the liability regime using the following instruments:

- The liability regime of "second-generation" international treaties covers a wider range of installations (in particular, radioactive waste and spent nuclear fuel repositories, nuclear installations under decommissioning, etc.),
- Increase in the minimum limits of liability for the operator, including limits of obligatory insurance,
- Geographical and type expansion of the range of damage for which the operator of the installation concerned is held liable.

In the field of civil liability for nuclear damage, the Czech Republic (like most countries of the Central and Eastern European area) is a party to two international conventions (Communication of the MFA No. 133/1994 Coll.), concluded under the auspices of the IAEA, namely:

- Vienna Convention on Civil Liability for Nuclear Damage of 1963 (hereinafter referred to as: "VC 1963"),
- Joint Protocol relating to the Application of the Vienna Convention and the Paris Convention of 1988 (hereinafter referred to as: "JP 1988").

The treaties listed above are not "self-executing" treaties, since the individual provisions thereof assume implementation (more detailed specification) in the legal system of contracting parties. In the Czech Republic, the provisions of the international treaties mentioned above were transposed into national law by way of **Act No. 18/1997 Coll., on the Peaceful Utilisation of Nuclear Energy and Ionising Radiation (the Atomic Act) and on Amendments and Additions to Related Acts** (hereinafter referred to as: the "Atomic Act"), which includes in Section 32(1) the so-called "reference clause" to the VC 1963 and JP 1988. This reference to the international conventions brings the licensees authorised to operate a nuclear installation within a specific system of liability, established by the VC 1963 and JP 1988, as well as the provisions of Chapter Five of the Atomic Act and subsidiary-applicable provisions of the Civil Code. The provisions of legislation governing the insurance sector will continue to be applicable to obligatory insurance. The legislation mentioned above sets up a liability framework that may be characterised as follows:

- The licensee licensed for operation of a nuclear installation is an entity, which has sole liability in case of "nuclear damage",
- "Nuclear damage" means the loss of life, any personal injury or any loss of, or damage to, property which arises out of or results from the radioactive properties or a combination of radioactive properties with toxic, explosive or other hazardous properties of nuclear fuel or radioactive products or waste in, or of nuclear material coming from, originating in, or sent to a nuclear installation. Nuclear damage shall also be damage arising in the form of costs of measures necessary to prevent or reduce exposure or restore the original or equivalent state of the environment, if these measures were made necessary by a nuclear event and the nature of the damage thus permits,
- "Nuclear installation" means "any nuclear reactor other than one with which a means of sea or air transport is equipped for use as a source of power, whether for propulsion thereof or for any other purpose; any factory using nuclear fuel for the production of nuclear material, or any factory for the processing of nuclear material, including any factory for the re-processing of irradiated nuclear fuel; and any facility where nuclear fuel is stored, other than storage incidental to the carriage of such material",
- In accordance with the VC 1963, the liability of an operator for nuclear damage caused by each single nuclear event shall be limited to the sum of CZK 8 billion for the case of damage, caused by accidents in nuclear installations used for power generation purposes, storage facilities and repositories of nuclear fuel, or to the sum of CZK 2 billion for the case of damage, caused by accidents in other nuclear installations (e.g. research reactors) and in the shipment of nuclear material,
- The operator shall be required to maintain insurance or other financial security covering his liability, while the sum insured for the first type of liability (operator's liability to the amount of CZK 8 billion) shall not be less than CZK 2 billion and for the second type of liability (operator's liability to the amount of CZK 2 billion) shall not be less than CZK 300 million,
- The VC 1963 provides that a contracting party shall ensure the payment of claims for compensation for nuclear damage which have been established against the operator by providing the necessary funds to the extent that the yield of insurance or other financial security is inadequate to satisfy such claims, but not in excess of the limit, if any, established pursuant to national regulation; this obligation is reflected in the Atomic Act, which sets out the state guarantee for the payment of established claims for compensation for nuclear damage, unless they are paid from compulsory insurance or other established financial security up to the amount of CZK 8 billion after exhaustion of the compensation of the insurer to the extent of CZK 2 billion *and vice versa* also for the second type of liability,
- The objective period for claims for compensation for nuclear damage is 10 years; the subjective period for such claims is 3 years,
- Jurisdiction over actions for compensation shall lie only with the court of the state within whose territory the event occurred in a nuclear installation.

From the perspective of the Czech Republic as an important (Central) European "nuclear" state, the issues of future modification of liability for nuclear damage may be seen in the following context:

- The Czech Republic is a party to the VC 1963 and the JP 1988. It is also a State signatory to two international conventions in the field of nuclear liability, which have not yet been ratified by the Czech Republic: Protocol of 1997 to Amend the Vienna Convention on Civil Liability for Nuclear Damage (hereinafter referred to as: "VC 1997") and the Convention on Supplementary Compensation for Nuclear Damage of 1997 (hereinafter referred to as: the "CSC 1997"),
- The process of ratification of the Protocols of 2004, which amend the two international conventions mentioned above, is currently under way in the Western European states, which are parties to the Paris Convention on Third Party Liability in the Field of Nuclear Energy of 1960 and the Brussels Convention of 1963 Supplementary to the Paris Convention of 1960. As part of the revised Paris-Brussels system of liability and compensation (i.e. system established by the Paris Convention of 1960, as amended by the Protocol of 2004 and the Brussels Convention of 1963, as amended by the Protocol of 2004), combining the insurance of the operators, public funds of individual Contracting States and common international fund will create a financial mass in the amount of EUR one and a half billion to compensate for each event in a nuclear installation, which occurs in the territory of the Contracting States to this system,
- The accession or ratification process of the VC 1997, backed and supported by the International Atomic Energy Agency, is currently under way in the Central and Eastern European states, which are parties to the VC 1963. Some of the states have already ratified the Protocol of 1997 (Romania, Latvia, Poland); other states are State Signatories thereto, but have not yet ratified it (those states include the Czech Republic as well as Hungary, Lithuania, and Ukraine),
- The European Atomic Energy Community (Euratom) has recently joined the two traditional international organisations, which are active in the field of nuclear liability (the Organization for Economic Cooperation and Development as the guarantor for the Paris-Brussels system and the International Atomic Energy Agency as the guarantor for the Vienna system). It can be assumed that the Euratom will aim to create a certain form of its own harmonised legal framework in the field of liability and compensation in response to the Fukushima accident,
- The ratification of the VC 1997 by those EU Member States, which are currently parties to the VC 1963 (Czech Republic, Slovakia, Hungary, Latvia, Estonia, Bulgaria) was authorised by the EU by decision of 15 July 2013 (Council Decision 2013/434/EU),
- Lastly, it is worth noting that the United States of America (USA) is also active in this field, convincing its foreign allies to access to and ratify the CSC 1997, which is the only international treaty in the field of nuclear liability to which the United States of America is a party. However, only Romania has ratified this convention in Europe.

As far as the future legislation relating to the liability for nuclear damage in the Czech law is concerned, it should be based, with regard to the above determinants, on the following assumptions:

- The future legislation should also anchor the fundamental liability principles, which are currently the major cornerstones to the liability regime of both main international systems (Vienna and Paris): exclusive and objective liability of the operator, possibility for the state to limit the liability of the operator, obligatory insurance, exclusive jurisdiction, objective and subjective time limit for a claim for compensation,

- Construction of new nuclear installations and further development of the nuclear energy sector in the Czech Republic should be also undertaken by strengthening the liability framework,
- In the future, the Czech Republic should be a part of the same contractual regime, in which the neighbouring states and the ("nuclear" as well as "non-nuclear") states of the wider Central and Eastern European area (including significant "nuclear" states such as the Russian Federation and Ukraine) are involved, with the connection to the legal regime established by the Paris Convention on Third Party Liability in the Field of Nuclear Energy of 1960 (including revised text of this convention) covered by the JP 1988,
- The connection of the Czech Republic to the revised Paris-Brussels system (the system of liability, established by the Paris Convention on Third Party Liability in the Field of Nuclear Energy of 1960 and the Brussels Convention of 1963 Supplementary to the Paris Convention of 1960, as amended by Protocols of 2004) cannot be considered an optimum option. Such a step would first require the termination of the VC 1963 (the international-legal regime does not allow the state to be simultaneously a party to both liability regimes), thus the termination of mutual liability links to other significant nuclear states of the wider Central and Eastern European area (e.g. Russian Federation, which is a party to the VC 1963, but is not a party to the JP 1988),
- The Czech Republic should promote, at the European level, a further strengthening of the legal framework established by the existing international conventions provided that any legislative initiative by the EU or Euratom should not undermine such liability regimes and the rights arising therefrom,
- As part of the liability regime established by the VC 1963, the Czech Republic should ratify the VC 1997, which represents a significant strengthening of the Vienna liability regime (the VC 1997 has already been ratified in a wider Central and Eastern European area by Poland, Romania, Montenegro, Belarus and Bosnia; the ratification of the VC 1997 is currently being contemplated by the Russian Federation),
- The ratification of the VC 1997 by the Czech Republic would result not only in a strengthening of the protection of potential injured parties, but would also be a positive signal in relation to the foreign countries, including those neighbouring states, which are negative to the peaceful utilisation of nuclear energy,
- In the event of future attempts by the Euratom or the EU to engage in national legislation relating to the civil liability for nuclear damage, the ratification of the VC 1997 by the Czech Republic could also serve as an argument that the Czech republic has adopted and transposed into its legal framework the latest forms of liability, offered by international law in this field.

Therefore, the ratification of the VC 1997 and its transposition into the national law of the Czech Republic seem to be optimal instruments for the future development of civil liability for nuclear damage. The liability regime, established by the VC 1997, is based on identical legal principles as the VC 1963 (i.e. on the principle of exclusive and objective liability of the operator, determination of the minimum limit of liability, obligatory liability insurance, objective and subjective limitation period, etc.).

The VC 1997 is not (as with the VC 1963) a "self-enforceable" international convention, i.e. its provisions foresee the transposition into national law. The following provisions can be mentioned of those provisions of the VC 1997, which may be considered as key provisions and which, in case of ratification, would require transposition into national law:

- A significant increase in the minimum limits of liability is one of the most important changes brought by the VC 1997. The VC 1997 newly relates the minimum limit of liability to the Special Drawing Rights (SDR). The VC 1997 also includes the following three options for determining the minimum limit of the operator's liability in national legislation (a) determination of the minimum limit of the operator's liability in the amount of 300 million SDRs, (b) determination of the minimum limit of the operator's liability in the amount of 150 million SDRs (sum "x") provided that the resources in the amount of the difference between the sum "x" and 300 million SDRs will be created through public funds, (c) determination of the minimum limit of the operator's liability in the amount of SDR 100 million, which is, pursuant to the Protocol of 1997, acceptable only for a transient period of fifteen years as from the date of entry into force of the VC 1997 (the VC 1997 entered into force in 2003, therefore the transient period of fifteen years (the so-called "phasing-in mechanism") will end in 2018,
- It follows from the above that the ratification of the VC 1997 in the national law would be possible using the following alternatives: (a) increasing the limit of the operator's liability up to the sum of 300 million SDRs, expressed in Czech crowns, (b) maintaining the current limit of the operator's liability and creating a public finance fund through state resources in the amount of the difference between the limit of the operator's liability and the sum, required in the VC 1997, (c) keeping the existing limit of the operator's liability for a transient period (until 2018) and increasing the limits or creating a public fund after that period,
- It follows from the above that the major problem of the possible ratification of the VC 1997 will be its financial implications (compare Table 1). Therefore, the transposition of requirements of the VC 1997 for the minimum limit of liability will result in either an increase in the operator's liability (thereby, *via facti* increase in its costs, which may be reflected in electricity price), or a burden of public budgets by creating a special finance fund,
- In addition, the VC 1997 contains a considerable widening of the term "nuclear damage". In addition to the "loss of life, any personal injury or any loss of, or damage to, property" (as defined in the VC 1963), the VC 1997 introduces other damage types: (a) economic loss arising from the loss or damage referred to above, if incurred by a person entitled to claim in respect of such loss or damage, (b) the costs of measures for the reinstatement of the environment, if such measures are actually taken or to be taken, (c) the loss of income deriving from an economic interest in any use or enjoyment of the environment, incurred as a result of a significant impairment of that environment, (d) the costs of preventive measures, and further loss or damage caused by such measures, (e) and finally, the VC 1997 includes a clause, which includes under the term "nuclear damage" any other economic loss, other than that caused by the impairment of the environment, if such damage is compatible with the definition in national law,
- Furthermore, the VC 1997 extends the objective time limit for a claim for compensation to 30 years; allows the contracting parties to fix a longer time limit in their national legislation provided that the obligatory insurance of the operator's liability is maintained throughout

that period. The new definition of the objective time limit for claims in the VC 1997 will have to be transposed into national legislation.

Table 7: *Comparison of the adjustment of the limits of the operator's liability in the current legislation of the Czech Republic and the limits required by the VC 1997*

Limits determined in the current national legislation	**Limits required by the VC 1997**	**Difference of the current condition compared with the condition required by the VC 1997**
8, 000, 000, 000.00 CZK 272, 953, 700.00 SDR	8, 792, 700, 000.00 CZK 300, 000, 000.00 SDR	(-) 792, 700, 000.00 CZK (-) 27, 046, 300.00 SDR
8, 000, 000, 000.00 CZK 272, 953, 700.00 SDR	4, 396, 350, 000.00 CZK (x 2) 150, 000, 000.00 SDR (x 2)	(-) 792, 700, 000.00 CZK (-) 27, 046, 300.00 SDR
8, 000, 000, 000.00 CZK 272, 953, 700.00 SDR	2, 930, 900, 000.00 CZK 100, 000, 000.00 SDR	(+) 5, 069, 100, 000.00 CZK (+) 172, 953, 700.00 SDR

The three fields of legislation mentioned above (increasing the minimum limits, broadening the scope of damage and extending the objective time limit for a claim for compensation) are considered to be key fields with regard to a strengthening of the international liability regime in the “post-Chernobyl” period. However, these progressive aspects are to a great extent limited by the fact that the VC 1997 has so far been ratified only by six (Argentina, Belarus, Latvia, Morocco, Poland and Romania) of the original fifteen State Signatories (Philippines, Indonesia, Lebanon, Lithuania, Hungary, Peru and Ukraine in addition to the Czech Republic). The Protocol entered into force in 2003, following the ratification by the fifth Contracting State. Following the entry into force of the Protocol, it can be accessed by any other state without requiring that state to first ratify the original version of the Vienna Convention of 1963. This has been recently undertaken by a number of the states in the wider Central and Eastern European area (Bosnia and Herzegovina, Montenegro, etc.). Therefore, two Vienna liability systems coexist at present: the *original,* which is governed by the VC 1963 and which involves, in addition to the Czech Republic, a number of the states in the Central and Eastern Europe, Asia and America, and the *revised*, which is governed by the VC 1997. The revised system so far covers only two states, which operate nuclear installations in their territory (Argentina and Romania). The ratification of the VC 1997 by the Czech Republic, which is a significant European “nuclear” state, would inevitably cause a strengthening of the importance of the revised Vienna liability system in a wider Central European area. This statement is derived from the fact that the VC 1997 is already in force in several states in the Central European area (Montenegro, Romania, Poland, Latvia) and other states are signatories to this international convention (Hungary, Lithuania) and the example of the Czech Republic might also lead to its ratification in those countries. The ratification of the VC 1997 would also strengthen the legitimacy of the Czech Nuclear Programme both internally in relation to the population and externally in relation to third countries, because it would mean a significant strengthening of standards relating to liability and compensation for the sake of a damage event.

In addition to the VC 1997, the Czech Republic is also a State Signatory to another international convention, namely the CSC 1997. The CSC 1997 is drawn up as a separate instrument of international law, with a prerequisite for the signing or accession to this convention not requiring the contracting state to be a party to one of the existing liability conventions. However, a prerequisite for the accession to the CSC 1997 is that the contracting state is a party to the Convention on Nuclear Safety of 1994. The purpose of the CSC 1997 is to establish a legal framework for the compensation for damage, which would be applicable to both the Contracting States of the Paris and Vienna liability system and the states, which are not part of them but which anchored identical liability principles in their national laws (i.e. the exclusive and objective liability of the operator, determination of the minimum limit of liability, obligatory insurance, objective and subjective time limits for a claim, etc.). Therefore, the ambition of the CSC 1997 is to establish a global regime of liability for nuclear damage, which could be participated in by states, which are not a party to any of the so far existing international conventions (this is currently the case of a number of significant “nuclear” states, e.g. Japan, China, Canada, Republic of South Africa, India).

The individual provisions of the CSC 1997 are compatible with the legal regulation in the existing liability conventions in principle, i.e. the inclusion of the fundamental principles of nuclear liability in national law is a prerequisite. In the case where a party to one of the treaties wishes to access to or ratify the CSC 1997, it would not have to change the existing system of nuclear liability in its national law. This is relevant also to the Czech Republic. However, the Czech Republic will have to transpose the provisions of the CSC 1997 relating to the public funds and decide which resources shall be, where necessary, used to create such public funds.

The CSC 1997 anchors a compensation mechanism, based on three degrees. Pursuant to the CSC 1997, resources accruing from first and second degrees of compensation shall be distributed without discrimination due to nationality or possibly place of residence. Each degree of compensation is defined in the CSC 1997 as follows:

- The first degree is the amount of financial resources of 300 million SDRs, which corresponds to the minimum limit of liability, provided for in the VC 1997. The CSC 1997 does not expressly explain how the existence of this amount of financial resources should be ensured. This can be done by determining the limit of the operator in the adequate amount or possibly by determining the limit of the operator's liability in combination with creating a public fund (compare above); it can therefore be concluded that the transposition of the requirements laid down in the VC 1997 is a precondition for accession to or ratification of the CSC 1997 (with the possibility of transposing the requirements of both international conventions into national legislation at once),
- The second degree of compensation has the nature of public funds, to which parties contribute financial resources according to the formula, formed by two variables (the first variable is derived from the value of the installed capacity of nuclear power plants and the second variable is derived from the value determined by the United Nations). In the application of the formula mentioned above, the contribution of “nuclear” states to public funds of the second degree is in the amount of 90%. At the same time, the CSC 1997 anchors the maximum limit of the contribution from each of the parties, with a clear intention to minimise the concerns of potential parties about high financial contributions to the compensation system. The amount of such resources is always conditional upon the number of parties to the CSC 1997 at the time of the damage event. The second degree of compensation is to be established in the amount, which is conditional upon the number of Contracting States. The CSC 1997 includes no requirement for the creation of funds on a

continuous basis or possibly before the occurrence of a damage event. The Convention only stipulates that 50% of financial resources, created within the second degree, are to be used for the purposes of compensation for damage arising outside the territory of a party, in the territory where the event occurred. The *ratio* of this arrangement is based on the assumption that the compensation for damage arising in the territory of the state where the event occurred is to be primarily secured by that state, i.e. the public authority, which permitted an installation and provided supervision. Public funds created within the second degree shall primarily serve to compensate for damage outside the territory of that state (the International Atomic Energy Agency established an Internet calculation portal, which may be used to calculate the contributions to be provided by individual (also potential) parties to public funds of the second degree. This is available at: http://ola.iaea.org/ola/CSCND/Calculate.asp); Tables 2 and 3 show the total amount of financial resources, created within the "second degree" of the CSC 1997 in two variants (both with the involvement of the Czech Republic), including the contribution to be provided by the Czech Republic in both variants within the "second degree",

- Furthermore, the CSC 1997 guarantees the right of a party to establish the third degree of compensation through public funds. This degree is optional. The Convention does not include rules relating to the distribution of financial resources through this compensation degree, but prohibits discrimination of the injured parties of "non-nuclear" states in the compensation through this degree due to the absence of reciprocity.

While the VC 1997 is the international convention already in force, the CSC 1997 shall enter into force 19 days following the presentation of the instruments of ratification to a depository by *at least* five states which will have a *minimum* of 400,000 units of the installed capacity of nuclear power plants available. Until 2008, the map of states which ratified the CSC 1997 was in principle very pessimistic. It only included Argentina, Morocco and Romania. The states with the highest capacities in the nuclear energy sector (France, Japan, Canada, Russian Federation, Spain, Sweden, Ukraine, United States of America and Great Britain) were entirely outside the regime, established by the CSC 1997. The ratification of the CSC 1997 by the USA in 2008 was undoubtedly a milestone.

From that moment on, several significant "nuclear" as well as "non-nuclear" states around the world became Signatory States to the CSC: India (2010), Canada (2013) and the United Arab Emirates (2014). The adoption of two legal standards is currently at an advanced stage in Japan to allow for the accession to the CSC 1997. It can therefore be assumed that during the following period, the CSC 1997 will become (after the ratification by Canada or possibly Japan) an international convention in force.

Table 8: *Contributions to the second pillar in case of participation of the present Contracting States + Japan and the Czech Republic*

State	Contribution expressed in SDR	Contribution expressed in USD
Argentina	1,782,675.00	2,748,118.00
Czech Republic	3,762,535.00	5,800,211.00
Japan	28,678,734.00	44,210,276.00
Morocco	24,854.00	38,314.00
Romania	1,403,096.00	2,162,971.00
United Arab Emirates	238,516.00	367,689.00

USA	45,683,748.00	70,424,695.00
Total	81,574,158.00	125,752,275.00

Table 9: *Contributions to the second pillar in case of participation of the present Contracting States + Japan, Canada and the Czech Republic*

State	Contribution expressed in SDR	Contribution expressed in USD
Argentina	1,784,662.00	2,751,181.00
Czech Republic	3,764,310.00	5,802,948.00
Japan	31,514,278.00	48,581,465.00
Canada	14,897,413.00	22,965,406.00
Morocco	25,139.00	38,753.00
Romania	1,404,136.00	2,164,573.00
United Arab Emirates	241,253.00	371,908.00
USA	50,200,623.00	77,387,774.00
Total	103,831,814.00	160,064,009.00

In relation to the future regulation of the civil liability for nuclear damage in the Czech Republic, it can therefore be stated as follows:

- **The further active development of the nuclear energy sector in the Czech Republic cannot be limited exclusively to the construction of new nuclear installations, but must be complemented with a strengthening of the national legislative environment, within which the field of liability for nuclear damage (in addition to legislation relating to nuclear safety, radioactive waste and spent nuclear fuel management, and radiation protection) plays a key role,**
- **The further development of legislation relating to the liability for nuclear damage in the Czech Republic should take place in accordance with the framework established by the existing multilateral international conventions, specifically the VC 1997 and the CSC 1997 (which have already been signed but not yet ratified by the Czech Republic), i.e. the currently anchored fundamental principles of liability (exclusive liability of the operator, liability limitation, obligatory insurance, exclusive jurisdiction, etc.) should continue to be maintained in the future, but should be optimised in accordance with the provisions of the "second generation" liability conventions,**
- **We recommend ratification of the VC 1997 or possibly the VC 1997 together with the CSC 1997, which would result not only in a strengthening of the liability framework in the Czech Republic but also a legitimisation of the development of the Czech Nuclear Programme in relation to the neighbouring ("nuclear" as well as "non-nuclear") states,**
- **We recommend ratification of the 1997 or possibly the VC 1997 together with the CSC 1997, which would further result in a legitimisation of the development of the Czech Nuclear Programme in relation to EU bodies, in particular with regard to possible attempts to harmonise the scope of liability for nuclear damage by means of European law.**

4 The Current Condition of the Nuclear Energy Sector in the Czech Republic

When defining priorities concerning the development of the nuclear energy sector and with a view to defining realistic development goals in individual segments, it is necessary to take into account the condition of the nuclear energy sector in the Czech Republic.

4.1 Operation and Service Life of the Existing Nuclear Power Plants

4.1.1 Operation and Availability

Currently, there are 6 commercial reactors operated in the Czech Republic (the Dukovany NPP (EDU) 4 pcs of the VVER 440 of the V-213 type and the Temelin NPP (ETE) 2 pcs of the VVER 1000 of the V-320 type);

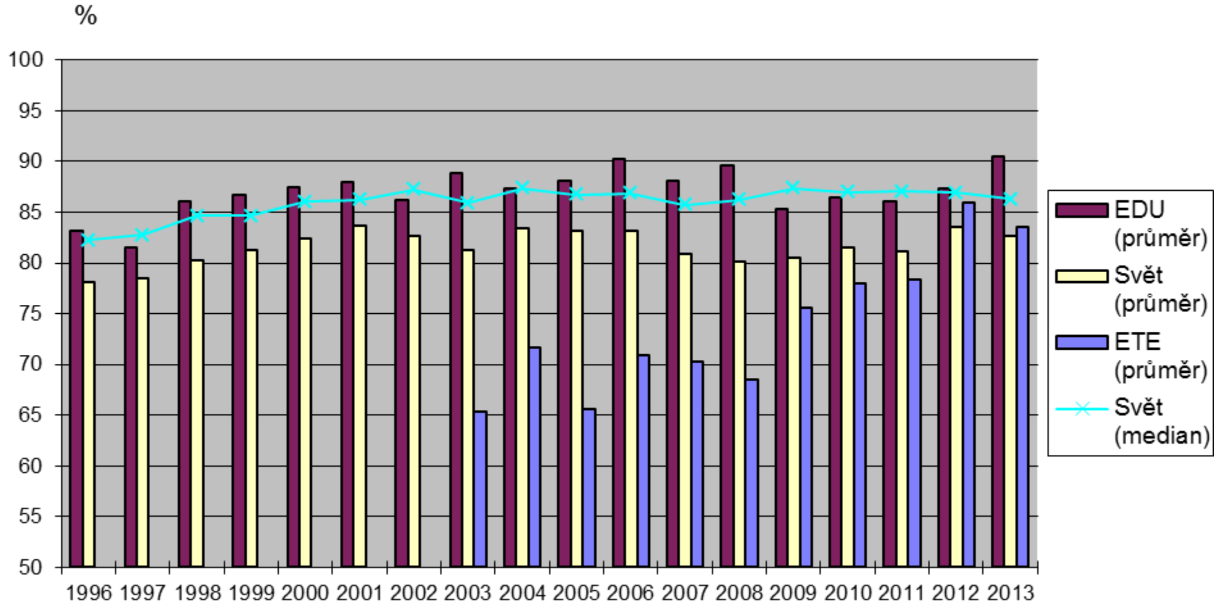
Both nuclear power plants represent a key and stable source of electric power in the Czech Republic with very good parameters and potential consisting in the supply of a certified supporting service (regulatory energy). In 2013, the production of each power plant exceeded 15 TWh, thus amounting to more than 35% of the total production of electric power in the Czech Republic. Both the ETE and the EDU ranks among the best operated power plants in the world according to the WANO criteria.

Since commissioning, the average operating availability of both power plants has been gradually growing. At the EDU, the operating availability has exceeded 90% and at the ETE 85%, which corresponds with the customary standards of pressurized-water reactors (PWR). The extent of availability is given by the campaign character of the operation where it is necessary to shut down the generating unit every year for a few weeks and remove the fuel elements in which the U235 fissionable isotope has been practically spent ("spent fuel") from the reactor and replace them with new fuel. The shutdown also enables general maintenance and repairs to be performed and this is why the failure rate during operation is so low.

Both NPPs have been operated at base load and provided the system with certain ancillary services. The advantage of the of the base load operation is given by the low variable costs and the relatively small difference between the prices of electricity in peak and basic consumption bands. Therefore, it is not good to make changes in the output power of the units under the existing circumstances. In the future an increase in the requirements of the transmission system imposed on the flexibility of the nuclear facilities in relation to the anticipated growth of the production generated in renewable energy resources may be expected. In such a case the nuclear power plants can offer a broad band of power control and can therefore act as an important stabilizing element of the power supply system in the case of a significant increase in the portion of renewable energy resources. The flexibility of advanced nuclear facilities exceeds that of the facilities being operated and their stabilisation role may thus be even more important.[12]

[12] The flexibility of the nuclear power plants and their potential future role in the power supply system is a topic the extent of which exceeds the subject of the NAP NE. In general, it is possible to confirm that the nuclear power plants meet all requirements imposed by the Czech Grid Code concerning flexibility and manoeuvrability of the units, the technical requirements defined by the document titled "*Requirements for Generators*" (RfG)

Graph no. 3: *Comparison of the ETE and EDU availability with the world*



EDU (průměr)	Dukovany NPP (average)
Svět (průměr)	World (average)
ETE (průměr)	Temelin NPP (average)
Svět (median)	World (median)

Source: ČEZ, a.s.

4.1.2 Age and Condition of the NPPs, Anticipated Further Operation and the Life-expectancy Plan

The four EDU units were gradually commissioned in 1985 – 87 with a design basis service life of 30 years and the two ETE units were commissioned in 2000 and 2002 also with a design basis service life of 30 years (40 years for buildings).

Based on the good operating experience it was possible to start using their technical design basis margins in both NPPs and utilize more advanced components. The original electric output of each EDU reactor unit was 440 MW and currently it is 500 MW on each unit. The original electric output of each ETE reactor unit 981 MW was increased to 1,080 MW (in 2014 on one unit and the other unit will be refurbished in this manner during a regular outage in 2015). In the coming years of operation

with applicability in the countries who are members of the European Network of Transmission System Operators for Electricity (ENTSO-E) as well as the recommending requirements of the European Utility Requirements (EUR). Individual technologies being considered for the new nuclear facility in the Czech Republic of course differ in terms of attained flexibility (power control band width, rate of change, number of cycles per service life, etc.). Nevertheless, it is possible to say that the nuclear power plants have been designed for changes in power output and if power output manoeuvres are made within the allowed limits and with defined trends, the service life of the unit equipment should not be used beyond the design basis concerned. The currently certified PpS at the ETE1are SR and MZ15: SR: band Pmax (1,085 – 1,045 MW) and Pmin (985 – 945 MW), RRSR = 100 MW, rate of loading 5 MW/min; MZ15: band Pmax (1,085 – 1,045 MW) and Pmin (1015 – 975 MW), RZMZ15B = 70 MW. At the EDU all four units were certified in the past for the following PpS: SR: within the band of +/- 40 MW at Cmax SR = 4.4 MW/min MZ15: within the band of +/- 66 MW at Cmax MZ15 = 4.4 MW/min.

of the EDU and ETE units, the second stage of the design basis margins use is anticipated, which means an additional increase in their electric output without any negative impact on the use of their service life.

A periodic safety review is performed once every 10 years and the State Office for Nuclear Safety (SÚJB) grants the licence for continuing operation based on the results thereof. The original design basis service life of the EDU and the ETE NPPs is 30 years and ČEZ has been providing measures so that the EDU and the ETE can be safely operated beyond this limit. On a global basis, the service life is extended up to 60 years (USA). In the EU, utility companies are planning to extend the service life to a maximum of 50 years.

Both the EDU and the ETE are refurbished on a continuous basis. The designs of both NPPs meet the safety requirements defined by the competent Czech authority which follows the best global practices. With the recent scientific knowledge no future increase in the strictness of safety requirements, under which it would not be technically feasible or economically viable to implement such requirements as investments in the EDU and the ETE, is anticipated. In addition, the political situation in the Czech Republic has been mostly favourable in the long run and therefore the EDU's and ETE's service life is given according to the natural ageing of the equipment and the costs related to its replacement. The profitability of maintaining the EDU operable by 2035, or if applicable 2045 is being considered by ČEZ. It must be mentioned that in the case of both existing domestic nuclear power plants there is a possibility of using generated waste heat to supply Brno or České Budějovice with thermal energy. Utilisation of this heat would result in a decrease in the need of primary energy sources. However, the construction of the necessary distance hot-water /steam systems is associated with certain, in particular social and economic, barriers.

In relation to the possibility of extending the service life of the nuclear power plants a variant technical and economic study has been executed. The study deals with technical, safety and economic aspects of the extension of the EDU units operation beyond the original design basis limit in alternatives of +10, +20 and +30 years. The study is updated on a continuous basis. Within the framework of these activities, the preparation of documentation attesting the use of service life and assessment reports for systems, buildings, structures and components in accordance with the respective SÚJB Safety Guideline is carried out. The outcomes of these scientific activities are subject to regular inspection by the SÚJB. In autumn 2015, the SÚJB will be submitted the complete documentation in the form of a so-called “Summary Evidence of the Readiness of Equipment and Staff”, which shall form a part of the application for the licence for the continuing operation of the EDU unit 1 by 2025 (Long Term Operation – LTO +10 years). The remaining three units will be subjected to the same procedure with a view to providing the EDU operation extension for the following period by 2026 (unit 2) – 2027 (unit 3 and 4).

In reaction to the accident in the Fukushima NPP, the EDU and the ETE underwent stress tests the purpose of which was to assess the resistance of the existing designs of the nuclear power plants to extreme external influences, in particular their resistance to beyond design basis earthquakes, floods and extreme climatic conditions resulting in the loss of the ultimate heat sink, a total loss of electric power supply or a combination thereof. The National Report on the EDU and the ETE Stress Tests concluded that the design basis, which was included in the structural design of both nuclear power plants is in compliance with the applicable nuclear legislation of the Czech Republic and have sufficient margins to the analysed, very unlikely and extreme conditions. Detailed analyses of the behaviour of the nuclear power plants under such extreme conditions allowed a number of technical and administrative recommendations for further increase in their robustness to be suggested. The Safety Enhancement Programme has been prepared for both the Dukovany NPP and the Temelin NPP. This action plan represents a complete set of measures to improve the safety of the Czech nuclear power plants in reaction to the accident in the Fukushima NPP, the implementation of which is in progress and a large number of which has been completed.

The long term goal is to maintain the operation of the Dukovany NPP at least to 2035 to 2037 – which means for a period of 50 years with the follow-up gradual decommissioning of individual units.[13] If the equipment condition allows and if the currently operated units, or at least some of them, fulfil the imposed safety and technical requirements to the full extent and if it is necessary for ensuring energy safety (for example in the case of a delay in the commissioning of the new nuclear facility on the Dukovany or the Temelin sites), it is advisable to strive for further extension.

In the case of the Temelin NPP, the long term intention is to attain the total operating time of the NPP for a period of 60 years, i.e. until 2060 (unit 1), or 2062 (unit 2) respectively.

After the decommissioning of the existing units in accordance with the approved plan of decommissioning, following an outage lasting several years, the units will be disposed of. The operator of the NPP will be responsible for the disposal under state surveillance. The radioactive waste will be taken over by the Radioactive Waste Repository Authority (RAWRA, under the applicable legislation).

4.2 Possibilities of the Construction of a New Nuclear Facility (NNF) - Readiness and the Limits of the Current Nuclear Sites in the Czech Republic

4.2.1 Temelin Site

A. **Site information**

The Temelin site is located in the City of Týn nad Vltavou and Temelin municipality. The current premises of the Temelin NPP are situated in the cadastral district of Křtěnov, Březí u Týna nad Vltavou and Temelinec municipalities and is administered under the administration district of the South Bohemian Region.

The construction of the Temelin NPP began in 1987 within the scope of 4 units, 1,000 MW each. In 1990 the construction of units 3 and 4 was discontinued and the construction of units 1 and 2 suspended. In 1993 the Government of the Czech Republic decided on the completion of units 1 and 2, which were then commissioned in 2001 and 2002.

- **The optimal site for the construction of the nuclear power plant** - the selection of the site for the Temelin NPP took into account potential negative interactions with the ambient environment. The meteorological, hydrological, geological and hydrogeological

[13] Considering the current development of the requirements for ensuring nuclear safety within the EU, there may be a risk of pressure to decommission all NPPs, which are not equipped with full-pressure robust containment, such as the EDU, which has never been subjected to the environmental impact assessment pursuant to Act No. 100/2001 Coll., which might become another potential risk in respect of the extension of its operation.

requirements do not impose any excessive restrictions on the design and the construction implementation. The site is subjected to a detailed survey.

- **The site has the infrastructure necessary for nuclear units** – it is a well-proven and well-tested site with a reserve of water (a dam), supply and discharge systems, connectivity to the power supply system, with highly qualified staff and with a high level of support from local residents.
- **The site and infrastructure has been prepared for the construction of 4 units since the beginning** – the site concept and infrastructure facilitate the extension of the existing NPP by two more units to a great extent.
- **It is possible to deploy 2 units of the NNF with an output of 1,000 – 1,700 MW on the site.**
- **There is a sufficient quantity of cooling water for all variants of output** – the studies by 2085 have concluded that the supply of cooling water will be provided for all variants of the extended output of the NPP (i.e. a total of up to 3,400 MW of new output).
- **The economic transportability of heavy and excessive-sized equipment has been tested** – the executed studies concluded that the optimal variant is a so-called combined transport using water transportation with short by-passes of the Slapy and Orlík dams using the existing roads (with necessary modifications) and with unloading from boats in Týn nad Vltavou.
- **The necessary land under the construction area is owned by ČEZ as is the land necessary for the construction facilities**– the acquisitions of land necessary for the integration of the construction facilities to facilitate construction are pending.
- **The acquisition of land to connect the necessary infrastructure is being completed** (land and easements for connection to the grid, raw and drinking water and waste water).
- **Connection to the grid is ensured under the concluded contracts –** a contract on the future agreement has been concluded with ČEPS. Under this agreement the connection conditions are clearly specified. The preparation of measures to be taken in the transmission grid has been launched.
- **The project is widely supported by the Czech public.**
- **Relations with the Regional Authority and municipalities are clearly defined** – the contract of the provision of measures in the territory of the South Bohemian Region of 25 November 2010 was concluded between the South Bohemian Regional Authority and ČEZ, a.s. The preparation of individual measures and the implementation thereof in some cases is in progress.

B. **The project of an NNF ETE 3,4 – the state of permitting and licensing procedures**

- **The project is fully compliant with the Land Use Development Policy of the Czech Republic, with the Rules of the Land Use Development of the South Bohemian Region and with the land use plans of the municipalities concerned.**
- **A positive EIA opinion has been issued** – on 18 January 2013 the Ministry of the Environment of the Czech Republic issued a positive EIA opinion. The validity of the EIA opinion pursuant to the applicable legislation is 5 years as of the date of issue (this time limit is suspended in the case of starting the follow-up procedure, which is usually a land use planning procedure. In the case of an NPP, this procedure may refer to the licence for the siting of a nuclear installation) with the possibility of extension by 5 more years. A certain complication may be the application of the conditions of the amended EIA Act, the beginning of legal effect of which is anticipated in 2015.
- **The licence for the siting of a nuclear installation pursuant to Act No. 18/1997 Coll. (the Atomic Act) has been issued**

- **The documentation for the land use planning procedure has been prepared and the rights to use the land for the road part of the combined water and road route with the by-passing of the Slapy, Kamýk, Orlík and Týn nad Vltavou waterworks have been provided.**
- **The permitting procedures for the related and induced investments inside as well as outside the site are pending, specifically in the following areas:**
  - connection of the Temelin NPP to the power supply system at the level of 110 kV and 400 kV;
  - transfer of wild animals from the area of interest following the issue of the final decision on dispensation from Act No. 114/1992 Coll.;
  - Structures related to the modification of roads in the South Bohemian Region are subject to various levels of approval

C. **Site limits**

Table 10: *Site limits (Temelin site)*

Type of limit	Description of the limit
The total capacity of the site for the completion of construction:	2 units with a total output of up to 3,400 MWe independently of the existing NPP operation.
Land	No limitation – all land for construction has been ensured Transfer of wild animals to new biotopes is necessary
Raw and drinking water	No limitation – see the valid EIA opinion
Transportability of components	Necessary modifications along the transport route – a combined water / road transport of excessive-sized components is assumed; a transportation study including economic impacts has been executed
Connection to the grid	Necessary measures to be taken in the power supply system – ČEPS has started working under the contract on the future agreement
Public relations with the region	Regional support of the construction; an agreement on cooperation clearly specifying the measures to be taken on the site has been concluded
Other limitations	None

4.2.2 Dukovany Site

A. **Site information**

The Dukovany site is situated 30 km to the south-west of Brno, on the right bank of the Jihlava river and is administered under the administration district of the Vysočina Region in close proximity to the boundary of the South Moravian Region.

In the period 1985 – 1987, 4 VVER 440 units of the V-213 type were gradually commissioned on the site. Their installed capacity today amounts to 4 × 500 MW. In 2015, ČEZ will apply for a 10-year extension of the operating licence until 2025 with a view to re-extending the licence at least until 2035. Optimisation and reduction are likely to follow.

The objective of activities being performed on the site is to build one new EDU 5 unit:

- **The EDU site has the infrastructure necessary for nuclear units** – it is a well-proven and well-tested site with a reserve of water (a dam), supply and discharge systems, connectivity to the power supply system, with highly qualified staff and with the support of local authorities.
- **Feasibility studies** – the deployment of 6 possible types of reactors has been analysed. The division of the types of reactors under consideration by capacity:

- Small-sized - with a capacity not exceeding 1,200 MW – MIR (Russia – ASE), Atmea1 (France + Japan – Atmea), AP1000 – (USA – WEC);
- Medium-sized – with the capacity of 1,455 MW – APR (Korea – KHNP);
- Large-sized – with the capacity of 1,750 MW – APWR (Japan – MHI), EPR (France – Areva).

- **Water** – From the point of view of the quantity and quality of water in the Jihlava river, it is possible to operate after the EDU 1 to 4 decommissioning in the site on a long-term basis either one large-sized unit or one medium-sized or two small-sized units. In the case of a gradual implementation of **two small-sized units**, the site will be optimally utilised.
- **Considering the potential date of commissioning of the EDU 5** (which is based on the risk analysis and schedule given by the Czech legislation **in 2032, 2037 at the latest),** it is possible to regard the preparation of one small-sized EDU 5 unit as a replacement rather than the extension of capacity.
- **Transport of excessive-sized and heavy components** – the route along the Elbe river to Kolín and then along the roads to Dukovany has been opted for with the necessity of investments in the transport infrastructure.
- **Connection to the grid is ensured under concluded contracts –** a contract on the future agreement has been concluded with ČEPS. Under this contract the connection conditions are clearly specified. Modifications are relatively easily implementable – the modifications of the Slavětice and Sokolnice switching stations and the consolidation of the existing Sokolnice-Slavětice line.
- **Geological and hydrogeological conditions** – two potential areas for the construction of the new unit have been identified and are being tested for the requirements imposed on the construction of the nuclear power plant.
- **Biological surveys** – no obstacle to construction has been identified; the impacts are redeemable.
- **All land under the construction site is owned by ČEZ**, the acquisitions of land for the connection of the necessary infrastructure is being finalised.
- **Attitude of the regions concerned** - the EDU 5 project is widely supported by both regional authorities, the association of 136 mayors within a 20-km radius around the NPP and the Energetické Třebíčsko association. The Dukovany NPP is the biggest employer in the region with an essential impact on its social stability.

The EDU 5 project has been recently accelerated so that the source materials for the EIA process opening are available early in 2015. At the same time, work on the description of the site as the basis of the future tender documentation necessary for the selection of the contractor was commenced.

B. **The project of an NNF EDU 5 – permitting and licensing procedures**

No licensing procedure is pending or has been opened. The recent development of the respective legislation (the amended EIA Act and the related acts) and updates to the State Energy Policy (SEC), the amended Land Use Development Policy of the Czech Republic and the attitude of the Government of the Czech Republic have been monitored.

The land use and energy plan – the EDU 5 project has been incorporated into all levels of the land use planning documentation. The project is compliant. The proposed State Energy Policy includes the construction project in Dukovany.

The priority is to ensure progress in the EIA process, i.e. the preparation of the necessary source materials and inputs with the follow-up preparation of the plan notification pursuant to Act No. 100/2001 Coll. on the environmental impact assessment. Attention is also paid to the preparation of the quality assurance programme, which will be subsequently subjected to the SÚJB approval.

As stated above, a contract on the future agreement has been concluded between ČEPS, a.s. and ČEZ, a.s. for the purpose of the reservation of the transmission capacity necessary for the connection of the NNF EDU 5 to the grid. This agreement is being amended by way of appendix due to changes in the anticipated dates of completion of the EDU 5 construction project.

C. **Site limits**

Table 11: *Site limits (Dukovany site)*

Type of limit	Description of the limit
The total capacity of the site for the completion of construction	Depends on the operation of the EDU 1 to 4: - A maximum of 1 unit with the capacity of 1,200 MW operated in parallel with the EDU 1 to 4 - The construction of a bigger unit to be operated in parallel with the existing EDU units would require the decommissioning or a considerable reduction in output of unit 1 of the existing NPP - In the case of decommissioning of the EDU 1 to 4, it is possible to have on the site a maximum of 2 × 1,200 MW or 1 × 1,400 MW or 1 × 1,700 MW Considering the preparation of the EIA document, it is necessary to decide on the method of future construction (extension × replacement)
Land	No limitation – acquisitions of land are pending
Raw and drinking water	The limited quantity and low quality of the water in the Jihlava river limits the size of the units (see the row "The total capacity of the site for the completion of construction")
Transportability of components	Necessary amendments along the transport route – a preliminary transport study has been executed; only a limited analysis of the economic consequences has been performed
Connection to the grid	In the case of the extension of the existing NPP, certain measures must be taken in the power supply system – the agreement with ČEPS has been signed In the case of replacement of the existing NPP, no measures are likely
Public relations with the region	Regional support of the construction; an agreement on cooperation clearly specifying the measures to be taken on the site has not been concluded yet
Other limitations	None

4.3 Human Resources, Structure by Age and Education, Quality

4.3.1 Current State of Education Support in the Nuclear Energy Sector

In relation to the declaration of the Czechoslovak Republic in 1955 concerning the peaceful nuclear programme with a view to building its first own nuclear power station in Jaslovské Bohunice, two educational institutions (the Faculty of Nuclear Sciences and Physical Engineering of Charles

University in Prague – since 1959 integrated into the Czech Technical University in Prague, the Secondary Industrial School of Nuclear Engineering in Prague) were established based on the decision of the government of that time together with a new research institute with the necessary experimental equipment (Institute of Nuclear Research in Řež u Prahy) and several specialised workplaces of major engineering companies. The most important workplaces were established in Škoda Plzeň (Vochov design office and Bolevec testing laboratory) as the first workplaces of the future Škoda jaderné strojírenství company.

The current condition can be characterised as follows:

a) The goal-directed support of the instruction and selection of students for the remaining educational institutions, which are able to prepare graduates for the construction and operation of new generation nuclear facilities is very limited, or even missing on the part of the state. The contribution of the state for undergraduate students is governed by a so-called coefficient of economic demands, which is the highest in the case of schools of art (the coefficient is 3.5 and higher), followed by schools focused on chemistry and technology (coef. 3.2), natural sciences (2.8), architecture (2.25 and higher), followed by technical schools regardless of specialisation (coef. 1.65). In addition, students are not motivated to study technical specialisations in any manner and the currently applied restrictions imposed on the number of students concern all types of schools equally – which means technical ones as well.

b) Support of science and research is currently focused exclusively on contract award procedures organised by the Technological Agency of the Czech Republic (TA CR) and the Czech Science Foundation and the selected ministries; investment resources from structural funds are allocated in the same manner and, moreover, with a significant restriction concerning educational and research institutions seated in Prague.

The contribution to research is granted based on merits and is referred to as a subsidy, which again influences the educational process as such resources cannot be used for educational purposes.

Resources allocated from the state budget without merits (which could possibly be controlled by the state) are intended for the Academy of Science of the Czech Republic. However, it will be difficult to ensure the specific preparation of experts for such a very specific and highly qualified activity in practice.

The currently available preparation of experts for nuclear facilities is so specific and comprehensive that even other European educational institutions are not able to cover the whole spectrum of preparation. The educational institutions voluntarily become members of educational associations, namely including the research institutes and the major companies who design and supply nuclear power plants (ENEN – European Nuclear Education Network). Although the voluntary basis improves general awareness, it cannot ensure goal-directed education for the nuclear energy sector, including the long-term preparation of experts for the Technical Support Organization (TSO) (Licensing and state supervision). As is obvious from all the aforementioned aspects, the state plays an unsubstitutable role in the implementation of the energy doctrine in the area of education, science and research if the development of nuclear power engineering is included.

4.3.2 Condition and Needs of Human Resources Development for the Securing of the Nuclear Energy Sector on a Long-term Basis

Development in the employment rate and its structure by education and age in the energy sector, including the nuclear energy sector

The employment rate in the industry of generation, transmission and distribution of electricity in 2008 – 2013 was slowly increasing and amounted to nearly 40,000 persons in 2013. However, the industries which are closely linked to the energy sector have faced a decrease in the employment rate which mostly affected industries focusing on the manufacture of motors and turbines (NACE 2811) and industries producing distribution and control systems (NACE 2712). In 2013, a total of 76,000 persons were employed in five specific industries (construction of engineering communications and service pipelines – NACE 4222, manufacture of electric motors, generators and transformers – NACE 2711, manufacture of steam boilers – NACE 253 in addition to the aforementioned).

In the nuclear energy sector as such (the Dukovany site and the Temelin site), a total of 2,270 persons, i.e. approximately 6% of employees of the industries concerning electricity generation, transmission and distribution, were employed in 2014. In this year, a total of 1,110 persons have been employed in the research for nuclear power engineering and 6,780 persons worked in companies specified as supply and delivery companies. With the exception of research, the employment rate in both segments of the nuclear energy sector in 2014 increased compared to 2008; very slightly in the case of NPPs – by less than 10%. A relatively significant increase, by more than 1/4, was recorded on the part of supply and delivery companies, specifically Vítkovice Power Engineering and Skoda JS. However, the portion of employees working exclusively for the nuclear energy industry is difficult to estimate in the case of research and particularly on the part of the supply and delivery companies. Nevertheless, it can be assumed that a smaller portion is concerned with the exception of Skoda JS.

Ageing is quicker in the industries specializing in electricity manufacture, transmission and distribution compared to the specified related industries and also compared to the remaining sectors of the economy as a whole. In the period 2012 – 2013, the portion of employees older than 51 years was 28% compared to 25% in the related industries and 26% in the remaining industries. This negative trend in industries focused on the generation, transmission and distribution of electricity is balanced to a certain extent by the increasing contribution of the younger generation of employees under the age of 30, which has increased to 18%.

Due to a high stability of employees in the nuclear energy sector their ageing is even more considerable – 50+ employees account for 40% of the total employment rate. The nuclear energy sector has recently witnessed an influx of young university graduates and therefore the relation between “senior” employees (51+) and “junior” employees (-30) in this group of employees has improved significantly from 8:1 in 2005 to approx. 2.4:1 in 2013. This positive trend was enabled by an increase in the number of graduates from technical fields of study, which, however, will not continue due to the adverse demographic trends. The number of students graduating from technical fields of study has been decreasing since 2011.

Even with no new nuclear units built, it will be necessary to substitute approximately 900 employees in the Dukovany and the Temelin sites and approximately 1,700 employees in the supply and delivery companies over the next 15 years. The pressure particularly on the availability of technically qualified workers would considerably increase in the case of any variant of the nuclear facilities extension. The need for new employees in such a case would be approximately 4 to 5 thousand persons exclusive of the employees of building companies that would certainly participate in the construction to a great extent. Considering the global plans concerning the development of the nuclear energy sector, where the construction of 174 reactors is being planned and the construction of 301 reactors is being preliminarily considered according to the World Nuclear Association, the knowledge base of Czech experts and Czech companies still represents an important competitive advantage on the global market. Nevertheless, the age of the experts who participated in the construction of the Czech nuclear power plants is approaching the retirement limit and the loss of valuable *know-how* is imminent.

Compared to the related industries, in particular the manufacturing industry, the generation, transmission and distribution of electricity is much more demanding in terms of employees' qualifications. University graduates account for more than ¼ of employees (28%) compared to 17% in the related industries and 11% in the manufacturing industry.

The nuclear energy sector as such is much more demanding in terms of qualified staff than the whole industry focused on electricity generation, transmission and distribution. University graduates account for nearly ½ of all employees and this ratio is increasing more dynamically than in the remaining industries. The possible accentuation of the nuclear energy industry development would increase the demand for highly qualified employees not only for the operation of nuclear facilities but also for designing and construction, as well as in related industries such as distribution or power engineering.

The changing demands for university qualification in the generation, transmission and distribution of electricity has resulted in changes in the structure of qualifications of employees in individual age groups. The homogeneity of the employees' qualification has been decreasing; while in the group of employees 55+, a total of 84% of persons are qualified in the four most frequent fields of study, in the middle-age generation (35 – 54 years of age) this figure is 72% and among persons belonging to the young generation (-34), only 55% have a qualification of this type. In the category of young employees, the number of persons qualified in the field of electrical engineering and power engineering and in the field of mechanical engineering, metal-working and metallurgy is lower by approximately ½. The penetration of information technologies into the energy sector has resulted in a five-fold increase in the ratio of graduates in computer sciences compared to employees of the older generation. The representation of graduates in economic fields of study is relatively stable in both marginal age groups. However, the middle-aged generation has a ratio of employees with this kind of qualification higher by approx. ½. The high ratio of one generation group in professions requiring qualification based on a particular field of study may indicate a problem when the next generation of employees replaces the previous one in the group of employees to the respective group of professions.

Unlike with professions requiring a university education, professions requiring secondary-school education do not change much and therefore it is possible to assume that the content of work changes more slowly. In all generations, electrical engineering and power engineering is the prevailing kind of qualification, although in the youngest generation the ratio of this field of study is decreasing (58% in the case of the 55+ generation, 47% in the case of -34 generation). However, a considerable decrease has been found in the ratio of employees qualified in the field of mechanical engineering, metal-working and metallurgy.

The demands for the qualification of employees in the individual industries are closely related to differences in the representation of the individual groups of professions. The groups of professions with a higher qualification (ISCO 1 – 4) represent a total of 60% of the total employment rate in the generation, transmission and distribution of electricity. In the related industries it is 47%, while in the manufacturing industry the figure is only about 31%.

In terms of profession, approximately 13 technical groups of professions that can be employed in the energy sector were selected. Four of them are represented in the energy sector (the energy sector + the related industries) so significantly that we can refer to them as professions specific or key for the energy sector to a great extent. From highly qualified professions, engineers qualified in the field of electrical engineering and power engineering and also technicians qualified in the field of electrical engineering and power engineering are concerned. From less qualified professions, electricians and operators of machines and equipment are concerned. Other professions important for the energy sector include technicians and engineers qualified in mechanical engineering and also foremen and similar employees in the production segment whose linkage to the energy sector is not so significant. In a majority of these professions, the employment rate has increased slightly regardless of the economic crisis, or at least copied the previous level. The group of mechanical engineers has been expanding.

Within the framework of individual technical professions the ageing process is obvious as it is even faster than the high average in the energy sector. A serious finding is the fact that among the oldest employees are those working in the professions, which require an extensive manpower and which are of key importance for the development of the energy sector. It is engineers qualified in electrical engineering and power engineering, technicians qualified in engineering and power engineering or operators of stationary machines and equipment. Among the other professions, which are not so numerous in the energy sector, are engineers qualified in civil engineering and mechanics and machinists. An increasingly smaller number of graduates will be available for the relatively large number of vacancies resulting from the employees' retirement. Any important investments in the energy sector will aggravate this problem.

Demand for professions employable in the energy sector has been prevailing on the labour market. In spring 2014, more than five thousand vacancies were advertised through labour offices and the portals jobs.cz and práce.cz. Demand for less qualified professions prevailed (45% of the total demand). Demand for professions requiring university education was comparable with demand for professions related to secondary education in terms of the number of advertised vacancies. Their ratio amounted to 28% in the case of university education and 27% in the case of secondary-school education. The most sought-after profession was engineer qualified in mechanical engineering; the labour market witnessed a lack of nearly one thousand persons with this qualification. A similar shortage can be seen in the case of persons qualified in the operation of stationary machines and equipment and welders where each of the professions was offered approximately nine hundred vacancies. The situation is a bit better with professions requiring secondary-school education; approximately 600 technicians qualified in mechanical engineering and a similar number of foremen in production were missed. Graduates from universities and technical secondary schools are sought after by employers. However, young people have little interest in these fields of study. Considering the unfavourable demographic trend, all employers will look for such professions with increasing difficulties and competition between employers from different segments of national economy will increase.

The unfavourable trend in the number of university graduates is obvious in the case of graduates from the fields of study focused on electrical engineering and power engineering where it can be expected that their qualification is best utilisable in the nuclear energy industry. Although the total numbers of graduates in bachelor's and master's study programmes has been shown to have increased, the numbers of graduates in the fields of study focused on electrical engineering and power engineering at the selected universities have been decreasing, specifically in terms of both the absolute number, and the ratio thereof to the number of graduates. Among graduates from secondary schools the decrease in the selected fields of study concerning electrical engineering and power engineering was also considerable. Between 2009 and 2012 the number of graduates with a secondary-school leaving examination decreased by 19%.

The overall reduced resources of young people with secondary-school or university qualification available for the energy sector are further reduced upon their entering the labour market and in the phase of making decisions on their follow-up professional career. As a result of the increasingly wide spectrum of labour opportunities in other sectors and for other reasons, a smaller portion of graduates come to work in the energy sector compared to the previous generations. This trend in career development can be best seen in graduates from secondary schools. In graduates from universities this problem is not so obvious so far. However, the problem consisting in the lack of experts available for the energy sector is aggravated by the decrease in the interest to study fields focused on electrical engineering and by the unfavourable demographic trend in the young population.

Regardless of the unfavourable trend in the numbers of students of technical fields of study at secondary schools and universities, the NPPs do not lack new employees thanks to the well-premeditated recruitment policy and the related close cooperation with the selected secondary schools and universities.

Employment in the nuclear energy sector is still relatively attractive for young people. However, possible further aggravation of the nuclear energy sector's image, the unclear position of the nuclear energy sector in the overall energy mix and a decrease in the number of graduates under the critical level disallowing the finding of graduates with the required personality profile necessary for the performance of certain professions may represent threats for the future.

However, the construction of a new unit brings a problem much more important in terms of the number of new employees considering their graduation from technical schools and the construction of two units in different sites can be regarded as a critical problem from the point of view of human resources.

Specifics of designing capacities

With the commissioning of the ETE 1,2 and the EMO 1,2 (end of 2002), the demand for engineering and designing work decreased and an efflux of capacities occurred.

In spite of the considerable reduction there are still engineering and designing capacities available for the support of the operation of the existing units and the construction of new units in the Czech Republic who:

- Worked until the present time on the units under operation and the newly implemented projects (there has been some construction on a continuous basis) and therefore they have practical experience both in designing and the course of the permitting procedure for the newly prepared units, as well as the construction and operation.
- Are comprehensive (involving all professions), which means that they can cover the whole issue both in the area subject to the Atomic Act (analyses, safety documentation), and in the area of the Building Act (EIA, permitting documentation) and everything which is related to the process of preparation and permitting of a new NPP.
- They are party involved in projects other than nuclear in the energy sector.

The key problem with the designing capacities (identical with that perceived in other engineering capacities in the nuclear energy sector) is the gradual increase in the average age and the continuing efflux to other fields.

4.3.3 Critical Prerequisites for the Provision of Human Resources

Employees for the provision of the NPP construction and operation

The operation of the currently operated nuclear units can be ensured regardless of the aforementioned condition of the specialised secondary and tertiary education – provided that the standards of the basic and secondary general education do not aggravate. A further deterioration of the standards – in particular as far as essential knowledge and skills in mathematics and physics is concerned – is limiting and might cause serious problems with a mere substitution necessary due to the ageing of the currently active employees. The nuclear energy sector – the operator of both NPPs – has a relatively well-known system of additional education and training for newly hired employees.

However, the construction of new units with a different generation of designing and manufacture and their future operation brings a brand new problem. As early as in the phase of previous (school-based and life-long) training, it is necessary to train a significant number of new employees who will be at least theoretically, or better also practically by means of practical training, trained for new technologies, specifically in the phase of both the construction, and operation thereof.

Comprehensive project capacities

The precondition for the long-term operation of nuclear units is the existence of one's own engineering capacities of such a scope and quality that enables the technical support of the operation of the units. The aforementioned necessitates the maintenance of the scope and long-term development of the existing project capacities. In addition to participation in various international institutions and programmes in the field of the nuclear energy sector, these concern in particular the possibility of practical application in specific construction projects, or modification of nuclear power plants, specifically through:

- participation in cooperation with supranational engineering companies that provide services in the nuclear energy sector and constitute a source of work on foreign projects,
- participation in cooperation with selected suppliers – long-term contracts.

The maintenance of the scope of project capacities in the field of the nuclear energy sector and its future extension for the needs of the construction of the NNF and the follow-up provision of all phases of the nuclear energy sector life cycle is realistic only in the case of the immediate continuation of the preparation (and the following implementation) of the NNF projects. The interruption of the NNF projects preparation would mean the continuation of the mostly irreversible efflux of such capacities to other sectors as a result of the lack of prospects, in particular in younger employees.

In the case of the decision on the continuation of the NNF preparation, another key factor of success will be the adaptation of the NNF documentation to comply with the legislative requirements of the Czech Republic. Such an adaptation must be implemented by the engineering capacities who have good knowledge of the legislation and practice of the permitting and licensing process in the Czech Republic. For this reason, the preparation of the required human resources is necessary in cooperation with the suppliers and organisations providing designing and engineering services, research institutes and universities. Such a potential of human resources cannot be obtained immediately as it is a long-term controlled process aiming at providing the necessary capacities.

4.4 Condition of the Industrial Base and its Potential in the Supply Chain

The potential of Czech companies can be divided into two basic skills:

- suppliers of technological units,
- suppliers of structural parts and construction site facilities.

The current condition is given (among other things) by the following facts:

- The companies are primarily focused in particular on the VVER 440 and 1000 technologies, which are now outdated technologies. The supplies are limited only on servicing activities and refurbishment projects, which means that the companies really face the loss of know-how as they do not have (with a few exceptions) the licence necessary for the new VVER units (AES 2006 starting with the VVER 1200, etc.),
- The supplies for the western technologies (EPR-AREVA and AP – Westinghouse, Kepco, Toshiba, GE, etc.) were in the past are now and certainly will remain in the future (under current conditions) a minor supplementation of the sale of the companies with a good reputation. However, the financial effect is negligible and the effect of the acquisition of know-how usable in the future is minimal,
- The completion of the Mochovce NPP 3&4 construction (440MW VVER) is the last project of this type of NPP under construction. The projects that will follow will be based on new technologies which Czech companies are not experienced in and often lack the necessary certifications or competences where applicable,

- Ukraine has become a problematic market. Nevertheless, even if the situation is stabilised, this region does not have much to offer (in the future only servicing activities or support thereof, or support of decommissioning. The issue of the construction of a new nuclear facility in Ukraine is disputable, but currently with much support received),
- The companies have only a limited staff and business opportunities, which could ensure expansion to such highly competitive and very closed markets, such as the market in Great Britain (the example is the limited scope supplies of Czech companies intended for the projects Olkiluoto or Flamanville),
- An important factor affecting the development plans of Czech companies is also the expected growth of the nuclear energy sector in the Czech Republic, which is defined in the State Energy Policy.

Czech companies are currently able to provide an important scope of supplies and services necessary for the construction of new nuclear facilities. Although they do not have the licence necessary for the III+ generation projects, or competences necessary for the comprehensive supply of a NPP as a whole, they may play an important role in the supply chain Engineering, Procurement, Construction (EPC) for the contractor's during construction (up to 75% portion in the total cost of construction), which will allow them to deploy their competences in the field of support of the long-term operation and maintenance of nuclear power plants where a key role is anticipated for them. In addition, the participation in the construction of nuclear power plants in the Czech Republic will provide Czech companies with the opportunity of future participation in the construction of nuclear power plants abroad, specifically together with the selected EPC contractor.

The new energy concept and the system of construction of a new nuclear facility must therefore include the Czech supply industry to a great extent (if we wish to maintain Czech know-how in the field of the nuclear energy sector at least on the same level or, ideally, at a higher level). In the ideal configuration of the technology supplier, Czech companies are able to provide up to 75% of supplies concerning the entire nuclear power plant and play an important role related to the overall coordination of the construction.

This will enable maintaining the potential of Czech industry providing supplies to the nuclear energy industry and create a base for its growth, expansion and future independence of the operator of new nuclear facilities in relation to their maintenance, refurbishment and decommissioning. In addition, the suppliers will acquire know-how related to new technologies and the base for the future export of equipment for similar facilities abroad (in particular in Central and Eastern Europe) will be created. Otherwise, the loss of know-how as well as the transition of key companies providing supplies to the nuclear energy sector to different fields of business is imminent as they will try to maintain their existence (in fact, this process has already started).

For the aforementioned reasons it is advisable, within the framework of the future tender for an NNF, to define specific instruments (e.g. a guaranteed portion of the Czech industry, co-participation of the investor in tender for suppliers, the application of “last call”, etc.) to maximize the ratio of Czech companies in the construction where the scope and structure of these instruments will depend on the applied model of business guarantees and the related legislative limitations. Obviously, in the case of the application of the public procurement law (PPL) the possible application of the instruments mentioned above is considerably limited.

5 Organisation of the Sector and the Role of the State

The nuclear energy sector has a wide scope – mechanical engineering, education, science and research, the specifics of state administration in the nuclear field (supervision, fuel solution, responsibility) and interferes directly or indirectly in many sectors of the economy. A good condition and the readiness of all relevant areas are necessary for the construction of nuclear facilities within the scheduled time and also for the provision of operation and safety at a high level. The development of the nuclear energy sector is organised and supported by the state in all countries. The state or a state-owned undertaking is mostly either a direct investor, or it provides guarantees (with the exception of the construction of Finnish NPPs, which are financed on a consumer-cooperative basis).

The organisation of the sector is closely related to the critical preconditions of the action plan implementation.

It is based on the following:

- The definition of the action plan for development
- The definition of unambiguous responsibility for the implementation thereof
- The unification of responsibilities with the administration of utility companies with capital participation of the state and a dialogue with private entities who are an important part of the chain
- Directing all institutions based on the selected strategy on the grounds of the government and the state administration
- A focus on the critical parts of the action plan and the critical areas of its effect and their gradual solution

5.1 Vision and Action Plan

The state has defined the public demand for the scope of the nuclear energy sector in the State Energy Policy. The State Energy Policy has been approved by a regular process, including the assessment of environmental impacts and socio-economic impacts. It is important that this concept is accepted and the current opposition and considered by the Chamber of Deputies so that it is a political commitment for future governments as well. The State Energy Policy defines the source of the Czech Republic, the role of the nuclear energy sector therein and the basic time frame for development.

The National Action Plan for the Development of the Nuclear Energy Sector is a document elaborating on the State Energy Policy, which only specifies the implementation programme within the limits of the Policy's strategic goals and corridors for the structure of electric power generation and utilizes individual primary energy sources. It defines tasks for individual government departments (legislation, concept, state administration performance), in particular for industry, education, science and research, legislation, regional development and foreign affairs. In addition, it defines the method of coordination of individual sectors and the schedule, the method of evaluation of the action plan fulfilment and the method of taking corrective actions. The State Energy Policy as a long-term strategic document is evaluated in five-year cycles. The NAP NE should be evaluated and updated when necessary once every 5 years. The NAP NE is approved by the government and constitutes a partial implementation plan of the State Energy Policy for the field of the nuclear energy sector.

5.2 Coordination of the Nuclear Energy Sector Development

Currently, the coordination of the nuclear energy sector development is not implemented in a goal-directed manner. The desirable condition is as follows:

Coordination is executed by a standing committee presided by the Minister of Industry and Trade. The Secretary of the government committee is the government representative for the nuclear energy sector.

The committee considers, on a regular quarterly basis, information concerning the fulfilment of the Action Plan for the Development of the Nuclear Energy Sector in the Czech Republic, submits proposals to the government for actions of an administrative and legislative character necessary for the fulfilment of the action plan and defines tasks for individual state authorities.

Members of the standing government Committee for the Nuclear Energy Sector are members of the government, the chairman of the SÚJB, the chairman of the RAWRA, the government representative for the nuclear energy sector, the chairman of the board of directors of ČEZ, a.s., the director of the CV ŘEŽ s.r.o., the representative of the Nuclear Industry Association and others depending on the status approved by the government.

Within the framework of its coordination tasks concerning the fulfilment of the action plan, the Committee focuses on the following areas:

- The supply chain and its readiness for supplies to the Czech Republic and its participation in international supplies.
- Supplies of nuclear fuel for the operation of NPPs in the Czech Republic, the actual fuel inventory and adherence to duties.
- The operational performance and reliability of the nuclear facilities.
- Human resources and their provision for the needs of the nuclear energy sector and the nuclear industry and research.
- Research in the field of nuclear safety, operational reliability and RAW and the coordination of international cooperation in nuclear research.
- The disposal of RAW in repositories and the fulfilment of the RAW disposal policy.
- Land use planning and permitting processes related to nuclear facilities.
- The coordination of international cooperation in the field of the nuclear energy sector.
- The plan of the development of legislation in the area of the construction and operation of nuclear power plants.

The Committee for the Nuclear Energy Sector approves the annual report on the fulfilment of the action plan covering

- The condition of the nuclear energy sector and industry and its change.
- The legislative framework and the fulfilment of legislative tasks.

- The fulfilment of the Action Plan for the Development of the Nuclear Energy Sector in the Czech Republic.
- International cooperation:
  - Bilateral and multilateral treaties and participation in international organisations.
  - International cooperation in research.
  - International cooperation within the framework of the supply chain.
  - International cooperation in education and training.

The **government representative for the nuclear energy sector** is appointed by the government for a period of 4 years and performs the office of the Secretary of the Committee for the Nuclear Energy Sector (Committee). Their tasks are as follows:

- To manage the office of the Committee and provide for the preparation of materials on the Committee's meetings' agenda.
- To act in the name of the Committee and on behalf of the Czech Republic with international partners in the area of the nuclear energy sector development, including strategic partners and parties interested in cooperation.
- To provide for the coordination of the preparation of and amendments to the legislation affecting the construction and operation of the nuclear power plants with a view to facilitating the permitting and licensing process and minimizing the related risks of impacts on deadlines and costs.
- To coordinate the state authorities and regional authorities during the preparation and construction of nuclear power plants.
- To monitor the fulfilment of the National Action Plan for the Development of the Nuclear Energy Sector and submit to the Committee proposals for measures.

5.3 Organisation of the Supply Chain

Although they are private companies owned by various owners, their common interest is to carry out business in the sector under the powerful control of the state. Knowledge and the maintenance or development thereof and the involvement of suppliers are important for the development of the sector as a whole.

It is recommended to initiate the establishment of an organisation which would associate the industrial undertakings participating in supplies for the nuclear energy sector. Such an organisation would be a partner of the Committee (with the representative of the organisation as a member thereof) and could provide for the transfer of knowledge between the government and the industry, participate in the assessment of the NAP NE and submit proposals aimed at the Committee and coordination of members thereof.

5.4 Independent Supervision

The responsibility of the state for nuclear safety is provided by an independent regulator – **the State Office for Nuclear Safety**. Its absolute independence and the maintenance of key competences at the national level, together with its involvement in international structures, is of key importance. It is important to ensure a sufficient amount of financial and human resources necessary for the fulfilment of all functions of nuclear supervision, including international cooperation.

5.5 RAW Management

The responsibility of the state for the safe disposal of radioactive waste is provided by the **Radioactive Waste Repository Authority (RAWRA)**, which is a state authority accountable to the Ministry of Industry and Trade. Considering the operational character of a number of activities performed by the RAWRA, it is advisable to convert the RAWRA into a state-owned undertaking with the powerful and direct role of the state maintained.

5.6 Coordination of Research

The goal-directed development of the research and development base in the field of the nuclear energy sector is in the strategic interest of the state. The state should also be more involved in the support of the development of research carried out in the nuclear energy sector. It is necessary to investigate the possibilities of the instruments utilisable from the point of view of the state for the prioritisation of nuclear research in terms of both capital participation in the research institutes, and, to the minimum necessary extent, within the framework of an independent chapter (envelope) for the nuclear energy industry through the TA CR. From the strategic point of view, it is also important to support involvement in international projects and cooperation with strategic partners during the construction of new nuclear facilities in the Czech Republic.

6 Construction of New Nuclear Facilities

As mentioned in previous chapters, the immediate continuation of the preparation of NNFs, followed by their construction, is a key prerequisite for:

a. Achieving the SEP objectives in the field of energy security of the Czech Republic
b. Implementing the international decarbonisation commitments of the Czech Republic
c. Ensuring the long-term sustainable development of the nuclear energy sector in the Czech Republic

In view of the existing extent of market deformations, frequent legislative-regulatory changes, and capital and investment requirements for the development of nuclear facilities, it is crucial that the state clearly declares its interest in the further development of the nuclear energy sector (according to the requirements defined in the approved SEP) and is ready to be adequately involved therein including the granting of any guarantees. The role of the state is recognised in both decisions of the European Commission (as for the Hinkley Point C Nuclear Power Plant) and publications of the International Energy Agency (e.g. Technology Roadmap Nuclear Energy 2014 or World Energy Investment Outlook 2014). The International Energy Agency imposes an obligation on the governments of the states to define clear policies and set a stable long-term strategy for nuclear development, including responsibility for the financing of nuclear development. The governments shall accordingly ensure the transparency of prices and stabilise their policies, which are crucial for capital-demanding investments in basic-load facilities.

6.1 Sites

With regard to the energy security of the Czech Republic as well as with regard to the overall social benefit, it is desirable from the perspective of the state to immediately initiate the preparation for siting and construction of one nuclear reactor at the Temelin site and one reactor at the Dukovany site as well as to protect potential risks by obtaining the required licences for the possible construction of two reactors at both sites.

It is recommended to prepare both projects in the option of a two-unit construction (in all steps, i.e. EIA, contractor selection, licence for siting, planning permission, licence for construction), with planning so far the implementation of only one unit at the given site, with the possibility of expanding to two units. This procedure will make it possible to take a decision on the number of units just before construction starts and at the same time, reduces the risk of failure to supply the necessary output when one of the projects is in an important delay or has an insurmountable obstacle to construction. The preparation of both projects should be initiated without delay. **In particular, to maintain the continuation of production at the Dukovany site, the construction of a unit at the Dukovany site and its commissioning by 2037 are crucial in order to ensure the continuity of the operation of a nuclear facility and human resources at the site until 2037 when the shutdown of the existing NPP is expected.**

Whereas, with the inclusion of all risks, the projects might not be completed on schedule based on the needs of the Czech Republic identified in the State Energy Policy, it is advisable to reduce risks mainly in the preparation of construction and the permitting and licensing procedure by appropriately amending all legal and implementing measures and ensure an environment that will make it possible to implement the construction projects on required schedules.

6.2 Investment Model

In general, three options for investors/investment models may be considered for further procedure:

- **Construction of a facility/facilities through the investor ČEZ, a.s., and possibly its 100% owned subsidiary – From the perspective of the state, the investment through the existing owner and operator of nuclear power plants ČEZ, a. s., and possibly its 100% owned subsidiary is the first and clearly the preferred option.** The major shareholder of the parent company ČEZ, a. s., is the Czech Republic with a capital share (as of 30 June 2014) in the amount of 69.78%. This option is based on the assumption that the company ČEZ following the approved State Energy Policy defining the intended structure for generating electricity of the Czech Republic, including objectives for the construction of new nuclear facilities in a defined term, would draw up an investment plan taking account of the current development of the energy sector in the EU including clear signals from the Framework 2030 and the Roadmap 2050. The necessary steps have already been taken by ČEZ, a. s., to complete the construction of Temelin NPP Units 3 and 4, and it has sufficient experience in the preparation of a project of such an extent. In addition to sufficient experience, the fact that ČEZ, a. s., is the owner and operator of nuclear units in the existing sites, thus having the land, necessary infrastructure and a team of a skilled workforce carved out for this need may be seen as an advantage of this option. It is subject to the approval by the general meeting of the company in accordance with the Articles of Association.

Table 12: *SWOT analysis – first option for the investment model*

S – strengths	W – weaknesses
• Zero impact on the state budget and electricity consumers in terms of the electricity price. • Follow-up to the work previously undertaken to complete the construction of Temelin Units 3 and 4. • Non-dilution of the competences; ensuring the entire project by the current owner and operator of NPP in the Czech Republic; sufficient experience in the preparation of a project of such an extent. • Availability of land, the necessary infrastructure and a team of experienced experts carved out for this need. • The investment shall be undertaken by a financially strong company and possibly its	• Possible higher costs of foreign capital compared to option 3. • Limited opportunity to defend the interests of the state - for example, a higher percentage of Czech suppliers of technology.

100% owned subsidiary, which is attractive for private investors who intend to join the project as well as for the financing institutions of the mentioned project.	

O – opportunities	T - threats
• Functioning investment project of a nature corresponding to other investments in the energy industry. • Reproduction of the assets of ČEZ, a.s.	• Continuation of the current situation on the electricity market/markets - lack of motivation to undertake the construction on the basis of market signals.

- **Association of investors – The second option is a <u>private investor consortium,</u>** i.e. an association of investors in order to achieve a certain goal (ČEZ, financial investor, large customer, contractor of nuclear unit, etc.). The composition of the consortium and the percentage distribution of shares depend on the willingness of individual investors to enter the project. In light of the experience from other projects in Europe, it could be presumed that in the existing market situation, such a consortium will expect some form of guarantees from the government.

Table 13: *SWOT analysis – second option for the investment model*

S – strengths	W – weaknesses
• A higher degree of the diversification of costs and potential risks. • Shared "know-how" among the companies participating in the project. • Potentially lower costs of foreign capital. • Pressure on the timely completion of the project.	• Lack of strong investors - electricity consumers. • In the existing market situation, it could be assumed that the government will be expected to provide the private consortium with a certain form of guarantees. • The granting of potential state aid requires notification by the European Commission. • A necessary procedure pursuant to the PPL or obtaining a derogation (the investor is not capital-linked to the contractor).

O - opportunities	T - threats
• In the case of higher market prices, competitive advantage for consumers participating in the project.	• Disapproval of the notification by the European Commission. • Potential inability to coordinate the interests

	of the individual investors within the consortium. • In the event of passing a certain part of the costs of a new nuclear facility on to consumers, a significant change may occur in the public attitude to the disadvantages of the construction.

- **State-owned enterprise** – The third option is **direct construction by the state through a newly established state-owned enterprise**. However, because of a large number of negative aspects and mainly because of the high impact on the state budget and the increasing national debt relating thereto, this option is the least likely and it is therefore mentioned only for the sake of completeness.

Table 14: *SWOT analysis – third option for the investment model*

S – strengths	W – weaknesses
• Opportunity to defend the interests of the state in favour of a higher percentage of Czech contractors. • Without the need for the entry of foreign capital.	• High impact on the state budget. • Increase in the national debt. • Inconsistency with the fiscal policy of the government in the field of the reduction of the state deficit and national debt. • Risk of a rating downgrade for the Czech Republic. • Insufficient experience of the state in the preparation of a project of such an extent (the state has no experience, qualified workforce, infrastructure, assets, etc.).

O – opportunities	T – threats
• Maintaining the strategic interests of the Czech Republic even in the case of persisting distortions on the electricity market.	• In the case of the continuation of the current situation on the electricity market, the state investment is at risk of a non-return with a negative impact on the state budget and national debt. • Insufficient pressure on cost reduction and the possibility of making the whole investment more expensive. • Insufficient pressure on compliance with the deadlines. • Large investments in the construction of new nuclear units may result in a threat to

	the funding of other areas of the state sphere (pensions, social policy, health, etc.). • Required approval of the European Commission of this construction model. • In the event of passing a certain part of the costs of a new nuclear facility on to consumers, a significant change may occur in the public attitude to the disadvantages of construction.

6.2.1 Share of Domestic Contractors

The above options have some differences in the opportunity to influence the share of domestic contractors in the overall supply. While in the first two options the state disposes only of indirect instruments for promoting a greater share of Czech companies (through the exercise of their shareholder rights, by defining the conditions for the Contract for Difference – CfD, etc.), in the third option the state may influence the share of Czech companies more effectively (provided that an exemption from the PPL has been obtained). The way of business organisation is the key factor for the possibility to influence the share of domestic contractors – in the case of the selection of the EPC contractor pursuant to the PPL, the amount of the share of domestic contractors cannot be evaluated and the instruments to motivate the EPC contractor to use domestic contractors are, therefore, very limited. In the case of obtaining an exemption from the PPL, the share of domestic contractors can be efficiently influenced (evaluation criterion, determination of the minimum share of domestic contractors, price preference, etc.). However, note that the preference rate for Czech companies could have a significant negative impact on the competitive environment, thereby on the total costs or, where appropriate, construction schedule. The potential selection of companies without previous experience in the construction of a specific technology increases moreover the total risks of the project again with a negative impact on the costs and date for construction. The possibility of influencing the share of Czech companies is also dependent on the selected model of commercial security because in the case of the procedure pursuant to the PPL, the possibilities of influencing the share of Czech companies in all options are very limited.

6.2.2 Recommended NNF Preparation Procedure

Due to the high uncertainty regarding the future situation on the electricity market, it is recommended to continue with the process of preparation and construction of a new nuclear facility in two stages.

In the first stage, it is absolutely crucial for the Czech Republic to maintain all necessary capacities for the future construction of new facilities. Therefore, it is needed to immediately continue the preparatory work leading to construction, including the obtaining of all necessary licences/permits and concluding contracts with contractors. The effectiveness of contracts will be limited to the activities required to ensure the project preparation needed for processing licensing and permitting documents, and for commencing construction after obtaining a building permit. ČEZ should continue to carry out this work. The timeframe up to obtaining a building permit is roughly around 2025.

Subsequently, at the latest before issuing a building permit, at the time when there will be the real need to decide to build new facilities and issue a notification of the full effectiveness of supply contract with a contractor, and real capital expenditures in the amount of approximately CZK 250 – 300 billion (during construction of two units), an assessment would be made based on the market situation whether the need for the construction of a new nuclear facility is still present and whether:

a) The market situation has been stabilised enough to allow the construction of new nuclear facilities without any state guarantees and ČEZ would build new facilities on a commercial basis.
b) Market deformations are still present and new nuclear facilities cannot be built without providing any guarantees. In such a case, the state should decide whether it will provide guarantees to an investor and what form they will take.[14]

In the case of the guarantees provided to the investor for financial return on the project, the use of the so-called compensation mechanism "Contract for Difference" (CfD) is discussed in some countries. This mechanism shall set the fixed electricity price, escalated using the price indexes and the deviations from the reference market price would be balanced by increasing/decreasing the electricity price for consumers. Therefore, the mechanism in question can have a direct impact on consumers depending on the development of electricity prices. At the same time, it can have an impact on the state budget if the energy prices were unbearable to consumers and the state undertook a part of the commitment. It is a form of support which has already obtained the assent of the European Commission (as for the Hinkley Point C Nuclear Power Plant) and sets a precedent in its own way to a number of new nuclear projects. Debt guarantees may be complementary to the CfD mechanism since they make it possible to ensure a greater volume of debt financing, thus reducing the required investor's rate of return. When providing guarantees, the state will receive a fee to the state budget within the meaning of Act No. 218/2000 Coll., on Budgetary Rules and on Amendment to Certain Related Acts (Budgetary Rules).

At the same time, the **implementation of the NNF construction project within the framework of a Special Purpose Vehicle (SPV),** into which all the relevant assets shall be brought in order to complete the construction of nuclear units at both existing sites, appears to be strategically advantageous (and even necessary in second and third options) in terms of the future investment model. The advantage of this procedure is primarily:

- A high flexibility in terms of future potential change in the investor model (allowing the capital entry of the state, strategic investor or technology supplier)
- Extension of the scope for financing the project (by the possibility of applying the project financing instruments)
- Transparent separation of the costs of construction of new units from the operation of the existing generating facilities

6.3 Economic and Time Aspects of NNF Construction

[14] Any form of state guarantee would constitute public aid within the meaning of Article 107, para. 1 of the Treaty on the Functioning of the European Union and would be subject to approval by the European Commission.

6.3.1 General Model Assumptions for Analysis

The inputs – investment and operational costs of the facility and the development of the electricity market price are generally crucial for the assessment of individual options. Specifically for CfD, mainly the following quantities enter into consideration:

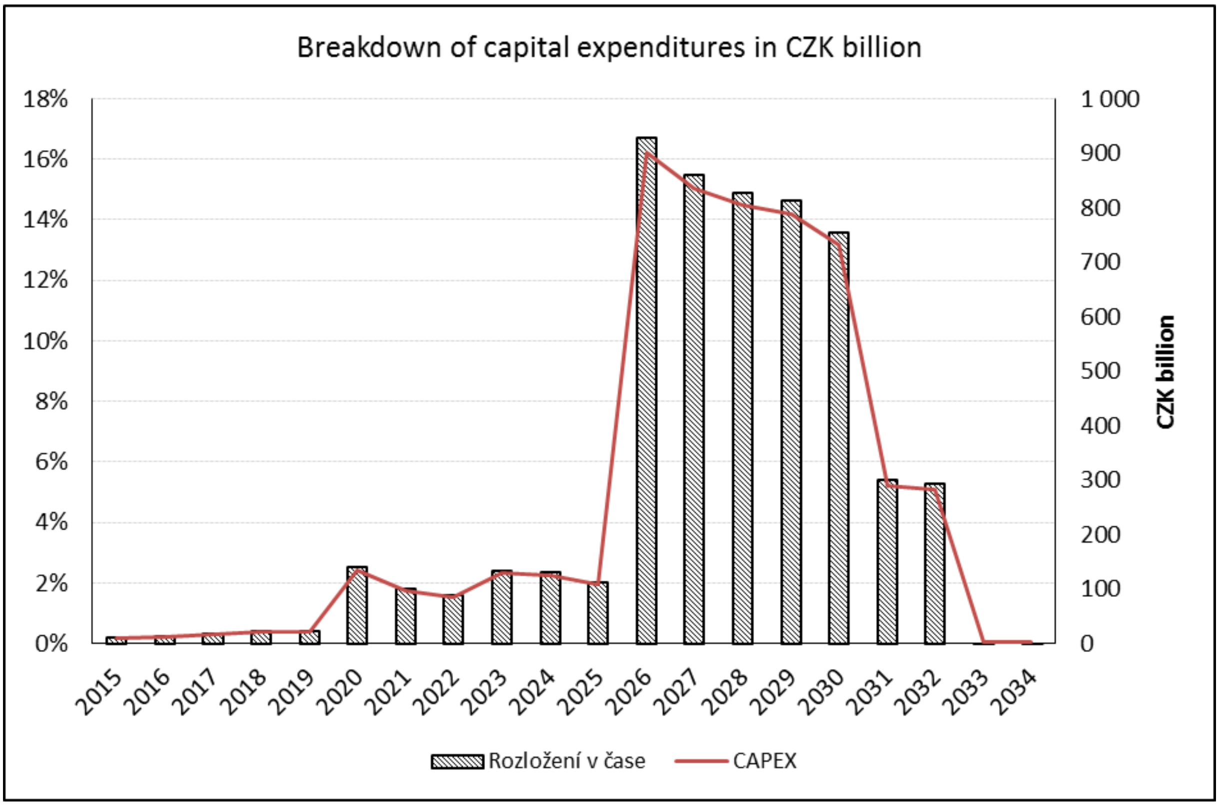
- Estimate of the total costs of investment.
- Rate of required return on the part of the investor.
- The length of a period of time, in which the guarantee is provided in the form of CfD – the analysis uses 3 options:
    - 60 years, corresponding to the planned operation of the facility,
    - 35 years, which is a model successfully notified by Great Britain, and
    - 15 years as model scenario.[15]
- Escalation factor – the analysis is carried out in real prices of 2015. Escalation factors for conversion for individual years are: 2.5% (2012), 1.5% (2013), 1.5% (2014). Years 2012 and 2013 are based on statistics, and the year 2014 is an expert estimate. The 2% escalation is taken into account for the year 2015 and thenceforth.

The analysis is presented on an example of the construction of **one unit with a total installed capacity of 1,200 MW**, while taking account of keeping specific capital expenditures as well as similar distribution over time for other sizes of facility by installed capacity. For example, for the unit 1,700 MW, the mentioned expenditures would have to be increased by approximately 40% (it is only a rough approximation as the costs of preparation will be similar for any unit size). **For the construction of two units at one site, compared to the construction of one unit, it is possible to consider a 10-20% reduction in specific capital expenditures.**

In this analysis, the **capital expenditures** of the facility are derived from the study “Synthesis on the Economics of Nuclear Energy” (Study for the European Commission, DG ENERGY, November 2013), where the total capital expenditures (CAPEX) on the basis of the applied escalation factor (for conversion of expenditures referred to in the study into prices of 2015) are equal to **4,500 EUR/kW for the construction of one unit**. For a gradual increase in capital expenditures see Graph no. 4 when year 1 is ideally – with regard to energy security – the year 2015.

[15] It is a model term, which should demonstrate the case where the aid is paid in a term shorter than in the two scenarios mentioned above. This term has also been chosen because it was a model-considered in the case of the Hinkley Point power plant and its new Unit C.

Graph no. 4: *CAPEX breakdown for NPP construction in years*



Rozpad investičních nákladů v mld. Kč	Breakdown of capital expenditures in CZK billion
Rozložení v čase	Distribution over time
CAPEX	CAPEX
mld. Kč	CZK billion

The breakdown of capital expenditures is determined on the basis of an expert estimate of the MIT with the use of information provided by ČEZ, a.s.

The specific distribution of expenditures over time as well as the whole process of NPP completion depends on the construction schedule for the new facility, which is accompanied by a number of risks. These may be mitigated to some extent through targeted actions undertaken by the state, investor and contractors. For an indicative construction schedule for the new facility in a deterministic option with maximum risk management as well as in a longer option reflecting the probabilistic materialisation of risks see the table below:

Table 15: *Indicative construction schedule for the new facility (on the basis of the legislation in force)*

Milestone	**Years from T0**	**Probable complication**	**Possible delay ***	**Real (years from T0)**
EIA opinion	5 years	International negotiation process – **purposeful extension by non-governmental organisations** and others; **effect of changes in legislation** (possibility of contesting the process, lawsuit).		5
Licence for siting (SÚJB)	5.5	Interruption of the process – request for additional information.		6.5
Selection of contractor	6.5	Complaint / action brought by an excluded or unsuccessful candidate; extension of the notification process with the EC; extension of the internal approval process.	+ 0 - 2 years **(+ 0 year)**	6.5
Final planning permission	8.5	Duration of the administrative procedure of the building authority due to the scope and complexity of the project; interruption of the procedure and request for additional information (interpretation of the Building Act); possible action for annulment of a planning permission (by parties to the procedure).	+ 0.5-2 years **(+0.8 year)**	9.3
Licence for construction (SÚJB)	9.5	Extension of the assessment process by the SÚJB; interruption of the process and a request for additional information (interpretation of legislation); **change in time limits in the amended Atomic Act**.	+ 1-2 years **(+ 1.5 year)**	11.8
Building permit = start of construction	10.5	Failure to meet the legislative time limits by the MIT with regard to the scope and complexity of the project; interruption of the process and request for additional information (interpretation of the Building Act), **action for annulment of a building permit** (by parties to the procedure).	+ 1 year **(+ 0.5 year)**	13.3
Commissioning Unit 1	17.5	Extension of the construction period as a result of **legislative changes**, non-quality on the part of the contractor.	+ 1-3 years **(+ 2 years)**	22.3

* Possible extension of the activity concerned on the critical path. In the longer schedule, the framework of construction risks already includes a risk of delay in construction due to commissioning. However, a specific distinction relating to the construction risks is significantly dependent on knowledge of a specific used technology, and thus they cannot be accurately identified at the stage of analysis. At the same time, the

schedule does not reflect other factors, which show up after a period when the new facility already supplies electricity to the grid.

In the case of deciding to start the preparations in 2015, the earliest real date is the year 2032 while significantly minimising any risks. Moreover, in the case of the Temelin NPP, a number of permissions/licences or possibly preparatory work already exists, thus allowing to further reduce the anticipated schedule assuming a significant acceleration of the selection of the EPC contractor (through an exemption from the PPL or by direct selection). In the case of targeted activity by the state aimed at reducing the risks of permitting and licensing processes as well as significantly accelerating the selection of the EPC contractor, this option for the Temelin NPP project may be considered a basic option, which will also make it possible to meet the requirements for the development of energy sources according to the ASEK. For the Dukovany project, the reduction as a result of the faster selection of the EPC contractor will not be significant, particularly in view of the necessity to obtain an EIA opinion and carry out other preparatory work that is already completed for the Temelin NPP project.

In the event of including risks for all sub-processes, the date for commissioning is the year 2037; however, this deadline is mainly from the viewpoint of the new facility in the Dukovany NPP in line with the needs of the state and the state should undertake the targeted actions to reduce the construction period of the new facility. The date was set on the basis of a risk analysis from the probabilistic level P65 (i.e.: there is a 65% probability of completing the first unit by the end of 2037).

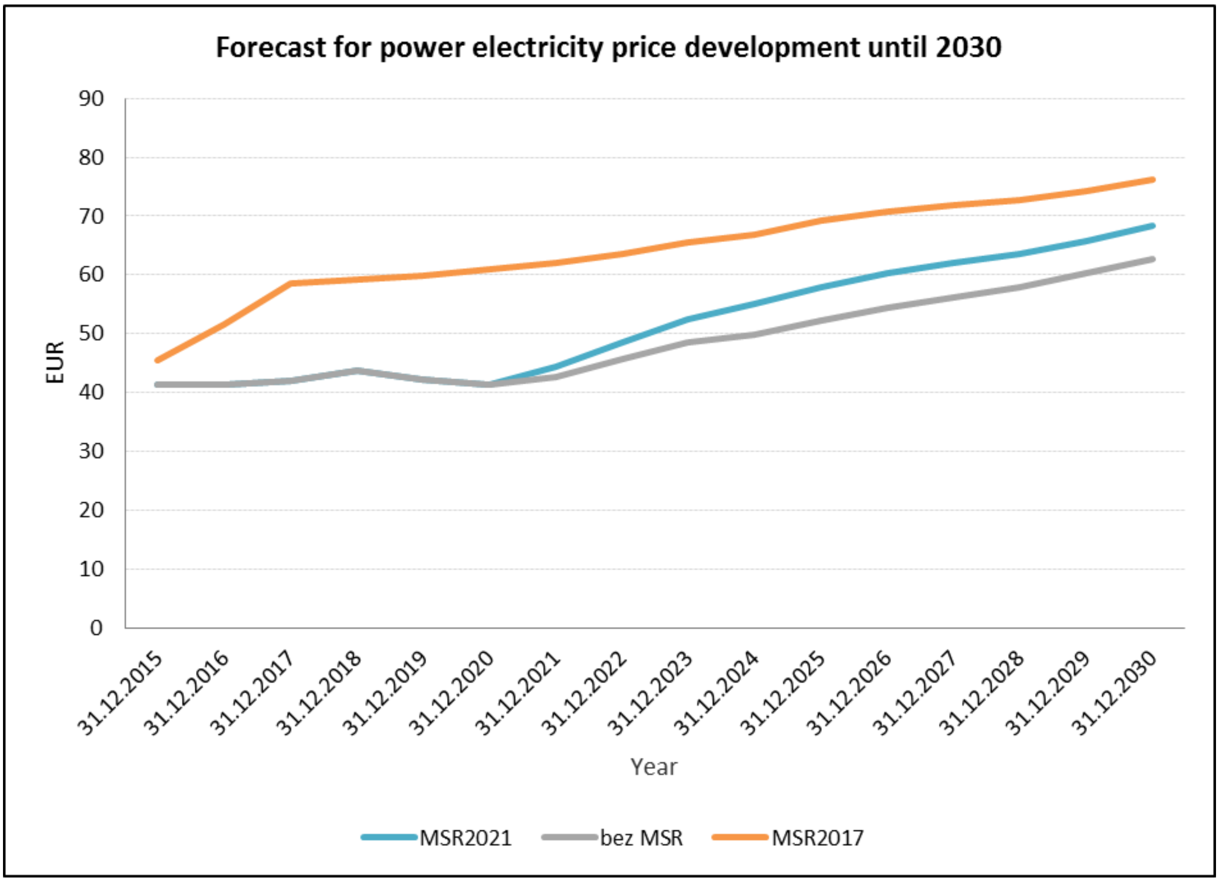
For the maximum inclusion of all risks in the longest option, we can even reach the year 2042. However, this deadline would mean any resignation by the state to implement the construction of new nuclear facilities. The risk analysis covers all risks across the whole construction of the NNF and it is certainly impossible to eliminate all the risks in the option. For example: the exclusion of unsuccessful candidates, exclusion of third parties in the planning permission procedure or contested EIA opinion due to new legislation. In case of finding an alternative method for ensuring a contractor (i.e. without the PPL) or in the event of a change in legislation for permitting and licensing, it is possible to adjust the basic (deterministic) schedule and/or mitigate the impacts of risks associated with the activities, thus reducing the expected period. Due to the hypothetical consideration, it is impossible to determine exactly how much the schedule would be reduced, but it is in the order of years.

The prediction of the **power electricity price** development in the context of the Czech Republic was calculated at the level of both variable and full (generation) costs of the so-called “closing power plant”. The price of power electricity should approximate this fundamental value, although it may fluctuate in transient periods on the basis of the development of other factors not directly influencing the costs of the closing power plant. In the environment of the liberalised electricity market, this fundamental value (marginal price) should be determined in the context of the pan-European market with a detailed statement of the offering party (*merit order*), cross-border capacities and other market restrictions. Therefore, this value was determined for a period until 2030 on the basis of the variable costs of the closing power plant and for a period beyond 2030 on the basis of the assumptions of the full costs of the closing power plant.

In a period until 2030, the individual options are calculated for three wholesale electricity prices – low, reference and high scenarios. Until 2030, the PLEXOS ® *Integrated Energy Model* was used for prediction purposes. Electricity prices are predicted with the use of the estimate of the development of real prices of energy commodities from the *World Energy Outlook* of 2013 provided by the IEA. Furthermore, the individual scenarios work with a different development of the price of emission allowances, which is linked to possible reform of the EU Emission Trading System:

- The low scenario (without MSR) assumes the unsuccessful introduction of the so-called "market stability reserve" (MSR) as part of the reform of the EU Emission Trading System (EU ETS), which would make it possible to regulate the amount of available allowances on the market.
- The reference scenario (MSR2021) assumes the introduction of the MSR not earlier than in a new trading period after 2020.
- The high scenario (MSR2017) assumes the putting of the MSR into practice already in 2017 when the "backloaded" allowances would be directly transferred to the reserve.

Graph no. 5: *Electricity price development until 2030*



Prognóza vývoje ceny silové elektřiny do roku 2030	Forecast for power electricity price development until 2030
rok	Year
MSR 2021	MSR 2021
bez MSR	without MSR
MSR 2017	MSR 2017

There is significant uncertainty over the period from 2030 to 2040 regarding the future values of relevant input parameters, detailed data relating to the production mix in Europe and prices of fundamentals as well as prices of carbon emission allowances, which makes the long-term power electricity price modelling very difficult. Therefore, the method of full costs of the so-called "closing power plant" was used for the prediction of power electricity price development over this period.

On this assumption, the electricity price should be based on the costs of the last type of source satisfying demand for electricity, at the level of full costs (i.e. the sum of variable and fixed costs).[16] The closing power plant should be a combined steam and gas power plant or possibly a high efficiency supercritical coal unit. The forecast should take account of the possible future development of the prices of inputs, i.e. mainly fuel and emission allowances, as well as the anticipated development of capital expenditures. The full costs for a combined steam and gas power plant are based on the long-term development of CO_2 prices (40, 63, 79 EUR/t) and on the assumptions for calculation in the range of 88-99 EUR/MWh and for a bituminous coal power plant 93-118 EUR/MWh at the price level of 2015.

Five scenarios will be taken into consideration for further impact analyses:

- Marginal scenarios for electricity prices set until 2030, i.e. the prices **62 and 76 EUR/MWh,**
- Marginal scenarios for prices set at full costs of a combined steam and gas power plant, i.e. prices **88 and 99 EUR/MWh**,
- Current level of forward stock prices **35 EUR/MWh**.

6.3.2 Ensuring the Return of Investment in the Option with the Use of CfD

Strike-price

To evaluate the strike-price depending on financing costs, the following is considered:

- Scenarios of CfD - 15 years, 35 years and 60 years
- Financing costs in the amount of
  - 6-9% for the investor (lower value assumes the CfD for a period of at least 35 years with a significant coverage of construction and operational risks and a high volume of debt guarantees)
  - 4-6% for construction through the state (4% corresponds to the historical average yield of German ten-year EUR bonds)
- Setting the CfD to bring the escalation of the CfD strike-price in line with the escalation of capital, operational and financial costs (in the case of different escalation in the CfD and costs, costs to cover such risks would have to included in total costs)
- The strike-price is calculated to achieve the required rate of return for a period of duration of the CfD.
- The strike-price will be tested whether it exceeds the value of full costs of the gas source of 99 EUR/MWh

[16] Within a certain (short-term) period, a closing power plant generates at the level of variable costs, due to the existence of sunk costs. However, a balance is, in a sense, considered in this case where the given price is acceptable to companies even when they enter the market and therefore, sunk costs do not enter the decision-making process.

Table 16: *Financing costs*

Strike-price [EUR/MWh]	Financing costs (nominal WACC in %)					
	Financing through investor with CfD					
				Financing through the state with CfD		
	9%	8%	7%	6%	5%	4%
CfD 60 years	92	79	68	59	51	44
CfD 35 years	99	86	75	66	58	52
CfD 15 years	128	114	103	92	83	76

Note: Values are in prices of 2015

The results of this analysis should be taken as indicative because a number of other marginal conditions and assumptions must be set for a detailed calculation of necessary strike-price.

The analysis of the strike-price for the CfD shows that the duration of the CfD is an essential parameter. The difference between 15 and 35 years is 24-29 EUR/MWh, while the difference between the CfD for 35 and 60 years is 6-7 EUR/MWh. In terms of the necessary amount of the CfD, the duration of 60 years no longer brings a significant benefit. The CfD for 15 years with financing over 6% exceeds the value of the full costs of the gas source, i.e. in terms of costs, it is not a solution for the Czech Republic. On the basis of the above, the optimum duration of the CfD is a period of around 35 years, when the required amount of the CfD is significantly reduced, and hence the potential negative impact on the customer.

In terms of the required rate of return for the investor, the difference between 9-6% is 33 EUR/MWh and with financing through the state in the range of 4-6%, the difference is 14 EUR/MWh with the CfD for 35 years. The reduction of the necessary amount of the CfD can therefore be achieved either by providing the investor with a significant security in setting the CfD and granting guarantees, or choosing direct financing from the state budget.

For the purposes of further assessment, the assessment will include the values for the CfD of 35 years and financing for 8, 6 and 4% (highlighted in Table), where 8% will represent the CfD when financed through an investor, 6% the CfD when financed through an investor with extraordinary coverage of construction and operational risks through the CfD and provision of a high volume of debt guarantees by the state, and 6% and 4% the financing through the state from state resources. The anticipated values must still be considered as very preliminary because they are strongly dependent on the specific allocation of risks particularly in the CfD setting, guarantees, construction, operation, shutdown and financial security of construction.

Budget and consumer impact analysis:

Since the CfD may be addressed to both the consumer and the state, the other four options are analysed in terms of the impact on the customer and on the state budget:

Table 17: *Financing options and rate of return guarantee*

Financing options and rate of return guarantee:		**Who guarantees the electricity tariff:**	
		Consumers (CfD)	State (CfD)
Construction financed by:	Private investor	1	3
	State	2	4

1. Private investor, CfD

- Potential impact on consumers after commissioning
- The CfD must guarantee the rate of return on investment acceptable to the private investor
- Moreover, the loan guarantee from the state has the potential for reducing the required rate of return
- Zero impact on the state budget (risk of impact on the state budget after commissioning when the impact on consumers can be so unbearable that the state undertakes a certain part of the guarantee)

2. State, CfD

- Potential impact on consumers after commissioning
- Significantly lower required rate of return than with the private investment
- Financing of the investment from the state budget, from the state off-budget debt or commercial debt with the state guarantee

3. Private investor, CfD with the state

- Financing is through a private investor
- The feed-in tariff must guarantee the rate of return on investment acceptable to the private investor
- Moreover, the loan guarantee from the state has the potential for reducing the required rate of return
- Potential impact on the state budget after commissioning

4. State without CfD

- Significantly lower required rate of return than with the private investment
- Financing of the investment from the state budget, from the state off-budget debt or commercial debt with the state guarantee
- Zero direct impact on the consumer

Customer impact:

The analysis of the impact on the customer is based on marginal scenarios for electricity prices set until 2030, i.e. prices of 62 and 76 EUR/MWh, marginal scenarios for prices set by the full costs of combined steam and gas power plant, i.e. prices 88-99 EUR/MWh and current level of FWD stock prices 35 EUR/MWh.

Table 18: *Annual customer impact*

Electricity price scenario [EUR/MWh]	Annual customer impact [billion CZK/year] for financing options and guarantee of the rate of return [in EUR/MWh]			
	1. Private investor, CfD 66-86 EUR/MWh	2. State, CfD 52-66 EUR/MWh	3. Investor, CfD with the state 66-86 EUR/MWh	4. State without CfD
35	-8 to -13	-4 to -8	-8 to -13	0
62	-1 to -6	3 to -1	-1 to -6	0
76	-3 to 3	6 to 3	-3 to 3	0
88	1 to 6	6 to 9	1 to 6	0
99	3 to 9	9 to 12	3 to 9	0

Note: a plus sign means a positive impact for the consumer, i.e. a fee for that year is received by the consumer from the producer and vice versa. Values are in the 2015 prices. The values also reflect the assumption that the costs, which could be potentially paid by the state, would in some way be reflected in the final electricity price for the customer.

The table below shows the estimate of expenditures (and possibly revenues) paid by the end customer provided that the expenditures (revenues) mentioned above are fully reflected in the final price. The values indicated in the table are based on the lower values shown in the table above. The estimate of net electricity consumption for 2025 from the ASEK document at the level of 66,429.1 GWh was used for quantification purposes. The assumption is to uniformly distribute the expenditures (revenues) per unit of consumption.

Table 19: *Estimated customer impact in the context of the final price (option 1)*

Electricity price scenario [EUR/MWh]	Annual customer impact [CZK/MWh] for financing options and the guarantee of the rate of return [EUR/MWh]:			
	1. Private investor, CfD 66-86 EUR/MWh	2. State, CfD 52-66 EUR/MWh	3. Investor, CfD with the state 66-86 EUR/MWh	4. State without CfD
35	-195.5	-120.3	-195.5	0
62	-90.2	-15.0	-90.2	0
76	-45.1	45.1	-45.1	0
88	15.0	90.2	15.0	0

99	45.1	135.4	45.1	0

The following table provides for a similar model calculation, also on the assumption of net electricity consumption at the level of 66,429.1 GWh, but with the use of higher values, as indicated in Table 18.

Table 20: *Estimated customer impact in the context of the final price (option 2)*

Electricity price scenario [EUR/MWh]	**Annual customer impact [CZK/MWh] for financing options and the guarantee of the rate of return [EUR/MWh]:**			
	1. Private investor, CfD 66-86 EUR/MWh	2. State, CfD 52-66 EUR/MWh	3. Investor, CfD with the state 66-86 EUR/MWh	4. State without CfD
35	-120.3	-60.2	-120.3	0
62	-15.0	45.1	-15.0	0
76	45.1	90.2	45.1	0
88	90.2	135.4	90.2	0
99	135.4	180.5	135.4	0

In the case of Option 3, lower interval values were used and the model-conversion was made with the use of net electricity consumption in 2040 according to the ASEK, which corresponds to the level of 74,071.9 GWh. Option 4 is based on the same level of net electricity consumption as Option 3, but assumes the higher one of the interval values, as indicated in Table 18.

Table 21: *Estimated customer impact in the context of the final price (option 3)*

Electricity price scenario [EUR/MWh]	**Annual customer impact [CZK/MWh] for financing options and the guarantee of the rate of return [EUR/MWh]:**			
	1. Private investor, CfD 66-86 EUR/MWh	2. State, CfD 52-66 EUR/MWh	3. Investor, CfD with the state 66-86 EUR/MWh	4. State without CfD
35	-175.5	-108.0	-175.5	0
62	-81.0	-13.5	-81.0	0
76	-40.5	40.5	-40.5	0
88	13.5	81.0	13.5	0
99	40.5	121.5	40.5	0

Table 22: *Estimated customer impact in the context of final price (option 4)*

Electricity price scenario [EUR/MWh]	**Annual customer impact [CZK/MWh] for financing options and the guarantee of the rate of return [EUR/MWh]:**			
	1. Private investor, CfD 66-86 EUR/MWh	2. State, CfD 52-66 EUR/MWh	3. Investor, CfD with the state 66-86 EUR/MWh	4. State without CfD
35	-108.0	-54.0	-108.0	0
62	-13.5	40.5	-13.5	0

76	40.5	81.0	40.5	0
88	81.0	121.5	81.0	0
99	121.5	162.0	121.5	0

Budget impact:

In the budget impact, both the negative and positive budget impacts are analysed relating to power plant construction and operation by the type of financing option and the rate of return guarantee:

Table 23: *Annual budget impact*

Type of budget impact	Annual budget impact [billion CZK/year] and [total expenses for the entire period]:			
	1. Private investor, CfD 66-86 EUR/MWh	2. State, CfD 52-66 EUR/MWh	3. Investor, CfD with the state 66-86 EUR/MWh	4. State without CfD
Expenditure on construction preparation (until the signature of the EPC contract)	0	-x0.1 [-3]	0	-x0.1 [-3]
Expenditure on construction (until the decision on construction)	0	-x1 [-20]	0	-x1 [-20]
Expenditure on construction (following the decision)	0	-25 [-120]	0	-25 [-120]
Revenue/Expenditure from NPP operation	0	6 to 11	9 to -13	3 to 19
Revenue from the payment for potential debt guarantee	[0.7]	0	[0.7]	0
Tax revenue during operation	2 to 3 [127 to 187]	1.4 to 2 [86 to 127]	2 to 3 [127 to 187]	0.5 to 3.5 [35 to 225]
Tax revenue during construction	1 [10]	1 [10]	1 [10]	1 [10]

Note:

1. *A minus sign means an expenditure and plus sign means revenue in the state budget.*
2. *As the construction expenditures change over time, "x" indicates the order of several units. For the time distribution of expenditures see Chapter 6.3.1. General Model Assumptions for Analysis.*
3. *Construction expenditures are shown without financing costs.*
4. *All values are in 2015 prices.*
5. *The cumulative expected impact for that period is placed between square brackets*
6. *The tax revenue includes personal income tax, i.e. NPP employees and suppliers (15%) and corporate income tax, i.e. NPP operator and technology suppliers (19%). The income tax is*

assessed by the rates referred to in Section 16 and Section 21 of Act No. 586/1992 Coll., on Income Tax. The VAT and other related taxes are not included.

7. *For the option "state without CfD", the calculation for limit values of anticipated electricity prices is provided to assess the income tax, i.e. 35 and 99 EUR/MWh.*
8. *The assumption is the construction of one new unit at CZK 143 billion.*
9. *As for the private investor, account is taken of the price for the CfD in the range of 66-86 EUR/MWh, while as for construction through the state, account is taken of the price for the CfD in the range of 52-66 EUR/MWh (probable lower investment costs in the case of investment implementation through the state can ensure a lower level of the final electricity price for CfD).*

6.3.3 Ensuring the Rate of Return of Investment in the Option of Direct Construction through the State - Model Example

Input timing:

In the direct construction by the state through the newly established state-owned enterprise, it is appropriate to first create the SPV by ČEZ to prepare the projects before the required milestone. The state subsequently enters this SPV with the use of its assets. At the time of entry, all previous necessary project costs and the values of the site/sites will be paid depending on the share of the state. For ensuring the possibility of preparing the sites, the state shall provide, prior to its entry and before other work commences, the SPV or ČEZ with a sufficient signal to show its intent to develop the project with this procedure. This signal could be the conclusion of the option contract, SPV purchase agreement, or other option for business organisation. In order to maintain the continuity of the comprehensive nuclear expertise and link to current sites, it is also advisable to keep a partial participating interest of ČEZ in the project.

Depending on the timing for the state entering the project, two options may be considered in principle:

A. Entry of the state into the SPV as soon as the latter has been established. In this case, the state has all further development under full control. The disadvantage of this procedure is that the state and the concerned state authorities are not prepared for the immediate entry of the state into the projects for new nuclear facilities, which will have a significant negative impact on the schedule for the preparatory stage.
B. Entry of the state into the SPV as soon as the set milestone has been fulfilled. To that point, the project would be developed by the current owner.

In Option B, the costs incurred in developing the project depend on the milestone reached. For one project, the costs can range from CZK 2.5 to 20 billion depending on the milestone. In parallel preparation of both projects, it can be assumed that the costs range from CZK 4.3 to 32 billion.

The amount of the costs incurred over individual years of project preparation until the issue of a building permit depends on the finally selected supply and investor model as well as on the business organisation model applied.

For anticipated limit costs incurred from 01/2015 into individual sub-milestones of the project see the table below:

Table 24: *Limit costs incurred from 01/2015 into individual sub-milestones of the project*

Milestone	Anticipated date (ETE / EDU)	Costs of 1 project (Temelin NPP – Dukovany NPP) [CZK billion]	Costs of parallel preparation of both projects [CZK billion]
Selection of the EPC contractor, EPC contract signature with partial effectiveness	2019	2.5 – 2.6	4.3
Issue of a planning permission	2022	10.7 – 10.9	17.5
Issue of a licence for construction (SÚJB)	2024	16.4 – 17.2	27.2
Issue of a building permit (readiness of the project for implementation, i.e. for the issue of a full effectiveness notice for the EPC contract)	2025	19.1 – 20.2	31.9

The expected limit costs in individual partial milestones of the project were determined on the following assumptions:

- The EPC supply model for the supply of power plant supplemented by investor-secured related and induced investments on and off site.
- The selection of the EPC contractor pursuant to public procurement law.
- The application of current legislation for permitting and licensing procedures.
- Not taking account of risks which have a major impact on the project schedule / budget (contestation in court, significant extension of permitting and licensing processes, etc.).
- The costs of the parallel preparation of both projects consider the maximum synergy in a context of joint or in parallel implemented selection process, the selection of the identical supplier, and permitting and licensing procedures running in parallel on a basis of identical technology.
- The projects are implemented through the SPV (costs of operation of the SPV are included in total costs).

The information mentioned above applies to project preparation in the option of two-unit construction (in all steps, i.e. EIA, contractor selection, licence for siting, planning permission, licence for construction), with planning so far of the implementation of only one unit at the given site, with the possibility of expanding to two units. The value of sites or the value of the part of ČEZ, a. s., allocated to the SPV is not included in the costs.

<u>Size of the capital participation of the state</u>

In order to minimise the impacts on the state budget, it is advisable to use both financing by the supplier (and/or strategic investor), the involvement of export agencies and external loans from banks or intergovernmental loans.

Specifically, the following ranges may be considered:

i. Partial financing by the equity of the technology supplier (or the strategic partner connected to the technology supplier). According to the preliminary comments made by potential suppliers and examples from projects in other countries, we expect the **supplier's**

involvement in the amount of 30% of the total equity share, i.e. depending on the equity share and debt, it is possible to expect 12-30% of the total investment.

ii. Using export credit agencies (ECA) from supplier's country/countries (debt financing for supplies from supplier's country/countries). According to the preliminary comments made by suppliers, we expect 80% coverage for supplies from supplier's countries. Assuming a 90% share of the EPC supply in the total costs of investment, a 40% share of the supply from supplier's countries of the EPC supply and 80% of coverage using the ECA, it is possible to consider a total of **approximately a 30% share** in total investment using the ECA (90% x 80% x 40%). In the event that the share of Czech supply companies was higher, the share covered using the ECA would be adequately reduced.

iii. External commercial or interstate debt financing with debt guarantees by the state. Due to the provided debt guarantee, it is possible to reduce the risk of adding the external debt to the national debt, thus reducing the future national debt as a result of the project implementation. We conservatively take account of a **30%** share of this financing in the total investment.

6.4 Business Organisation Options

With regard to the duration of each individual method of business organisation and the possibilities of obtaining a higher volume of financing from the technology supplier, selection **through a strategic partner** appears appropriate, either by construction on the basis of the exemption of the European Commission from the public procurement regime or under an interstate contract. The exact procedure to be applied will be specified later.

In the case of the option of the direct involvement of the state in construction through the state-owned company and with the participation of the strategic partner, the participation of the existing owner and operator of nuclear facilities in the project is not excluded. Risks related to the application of the model must be further analysed and carefully identified if this option is selected. **The feasibility in the Czech Republic must be legally analysed in sufficient detail before making the decision on the method of organisation.**

6.5 Summary of Recommended Actions for the Construction of New Nuclear Facilities in the Czech Republic

a. **Given that some of the options of the investment model require the establishment of a special purpose vehicle (SPV), into which all the relevant assets shall be brought in order to complete the construction of nuclear units at both existing sites, it is advisable to start preparing this process at the level of the company ČEZ. At the same time, the preparations for the selection of the EPC contractor should be started in accordance with the selected business model.**
b. **At the same time, it is crucial to avoid irreversible steps within the ČEZ Group, which would lead to the reduction of human capacities required to implement this NAP NE. Furthermore, it is necessary to build competences for the project team.**
c. **Initiating contacts with strategic partners for the construction of a nuclear unit in the Czech Republic.**
d. **Negotiations with the European Commission on how to select a contractor, financing method and to ensure a return on investment.**
e. **Immediate continuation of the project preparation in the option of two units with the subsequent construction of one unit (and with a possibility of extension to two units) at the Temelin site.**
    a. SPV – preparation for allocation to allow accession of a partner.
    b. EIA – compliance with the conditions.
    c. Preparation for the selection of a contractor – technical documentation.
    d. Licence for siting - for SPV.
    e. Continuation of the site preparation for the construction of NNF.
    f. Continuation of the acquisition of necessary lands.
    g. Continuation of the activities leading to the obtainment of necessary licences and permits.
    h. Preparation and calculation of related and induced investments (implementation following the decision on the investor and business organisation model).
f. **Immediate continuation of the project preparation in the option of two units with the subsequent construction of one unit (and with a possibility of extension to two units) at the Dukovany site.**
    a. SPV – preparation for allocation to allow the accession of a partner.
    b. EIA – preparation and submission of documents.
    c. Preparation for the selection of a contractor – technical documentation.
    d. Licence for siting - for SPV.
    e. Continuation of the site preparation for the construction of the NNF.
    f. Continuation of the acquisition of necessary lands.
    g. Continuation of the activities leading to the obtainment of necessary licences and permits.
    h. Preparation and calculation of related and induced investments (implementation following the decision on the investor and business organisation model).

g. Beginning the preparation of legislative changes in order to simplify the permitting and licensing process and minimise the associated risks of impacts on deadlines and costs.

h. Not later than before issuing a building permit, to assess whether the need for construction of a new nuclear facility is still present and whether the market situation has been stabilised, which would allow construction on a commercial basis, i.e. without the need of state guarantees.

7 Critical Prerequisites for Achieving the Objectives of the Development of the Nuclear Energy Sector

The following is critical for achieving the objectives of the development of the nuclear energy sector referred to in the SEP and Chapter 1 hereof:

- Political support for the strategy and consensus across the political spectrum.
- Financing and ensuring the rate of return of investment of a new nuclear facility.
- Development of electricity consumption and the forecast for the development.
- Public acceptance of nuclear energy.
- The capacity to comply with the action plan and the ability to take a decision on a strategic partner for the potential construction of a new nuclear facility.
- Construction of a new nuclear facility (it is a critical point in itself due to the ensuring of the possibility of maintaining the know-how, i.e. put simply, if we build, a prerequisite for sustainable nuclear energy is created; if we do not build, the meaning of the term "sustainable nuclear energy" ceases to make sense in conjunction with the Czech supply industry, and large cooperation with a technology supplier and foreign suppliers as such is required for the potential operation of any unit type).
- Control of compliance with the action plan and moving compliance with the action plan to the governmental level.
- Security of supplies with a significant share of Czech companies in construction (provided that the requirements for quality, safety and technical and economic competitiveness have been met).
- Maintaining and renewing knowledge base (deliveries of components, operational knowledge, participation in nuclear research).
- Concentrated and systematic efforts of the state in the development of the nuclear energy sector (coordination, legislative conditions, etc.).
- Maintaining and renewing human resources (quality and quantity).

8 Priorities for the Development of the Nuclear Energy Sector, Measures in Individual Areas

8.1 Nuclear Safety

As stated in Chapter 3, ensuring nuclear safety is of the highest priority of the nuclear energy sector.

8.1.1 Measures to Strengthen Nuclear Safety

a) Continuously support the role of SÚJB in the field of nuclear energy in order to continue to ensure the long-term fulfilment of IAEA recommendations in the field of nuclear safety.

- Responsibility: Government of the Czech Republic
- Deadline: continuously

b) In connection to the construction of NNF in the Czech Republic, involve the Czech Republic in the MDEP.

- Responsibility: SÚJB
- Deadline: 31/ 12/ 2016

c) Create the conditions necessary for the maintenance and further development of the required domestic staff and knowledge infrastructure to ensure nuclear safety, in respect of all entities involved in ensuring nuclear safety.

- Responsibility: MIT/ČEZ Group
- Deadline: continuously

d) Ensure financing for technical support and research for supervision, either directly from the SÚJB's budget or in the form of including it in the support for research in the field of nuclear energy as a whole.

- Responsibility: SÚJB/TA CR
- Deadline: continuously

e) Prepare documents for accession of the Czech Republic to the Vienna Convention on Civil Liability for Nuclear Damage of 1997 (VC 1997), or the VC 1997 together with the Convention on Supplementary Compensation for Nuclear Damage of 1997 to enable the Czech Republic to join this Convention as of 1 January 2017.

- Responsibility: MIT
- Deadline: by 31/ 12/ 2016

8.2 Role of the State and Organisation of the Nuclear Energy Sector

The active role of the state in defining the objectives for the development of the nuclear energy sector and creating conditions for their fulfilment is irreplaceable. The active role of the state consists in coordinating the organisation of the nuclear energy sector and establishing such legislative and economic environment to make it possible to achieve the objectives of the development of the nuclear energy sector.

8.2.1 Stabilisation of the Economic Environment

The current situation in the energy market does not support the construction of conventional energy facilities (in particular, facilities with long service life, i.e. nuclear). The construction of nuclear facilities in a number of neighbouring countries is allowed through a guaranteed rate of return for investors. Depending on the selected investor model, an adequate type of measure should be applied to the Czech Republic.

8.2.2 Development of Legislation in the Field of Permitting Procedures

The current situation in the legislative environment in the field of construction of new nuclear facilities means a significant extension of project preparation mainly for the following reasons:

- **A large number of mutually linked and conditional procedures unreasonably extends a period of preparation for the construction of a nuclear power plant** (even as compared to other EU countries) – a large number of procedures also makes it possible to repeatedly contest a preparation process by construction opponents with a view to delaying to a maximum extent or avoiding to a full extent the construction of an investment unit
- **With regard to the requirements of the land planning procedure and the related permissions**, and with regard to the specifics of nuclear projects (see above), **it is necessary to select a contractor for a nuclear power plant before starting to prepare documentation for the land planning procedure** – this significantly extends the time between signing of the contract with the contractor and the real start of construction, which significantly increases the risk of the cost increase and the extension of construction deadlines
- **The conditions of the planning permission are known not earlier than after the completion of the Basic Design and preparation of the Preliminary Safety Report pursuant to the Atomic Act** – this may result in a need to revise documentation with a large impact on the schedule and costs

Proposed measures:

1. Prepare an act on strategic structures to integrate all permitting procedures needed for the construction of structures of a strategic nature (except for the Atomic Act).
2. In the act on strategic structures, allow the investor to choose between a one-stage and two-stage uniform permitting procedure (one-stage type would be normally applied to line structures and structures where it is possible to specify the technical modification regardless of contractor selection; the two-stage type would be applied, for example, to more complex structures, which are dependent on a specific technical modification of the contractor) or to allow for the combined approach (one- and two-stage procedure) for each individual structure of the entire investment project.
3. Within the framework of one-stage uniform permitting procedure, integrate all permitting processes into one procedure.
4. Within the framework of two-stage permitting process:
    a. At the first stage of permission (single planning permission) – integrate the EIA procedure, the land planning procedure including the incorporation of other permitting processes requiring permission – within the framework of this first stage,

the so-called **"covering method" of a single planning permission would set the maximum area boundary including maximum height arrangement**, the individual buildings necessary for operation would be located within this area, with their specific height and spatial arrangements being specified at the second stage. The uniform planning permission would also contain limits laid down by the authorities concerned pursuant to the binding opinions (e.g. maximum possible water consumption, the maximum quantity and quality of water discharge, etc.) and the limits at the second stage of the permitting process would be not-to-exceed limits.

b. At the second stage (single permission for implementation) – building permit procedure and related processes including the review of compliance with the conditions of a single planning permission (including EIA conditions).

Note:

1. The possibility of applying the "covering principle" is a key factor for the first stage of the two-stage permitting process.
2. On the contrary, the existence of only a one-stage single permitting procedure (and impossibility to act upon the two-stage permitting procedure) would significantly complicate and extend the preparation of investment projects of a nuclear power plant nature because the contractor would have to be selected before starting to prepare documentation for the permitting procedure already prior to the start of the EIA process.

8.2.3 Measures in the Field of Organisation of the Nuclear Energy Sector

a) Prepare the NAP NE for the legislative process.

- Provided by: MIT
- Deadline: 31/ 12/ 2016

b) Set up a committee with a governmental representative for the nuclear energy sector as a secretary.

- Provided by: MIT
- Deadline: 30/ 09/ 2015

c) Methodically prepare the functioning of organisation bringing together industrial enterprises engaged in the field of nuclear energy.

- Provided by: MIT
- Deadline: 31/ 12/ 2016

d) Prepare an analysis of options for addressing problems related to strategic structures using the Building Act, which would contain the possibility of choosing between one-stage and two-stage single permitting procedure in accordance with the principles defined in the preceding chapter and following this analysis, formulate, where appropriate, a proposal for substantive purpose of the act on strategic structures.

- Provided by: MRD and MIT, in cooperation with ME
- Deadline: 31/ 12/ 2015

e) Systematically promote the further utilisation of nuclear energy under the international policy of the Czech Republic and map the positions of other states.

- Provided by: MIT, in cooperation with MFA, SÚJB
- Deadline: continuously

8.3 Long-term Operation of Dukovany NPP (Followed by Temelin NPP)

Following its decision to ensure the long-term operation of the Dukovany NPP (LTO) after its design life, ČEZ has intensively prepared, on a long-term basis, specific measures to obtain a licence for the operation for each individual unit even after the expiry of their design life. The objective is to ensure safe operation, stable supplies even when shutting down coal units and, last but not least, the necessary cash flow of ČEZ and resources for possible further construction.

A variant technical-economic study has been drawn up, dealing with the technical, safety and economic aspects of operation after the expiry of the original design life in alternatives of +10, +20 and +30 years, which shall be continuously updated. In the study it has been shown that all the variants considered are technically feasible in accordance with the international standards and requirements for nuclear safety. At the same time, no technical obstacle has been identified, which would exclude **operation until 2045-47 (+30 years).** The study also showed that the economic efficiency of all three options is high, higher than with alternative power plants generating the same quantity of electricity with the same system characteristics, i.e. at the basic level of the load diagram of the electricity network. The robustness of the economic efficiency of individual options was tested using the sensitivity analyses of key input parameters (electricity price, nuclear fuel, total investment, outage duration, etc.). The results of the analysis showed that the values of economic efficiency are predictively stable and the likelihood of achieving them is very high. At the same time, from the long-term economic perspective, the economic calculations for individual options conclude clearly (with regard to the available assumptions and analyses) that the economic advantage of the operation of the existing units of the Dukovany NPP increases with the duration of their operation.

The greatest risks of further operation of the Dukovany NPP in alternatives LTO +20 and LTO +30 are mainly in the political-regulatory field. A crucial factor for the future long-term operation of NPP is the positive perception by the public and hence by political representation. Seen in this light, the greatest risk is the inadequate increase in the requirements for operational safety and the quality of nuclear facilities and the setting of regulatory requirements to the extent that will have a negative impact on the economic operation of the facility or will economically prevent or directly prohibit further operation of facility (flexible coverage of RES, capacity mechanisms, the Corfu Declaration, increased insurance for nuclear damage, requirements for NPP design, RAW disposal, storage of spent fuel, escalation of requirements in the EIA process, etc.). The increasing integration of European countries and the possible transfer of powers from the Czech Republic to the EU level can change/limit the current sovereignty of the Czech Republic in deciding on nuclear facilities. At the same time, there may be a further transfer of legislation and regulation in the field of energy with a negative impact for the economy of the facility or its operation. For example, the approved energy-climate policy of the EU in the field of binding objectives of the reduction of CO_2 and the share of energy generated from RES does not directly jeopardise the long-term operation of NPP, which cannot be said of non-binding objective regarding energy efficiency. For nuclear power plants, the reactor thermal output is regarded as a primary source, and thus electricity generated from NPP is stated with efficiency around 33%. This could lead to pressure to replace the core by other sources with higher efficiency.

These risks mean that after the shutdown of the last nuclear unit in Germany in 2022, of a more modern design than with units in the Dukovany NPP, at the time of the validity of new EC directive relating to nuclear safety, a lot of pressure may be expected to shut down the NPP VVER 440 MW. An example was the shutdown of Bohunice V1 NPP units upon accession to the EU (these units were VVER 440 MW units of the older type V 230), which was a political decision.

The current energy concept of the Czech Republic as well as political representation including the public support the nuclear energy sector in the majority. However, in a period exceeding several election periods, it is impossible to exclude its change or a change in the attitude of the Czech public due to, for example, major accident on domestic or foreign NPPs, reduced reliability and safety of NPPs or inadequate communication at home and abroad.

The maximum capital expenditures associated with the long-term operation of the Dukovany NPP beyond 2025 are estimated on the basis of today's knowledge between 2023 and 2027 in the order of several tens of billions of CZK. The amount of investments, their distribution over years, links to and impacts on the duration of unit outages and the overall economic efficiency of the long-term operation of the Dukovany NPP are the subject of an ongoing updating of the technical-economic study for the options of +20 and +30 years.

The fundamental objective of the measures to ensure long-term operation is to maintain the operation of the Dukovany NPP until 2035-2037 with subsequent shutdown and abandonment. If technically, economically and from a safety point of view possible, it is advisable to extend the life time by another ten years.

8.3.1 Measures for the Field of the Long-term Operation of Existing NPPs

a) Optimise, at the national level, the requirements of international and supranational institutions to enhance the safety of nuclear installations with regard to the reality of cost impacts.

  - Provided by: SÚJB, in cooperation with MIT
  - Deadline: continuously

b) Promote the external communication strategy of ČEZ for the long-term operation of the existing operated NPPs.

  - Provided by: MIT, in cooperation with the Office of the Government
  - Deadline: continuously

c) Step up communication/cooperation within the states operating VVER units in order to maintain the long-term acceptability of the VVER 440 technology as a standard comparable in terms of safety with the units of other producers/capacities.

  - Provided by: MIT, in cooperation with ČEZ, SÚJB
  - Deadline: continuously

d) Draw up a socio-economic study (TIA) on the impacts of NPP operation/construction on the microregion for each nuclear plant site.

  - Provided by: the competent region, in cooperation with MIT, ČEZ
  - Deadline: 31/ 12/ 2015

8.4 End of Fuel Cycle Design – Capacity and Safety of Repositories

The basic concept of SNF management is deep geological disposal in a repository built in the territory of the Czech Republic. As regards storage capacities and the strategy for final disposal, it is necessary to ensure the long-term and safe disposal of SNF.

8.4.1 Measures for the Field of the Long-term Operation of Existing NPPs

a) Put a deep geological repository into operation around 2065.

- Provided by: RAWRA
- Deadline: according to the RAW and SNF Management Concept

b) Select the site by 2025.

- Provided by: RAWRA
- Deadline: according to the RAW and SNF Management Concept

c) Start construction of a deep geological repository after 2050.

- Provided by: RAWRA
- Deadline: according to the RAW and SNF Management Concept

d) Ensure that the capacity of a deep geological repository will be sufficient to cover the volume of SNF to the extent of the envisaged generation in the NPP until 2100, including HLW from the abandonment of power plants and reserves for HLW in case of an accident at the NPP.

- Provided by: RAWRA
- Deadline: according to the RAW and SNF Management Concept

e) Ensure that the operation of the near surface repositories for LLW and ILW is extended and expanded in a timely manner to be able to absorb all LLW/ILW from the operation of nuclear installations, industry and the health sector, including waste from the final abandonment of nuclear installations.

- Provided by: RAWRA
- Deadline: continuously according to the RAW and SNF Management Concept

8.5 Preparation for NPP Shutdown

Following the final decision on the option for the Dukovany NPP operation extension, the relevant programme must be drawn up relating to the shutdown of each individual unit of the Dukovany NPP and synchronised with the construction of another unit/units at the EDU site.

A similar procedure should be adopted for the Temelin NPP where similar LTO programmes should be drawn up to address the variant extension of the operation of both units up to 60 years.

From the perspective of the state, it is crucial to carry out decommissioning and abandonment of NPPs with the minimum negative environmental impacts, while respecting the highest world standards. Timing of the abandonment of nuclear power plants following their shutdown shall be carried out in accordance with the selected and approved procedure of the current operator of the facility.

8.5.1 Measures for the Field of NPP Shutdown

The following is required in the field of NPP shutdown:

- Provide targeted sufficiency of financial resources from the operator of a nuclear installation to finance the whole decommissioning phase including periodic assessment of the project costs of abandonment and modification of requirements for the respective reserves.
- Provide sufficient human and industrial resources for the shutdown of NPP in the territory of the Czech Republic, taking account of concurrent process of shutdown and abandonment of shut down NPPs across Europe.
- Promote the involvement of Czech companies in the process of shutdown and abandonment of shut down NPPs across Europe already in the present, in order to gain the necessary know-how as well as new business opportunities.

8.6 Continuation of Preparation and Construction of NNF

For detailed description of recommendations for the field of NNF construction see Chapter 6 (Construction of New Nuclear Facilities).

8.6.1 Measures for the Field of Construction of NNF

a) Discuss with ČEZ any possibility of establishing a special purpose vehicle (SPV) for bringing all the relevant assets to complete nuclear units at the Dukovany and Temelin sites.

  - Provided by: MF
  - Deadline: 30/ 09/ 2015

b) Discuss with ČEZ, a.s., from the position of the administrator of property rights, implementation of the NAP NE document in the field of construction of NNF, with regard to the preferred option from the perspective of the state.

  - Provided by: MF
  - Deadline: immediately following the approval of this document

c) Present to the government a study on a specific method of construction of new nuclear units in the Czech Republic with the selected business-investment model and other necessary actions to ensure construction.

  - Provided by: MIT in cooperation with MF
  - Deadline: 31/ 12/ 2015

d) Ensure the identification and contacting of strategic partners for the construction of a new nuclear facility in the Czech Republic.

  - Provided by: MIT
  - Deadline: 31/ 12/ 2015

e) Open negotiations with the European Commission on the method of supplier selection, financing, rate of return guarantee and state support.

  - Provided by: MIT
  - Deadline: 31/ 12/ 2016

8.7 Communication with the Public and Non-governmental Organisations

The operator shall actively communicate with the vicinity of nuclear power plants and the regions of its operation. It applies a graded approach, always choosing a communication mix suitable for the target group. This is two-way communication where operators not only communicate facts and plans, but also answer questions, provide technical and physical assistance in the vicinity and reflect local needs.

The operator applies a differentiated approach. As for the Temelin NPP, an association of towns and municipalities “Energoregio Temelínsko” is currently being established, but it mainly serves as a platform for Mayors. Due to the lower number of towns and municipalities in the Emergency Planning Zone (only 32 local governments), the Temelin NPP has the possibility of communicating with all Mayors and representatives, or possibly civil associations and societies, or directly citizens. This activity is carried out with the use of a number of means and channels. They include, but are not limited to, means of mass communication, means of direct marketing, events, and a number of personal meetings. In general, the operator uses both operational means (e.g. SMS messages for information of urgent nature, e.g. reasons for extraordinary noise event) and fixed means. A specific area is the fulfilment of operator's obligations resulting from the so-called “Melk Protocol”, in accordance with which the Austrian party is informed by the Temelin NPP personnel every working day on generation and events at the Temelin NPP. This daily report (in Czech language) is also sent to all local and most national media and stakeholders. The Czech, English and German version thereof is also available on the operator's website. The management of the Temelin NPP is also in contact with non-governmental organisations in both the Czech Republic, Germany and Austria. In addition to active information and question answering, the operator directly takes part in excursions of non-governmental organisations and knowing the Temelin NPP. Directly in the field of emergency preparedness, the operator mainly cooperates, in addition to state, local and regional authorities, and Integrated Rescue System, with Austria, whose services of Civil Defence are informed on exercises, can participate therein and also actively knowing the Temelin NPP (including excursions within the guarded area).

As for the Dukovany NPP, it is impossible to communicate directly with all stakeholders in the Emergency Planning Zone. This zone is significantly larger and includes approximately 120 towns and municipalities in two regions. Therefore, citizens of such municipalities are partly represented through several associations – e.g. “Energetické Třebíčsko”. The area of safety including emergency preparedness is mainly being focused on by the Civil Safety Commission (CSC), whose members are representatives of municipalities and have their experts on the part of the operator. This association meets on a regular basis and its activity covers a number of activities in the area of safety. It is in regular contact with the management of the power plant, holds its own seminars and workshops and arranges meetings with the representatives of municipalities from other “nuclear” region. The means of communication are virtually the same as with the Temelin NPP, however, due to the very high number of municipalities, it cannot offer a visitor programme for reactor halls in the area, but it is offered through the CSC.

Both Czech NPPs are a key element of education for the whole Czech Republic. The operator promotes technical education and the development of knowledge on energy in general to the maximum extent. It participates in the programme of discussions held by the JLM agency, which give the vast majority of secondary-school students in the Czech Republic the opportunity to become familiar with the energy-related problems and receive answers to all their questions. The operator also participates in a number of other education programmes, not focused only on the nuclear energy sector but on the energy sector as a whole. The Information Centres at both power plants are a very important educational element.

8.7.1 Measures for the Field of Communication with Public and Non-governmental Organisations

a) Maintain a high level of awareness among citizens regarding the operation of NPPs in the territory of the Czech Republic.

- Provided by: ČEZ, a.s. + Committee for the Nuclear Energy Sector
- Deadline: continuously

8.8 Ensuring Long-term Nuclear Fuel Cycle

The field of nuclear fuel cycle includes the following priorities:

- Selection of the closed fuel cycle with fast reactors in the case of their commercialisation, otherwise keeping with the strategy for open fuel cycle with pressurized water reactors.
- Ensuring the long-term security of nuclear fuel supplies
- Within the framework of raw-material policy, the strategy for natural uranium mining in the Czech Republic should be completed. However, it is irrelevant in terms of implementation of the vision of the development of the nuclear energy sector in the Czech Republic.

8.8.1 Measures for the Field of the Nuclear Fuel Cycle

a) Prepare a comprehensive strategy for the field of the nuclear fuel cycle.

- Responsibility: MIT, ČEZ's cooperation
- Deadline: 21/ 12/ 2015

b) Take part in research for the exploitation of non-conventional uranium resources in order to get access to cheaper resources than those available on the market, for the case of the failure to commercialise fast reactors by 2100.

- Responsibility: MIT, ČEZ's cooperation
- Deadline: continuously

c) Take part in cooperation on the development of fast reactor and its fuel cycle.

- Responsibility: MIT, ČEZ's cooperation

d) Prepare a technical-economic study for fuel (MOX) recycling options to the extent of 25% of the core in selecting technology for NNF.

- Responsibility: MIT
- Deadline: 31/ 12/ 2016

e) Carry out a study for ensuring potential future transport routes for SNF.

- Responsibility: RAWRA
- Deadline: 31/ 12/ 2016

8.9 Long-term Security of Fuel Supplies (Resources, Contracts, Fabrication Capacities)

The current fuel inventory in the Czech Republic normally for one year of operation is absolutely insufficient in terms of energy security, in particular with respect to suppliers from Russia and the geopolitical context. Creating nuclear fuel inventory for the given reactor type is today generally applied, but does not cover long-term failure and in the event of a crisis, requires starting immediately to prepare and license an alternative fuel. As part of the SEC, priority was given to the objective to increase nuclear fuel inventory in the Czech Republic to fully cover one four-year fuel cycle, including a potential increase in storage capacities.

8.9.1 Measures for the Field of Long-term Security of Fuel Supplies

a) Prepare a study for the most appropriate procedure for the security of nuclear fuel resources to the extent defined in the SEP to cover one fuel cycle of all NPPs.

  - Provided by: MIT, cooperation: ČEZ
  - Deadline: 31/ 12/ 2015

b) Prepare a legislative framework for the implementation of outputs of the study for the most appropriate procedure for the security of nuclear fuel.

  - Provided by: MIT, MF's cooperation
  - Deadline: 31/ 12/ 2016

8.10 Human Resource Renewal and Development

Conditions for maintaining or renewing a knowledge base are as follows:

- The nuclear field is a long-term perspective of employment for specialists from many fields in the Czech Republic.
  - The state must not only declare this fact but also create real conditions/incentives for its fulfilment (scholarships and studying abroad, support to companies focused on the field of nuclear energy in employing young specialists, etc.).
- Concentrating existing knowledge/people in interlinked companies, preferably with a share of the state.
  - Either ČEZ or a new company with a share of the state, which shall perform the position of an investor for new units and shall start the preparations for their construction. Concentrate experienced people there and link them to new young specialists, who have the real precondition to go through the whole preparation and construction of a new unit.
- Require the transfer of know-how from the future contractor for NPP (carrier of primary circuit technology).
  - The contractor shall provide know-how to the extent necessary for operation and maintenance including any required modifications, independently of the original supplier of technology.

The involvement in international structures and projects is crucial for maintaining the knowledge base. The condition is a close partnership with other countries, where nuclear facilities are being built up, among others, consisting of the exchange of experience and personnel, as well as involvement in other projects of suppliers to be engaged in the construction of a new nuclear facility in the Czech Republic.

The state cannot and need not support the whole education and training cycles of specialists for the nuclear energy sector. However, the following four segments are necessary in terms of priorities:

1) Secondary-level vocational for the energy sector
2) Master's (engineering) part of training at the university level
3) Specific-oriented part of doctoral studies
4) Specific segment of Lifelong Training

<u>Level 2 university education – master's and preliminary degree – secondary-level vocational training for the energy sector</u>

1) Secondary-level vocational for the energy sector

   This part of vocational training can be efficiently supported only by operators of nuclear facilities and suppliers for the nuclear energy sector. Therefore, the support for education for the energy sector in general should form a part of regional energy concepts (Act on Energy Management), all the more so on account of the fact that the mobility of the workforce in the Czech Republic is still significantly lower than in most countries of the OECD and the current trends suggest only evolution and not a dramatic change in the field of mobility, in particular for secondary-level specialisations.

2) Master's (engineering) part of training at the university level

   University-level training must necessarily be on a multidisciplinary basis, its full extent cannot be covered by a single one university (and not at all at one single faculty) throughout the Czech Republic.

   A horizontally oriented programme of studies across faculties and selected universities with the direct participation of specialists from practice and research and with the involvement of qualified foreign segment of specialists is a viable way. A volunteer European Network Education Network (ENEN) and its Czech mutation (Czech Nuclear Education Network – CENEN) form an indicative base.

   The way of system support for technical fields (and possible selection) should be the result of the proposal for and the method of implementation of the purpose-targeted support of three entities: the state (MEYS, MIT, MRD), operators of nuclear installations and potential suppliers.

   The analogy to the "committee for..." could probably be the most efficient conciliation or management form because this level will probably also be necessary in terms of the financing and implementation of another nuclear facility. – Generate a task therefrom for the management system in the field of education.

Third-level university education – doctor and Lifelong Training (LT)

This part of human resources training is of the highest priority. It mainly concerns the issue of TSO, which includes the whole licensing process of nuclear facilities and state supervision (SÚJB), which is not, in terms of human and financial resources, prepared for the stage of construction of one or even two facilities at two sites.

In this respect, the participation of the SÚJB in the preparation and provision of human resources is unsubstitutable in terms of qualification and the necessary basic numbers in a particular period of time. From the time point of view, the start of training is today already behind schedule.

For effective remedy, the following priorities are required:

1) Participation and specific function of the SÚJB in the preparation of implementation and support for level 2 university technical education
2) Selective extension of the powers of the institution for the preparation and implementation and support for level 2 university education to level 3 and specific-oriented LT
3) Establishment (transformation) of the National Research Nuclear Laboratory to provide the necessary experimental and certification base for TSO and form, at the same time, a part of the training system of specialists with the highest level of expertise in the nuclear energy sector.

Project capacities

Project capacities fully relate to the segment of secondary- and second-level education.

It should be noted that the period of training of a graduate to become an independently working engineer takes approximately 4 – 6 years for the variant that the graduate has the basic expertise for the specialisation in question. If retraining or supplementation of the required basic knowledge is necessary, a minimum two-year extension of the training period should be taken into account.

8.10.1 Measures for the Field of Human Resource Renewal and Development

a) Support for the improvement and modification of the education system at all levels in order to ensure the requirements for human resources in accordance with the NAP NE.
    - Provided by: MEYS
    - Deadline: Continuously

8.11 Support for the Czech Nuclear Industry

The objective is to develop and maintain an efficient domestic supply chain for the construction, operation and shutdown of NPP at home and abroad, with all positive impacts on the creation of GDP, employment rate as well as maintaining know-how and an adequate level of strategic independence.

8.11.1 Measures to Support the Czech Nuclear Industry

a) When deciding on the investor-business model for the construction of new NPPs in the Czech Republic, to prefer such a model, which is likely to provide sufficient pressure to achieve a significant share of supplies from the Czech Republic in the construction of NNF.

- Provided by: Government of the Czech Republic
- Deadline: 30/ 06/ 2015

b) Targeted-promote the application of the Czech nuclear industry in selected priority countries.

- Provided by: MIT, MFA. Czech Trade
- Deadline: continuously

8.12 Research and Development in the Field of Nuclear Energy

In the field of operational research, the need for research and development in the field of safety and reliability enhancement, cost reduction and operational life extension of nuclear power plants is topical. Another significant feature is the even higher rate of internationalisation of nuclear research with regard to the requirement for the enhancement of operational safety of nuclear power plants. This applies to both existing and future Generation IV nuclear reactors.

Research will be primarily focused in the following four areas:

Promoting safety in nuclear installations *(Priority Sub-target 1.2.2 of the priority area "Sustainability of Nuclear Energy and Material Sources")*[17]

- Promoting safety for the needs of regulatory bodies
- Promoting safety in operated nuclear installations and nuclear installations under preparation

Research and development must contribute to enhancing nuclear safety of both operated nuclear installations and nuclear installations under preparation. Therefore, involvement is necessary in international cooperation in the fields of research defined in the SET Plan (European Strategic Energy Technology Plan) of the European Commission, in particular in the framework programmes of the EURATOM, and under the Sustainable Nuclear Energy Technology Platform (SNETP) in the NUGENIA. Furthermore, there is the need for cooperation and involvement within the working groups of the NEA, IAEA as well as making use of bilateral cooperation within and outside the European Union.

Effective long-term use of current NPPs (*Priority Sub-target 1.2.1 of the priority area "Sustainability of Nuclear Energy and Material Sources"***)**

- Ensuring the reliability and long-term effective operation of existing nuclear installations
- Progressive materials and technologies for the nuclear energy sector
- Problems related to the decommissioning of nuclear installations

Research and development must flexibly respond to operating experience. As far as possible, involvement is necessary in international cooperation, in particular industrial initiatives prepared under the SET Plan, under the Sustainable Nuclear Energy Technology Platform (SNETP) in the NUGENIA, cooperation within the NEA and making use of bilateral cooperation within and outside the European Union.

Research ensuring support for the construction and operation of new economically effective units (*Priority Sub-target 1.2.3 of the priority area "Sustainability of Nuclear Energy and Material Sources"***)**

- Research, development and innovations for new Generation III/III+ nuclear power plants: design standardisation, new procedures during construction, features of passive safety, higher reliability, creation and transfer of new know-how.
- Providing knowledge and sufficient data for the needs of comprehensive technical-economic assessments and knowledge management, not only from the operation of nuclear power

[17] Resolution of the Government of the Czech Republic No. 552 of 19 July 2012, on National Priorities of Oriented Research, Experimental Development and Innovations.

plants but also from the operation of experimental facilities (research reactors, experimental loops, irradiation channels, autoclaves, etc.).

Research and development of the fuel cycle (*Priority Sub-target 1.2.4 of the priority area "Sustainability of Nuclear Energy and Material Sources"***)**

- Instruments and methodologies for the optimisation and higher exploitation of fuel
- Progressive methods for spent nuclear fuel and radioactive waste management
- Research and development in the field of fabrication and related material research in the case of the construction of a fabrication plant in the Czech Republic

Research and development of Generation IV reactors (*Priority Sub-target 1.2.6 of the priority area "Sustainability of Nuclear Energy and Material Sources"***)**

The objective of this field is the involvement of the research organisations of the Czech Republic in research and development of Generation IV nuclear reactors (GFR - ALLEGRO Project (priority project), LFR - ALFRED Project, SCWR – FQT Project, V/HTR) under the SET Plan, the Sustainable Nuclear Energy Technology Platform (SNETP) and its European Sustainable Nuclear Industrial Initiative (ESNII) as well as under bilateral and multilateral cooperation (e.g. V4G4 Centre of Excellence) within and outside the European Union (GIF). It is desirable that the Czech research organisation continue to be significantly involved in the organisation of work within the working bodies of the GIF.

Development of advanced Generation IV nuclear reactors under international cooperation shall facilitate the long-term, efficient and safe utilisation of nuclear energy after 2050 leading to ensure the exploitation of all potential of nuclear fuel and the reduction of the radioactive waste volume from nuclear power plants for disposal in a deep geological repository.

8.12.1 Measures for the Field of Science and Research

a) Prepare the state policy for research and development for the field of nuclear energy or as a segment for the field of nuclear energy as a whole.

   - Provided by: MIT
   - Deadline: 31/ 12/ 2016

b) Following the policy, prepare instruments for the strategic streamlining of public support for research, development and innovations in the field of nuclear energy.

   - Provided by: MIT
   - Deadline: 31/ 12/ 2017

c) Ensure the fulfilment of research support for the newly established role of the state in the field of nuclear energy.

   - Provided by: MIT
   - Deadline: continuously

d) Prepare input for the strategic partnership in the field of support for the revitalisation of the supply industry, participation of the industry and research to demonstrate a fast reactor and cooperation in the field of the closing of fuel cycle.

   - Provided by: MIT

- Deadline: 31/ 12/ 2016

e) Strengthen the involvement in international cooperation in the field of research, development and innovations, and the financing method.

- Provided by: MEYS
- Deadline: continuously

9 Key Tasks for the Most Recent Period (for 2015)

Table 25: *Key tasks for the most recent period (for 2015) - part 1*

Task No.	Task specification	Responsibility / cooperation	Deadline
1	Establish and appoint a standing committee for the nuclear energy sector	MIT, MF	09/2015
2	Establish and appoint a government representative for the nuclear energy sector	Prime Minister / MIT, MF	09/2015
3	Hold one round of talks with all potential EPC contractors in order: - To verify their interest in participating in the selection procedure for the supply of NNF - To verify the possibility and extent of capital participation in the construction of NNF (share in the SPV) - To identify the scope of possible conditions for capital participation in the construction of NNF (requirements for guarantees, limitations on a holding period of share in the SPV, etc.) - To identify the possible forms and the extent of financing of the construction of NNF - To verify their capacities and potential impacts in the simultaneous preparation of up to two units in two projects, but implementation of only one unit.	MIT	06/2016
4	- Discuss with ČEZ, a.s., from the position of an administrator of property rights, implementation of the NAP NE document in the field of construction of NNF, with regard to the preferred option from the perspective of the state.	MF	07/2015

Table 26: *Key tasks for the most recent period (for 2015) - part 2*

Task No.	Task specification	Responsibility / cooperation	Deadline
5	Provide legal analysis to assess the capacities for the construction of NNF of companies within the ČEZ Group on the basis of the instruction of a majority shareholder.	MIT	12/2015
6	Provide legal analysis for the feasibility of business organisation alternatives: - Obtain an exemption from the application of the PPL for the selection of EPC contractor - Direct award of construction under an inter-governmental agreement	MIT	12/2015
7	Provide legal analysis for compliance of the individual investor and business organisation models with the rules for public support (CfD, state guarantees for debt, participation of the state in the financing of the construction, state guarantees for company acquisition) Provide analysis for legislative changes in order to minimise the risks and their impacts in the field of permitting and licensing processes for the preparation and construction of NNF	MIT	12/2015
8	Decide on the investment and business model for the construction of NNF	Government	06/2016
9	Following the conclusions of the NAP NE, prepare a document for discussion at the Government of the Czech Republic, which shall specify actions to be taken, particularly in the following areas: - Preferred model for investor-business organisation of construction of NNF - Update of the measures and specification of tasks in the individual fields of the development of the nuclear energy sector (see Chapter 6) for 2016 – 2021 and perspective until 2030 - Schedule for legislative changes in order to minimise the risks and their impacts in the field of permitting and licensing processes for the preparation and construction of NNF - Expected schedule for the preparation and construction of NNF, drawn up on the basis of the selected investor and business model	MIT / MF	12/2016

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List of Abbreviations

APR	Advanced Power Reactor
APWR	Advanced Pressurized Water Reactor
ASE	Atomstroyexport
AtomZ	Atomic Act
CAPEX	Capital Expenditure
CfD	Contract for Difference
LT	Lifelong Training
CMA	Czech Mining Authority
CTU	Czech Technical University
ECA	Export Credit Agency
Dukovany NPP	Dukovany Nuclear Power Plant
EIA	Environmental Impact Assessment
Mochovce NPP	Mochovce Nuclear Power Plant
ENEN	European Nuclear Education Network
EPC	Engineering, Procurement, Construction
Temelin NPP	Temelin Nuclear Power Plant
EU	European Union
GE	General electrics
GDP	Gross Domestic Product
DGR	Deep Geological Repository
IEA	International Energy Agency
NPP	nuclear power plant
KHNP	Korea Hydro & Nuclear Power
LTO	Long Term Operation
IAEA	International Atomic Energy Agency
MDEP	Multinational Design Evaluation Programme
MF	Ministry of Finance
MRD	Ministry of Regional Development
MOX	Mixed oxide
MIT	Ministry of Industry and Trade
MSR	Market Stability Reserve
MEYS	Ministry of Education, Youth and Sports
MFA	Ministry of Foreign Affairs
ME	Ministry of the Environment
NACE	Statistical Classification of Economic Activities
LLW	Low-level waste
NAP NE	National Action Plan for the Development of the Nuclear Energy Sector in the Czech Republic
NATO	North Atlantic Treaty Organization
NEA	Nuclear Energy Agency
NNF	New Nuclear Facility
NUGENIA	Nuclear Generation II & III Association (Association for cooperation in the field of research and development targeted on generation II and III nuclear power plants)

CSC	Civil Safety Commission
OECD	Organisation for Economic Co-operation and Development
RES	Renewable Energy Sources
RAW	Radioactive waste
ILW	Intermediate-level waste
SDR	Special Drawing Rights
SEA	Strategic Environmental Assessment
SEP	State Energy Policy
SNETP	Sustainable Nuclear Energy Technology Platform
JP 1988	Joint Protocol relating to the Application of the Vienna Convention and the Paris Convention of 1988
SPV	Special Purpose Vehicle
SÚJB	State Office for Nuclear Safety
RAWRA	Radioactive Waste Repository Authority
HM	Heavy Metals
TA CR	Technology Agency of the Czech Republic
TSO	Technical Support Organization
USA	United States of America
CHU	Charles University
CSC 1997	Convention on Supplementary Compensation for Nuclear Damage of 1997
UJV	Nuclear Research Institute
RAWR	Radioactive Waste Repository
HLW	High-level waste
S&R	Science and Research
S,R&I	Science, Research and Innovation
SNF	Spent Nuclear Fuel
U	University
VC 1963	Vienna Convention on Civil Liability for Nuclear Damage of 1963
VC 1997	Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage
VVER	Water-Water Energetic Reactor
WACC	Weighted Average Cost of Capital
WANO	World Association of Nuclear Operators
PPL	Public procurement law
E	Environment

Annex 1: Experience from NPP Projects under Preparation in Selected Countries

Ensuring the rate of return is considered or discussed for new nuclear projects in Europe.

State	Country	Name	Capacity in MW	Guarantee of return	Owner/support scheme
Under construction	Slovakia	Mochovce 3&4	2x471	No	Enel The construction was valued at the acquisition price of Slovenské elektrárne
	France	Flamanville 3	1x1,700	Yes*	EdF Prepaid PPA – part of financing provided by Exeltium
	Finland	Olkiluoto 3	1x1,720	Yes*	TVO PPA for costs, support through export agencies, low-interest loans from state-owned organisations
Planned	France	Penly 3	1x1,750	Yes	EdF Two-tariff system under consideration (regulated and liberalised)
	UK	Hinkley Point	2x1,700	Yes	Planning EdF CfD and guarantees for loans
Design	UK	Sizewell C	2x1,700	Yes	
	UK	Oldbury B	2x1 700/ 3x1 200	Yes	Acquired by GE Hitachi CfD is assumed
	UK	Wylfa	2x1,670/ 3x1,200	Yes	
	UK	Moorside	3x1,200	Yes	NuGen (60% Toshiba, 40% GdF) CfD is assumed, sale of 60% of Toshiba is envisaged after the completion of the project
	Lithuania	Visaginas	1x1,300	?	Co-investor and strategic partner GE Hitachi Joint efforts by Latvia, Lithuania and Estonia (and Poland)
	Finland	Olkiluoto 4	?	Yes*	TVO PPA for costs
	Finland	Hanhikivi	1x1,200	Yes*	
	Czech Republic	Temelin NPP 3&4	2x?	?	ČEZ Discussed methods for ensuring the rate of return and financing
	Slovakia	Bohunice	1x1,200?	?	JESS Discussed requirement for ensuring the rate of return
	Hungary	Paks	2x1,200	?	MVM Inter-governmental agreement, inter-governmental loan
	Poland	?	up to 6,000	?	

*owners=consumers bear the market risk

Finland – Hanhikivi Project (MIR1200)

Summary of main characteristics:

- Who bears the capital expenditures: investors and technology supplier
- Who acts as the guarantor of electricity price: investors, who are consumers at the same time – Mankala model
- How was/will be the contractor selected: direct negotiation on the basis of exemption of the European Commission from the application of the public procurement law

Detail:

The Finnish balance of electricity generation is deficit.

A three-stage permitting procedure is stipulated by legislation for the construction of nuclear facilities, with the following steps:

- Decision in Principle - decisions by governmental and authorisation authorities approved by the Parliament on the basis of:
    - Energy policy
    - Opinion of the STUK (Finnish regulatory body, equivalent to the SÚJB) with respect to the safety
    - Opinion of the public and DOSS with respect to the request
    - Opinion of the municipalities with respect to the site
- Building permit
- Licence for operation

The so-called “Mankala” off-market model is applied in Finland, aimed at diversifying costs and risks of large projects among owners, to whom the investment would be infeasible. The basic element of the model is the Power Purchase Agreement (PPA), when the investor is composed of companies, which guarantee electricity consumption by ownership shares at cost price throughout the life time.

For the Hanhikivi project, a co-investor was selected through direct negotiation, who brings suppliers and debt financing, which results in:

- Pressure on the contract price – reduction of provisions for project risks
- Higher pressure on the completion of the project with the originally specified parameters
- The higher rating of the co-investor increases the rating of the project

Measures and guarantees (investment model structure, tax-free electricity price, agreed electricity price for shareholders in the year of commissioning – PPA) mean more favourable conditions for the possibilities of financing the project and achieving a high involvement of foreign capital. There is a reduction in the WACC (Weighted Average Cost of Capital) due to the reduction in the burden of the debt service, as a result of loan options offered by export loan and transferable bonds, project guarantee through the PPA contract and involvement of commercial loans at an advanced stage of the project.

- Rosatom, technology (1×MIR1200) supplier, gained 34% in the project instead of E.ON, which withdrew from the project; the rest is owned by Finnish investors.
- Capital expenditures are estimated at EUR 4-6 billion (Rosatom's share estimated below EUR 2 billion).
- Rosatom expects that the rate of return on investment will be ensured through electricity sale in the Finnish market; other investors have guaranteed electricity generation price from Rosatom at the level of approximately 55 EUR/MWh (further escalated)
- Rosatom is foreseen to provide a significant part of debt financing.
- PPL: exemption granted (in 2006)

SWOT analysis for the use of the same model in the Czech Republic:

S – strengths	W – weaknesses
• Diversification of costs and risks • Pressure on the contract price • Pressure on timely completion – contractor's involvement • Financing through favourable loans under the PPA	• Not applicable under conditions in the Czech Republic – there is a lack of strong investors - EE consumers • Based on a belief in electricity shortages in the future and higher electricity price • Acting upon the PPL or obtaining an exemption required, or international agreement with EU Non-member State • Export bank lending money for purchases in the country of origin = lesser involvement of the Czech industry
O - opportunities	**T - threats**
• Investors guarantee electricity consumption at cost price – this works at the lower market EE price • At high market prices, a competitive advantage for investors	• High risk of little interest of investors in the region • The electricity market may be influenced by other regulations • Failure to obtain an exemption for acting upon the PPL or consent to enter into an international agreement

Summary of the SWOT analysis: cannot in practice be used in the Czech Republic.

Hungary – PAKS II (MIR 1200) Project

Summary of main characteristics:

- Who bears the capital expenditures: state-owned company
- Who acts as the guarantor of the electricity price: the state
- How the contractor was/will be selected: strategic selection (direct negotiation)

Detail: The current status of the project and the conclusions resulting therefrom are as follows:

- Legislation
    - Application of the exemption in accordance with the provisions of the directive on public procurement procedures (2004/17) (inter-governmental agreement – HU-RU – technology supplier Rosatom - (Paks NPP MIR 1200)
    - No changes in permitting and licensing legislation are envisaged
    - Changes in legislation in the field of investment protection required
- Investment model
    - Project management company (MVM's subsidiary with insufficient equity)
- Price estimated at approximately EUR 12 billion. Debt financing (Russian Federation)
    - State loan (Government of the Russian Federation) – ongoing notification of public support with the European Commission in accordance with Article 107 SFEU.
    - Scope of EUR 10 billion
    - 80% of each approved invoice
- Own resources (Government of the Hungary)
    - 20% of each approved invoice
- Lower interest rate than on the market (the loan is not reflected in electricity prices, but in national debt).
- The risk of electricity prices is probably borne by the Hungarian state.

SWOT analysis for the use of the same model in the Czech Republic:

S – strengths	**W – weaknesses**
• Application of the exemption from the public procurement law • Interest rates are lower • Zero direct impact on the consumer	• Financing of the investment by a share from the state budget, from the state off-budget debt or commercial debt with the state guarantee • The risk of electricity prices is borne by the state budget (indirect impact on the population). • Only for suppliers outside the EU • Minimum pressure on the contract terms and conditions – little involvement of the supplier in the fulfilment of deadlines and the increase in costs
O - opportunities	**T - threats**
• In the case of higher feed-in tariffs – revenue for the Treasury	• Disapproval of the notification • There is no precedent – it is unclear whether it is feasible within the scope of the EC rules

Summary of the SWOT analysis: can be used in the Czech Republic on the assumption of strong involvement of the state and willingness to increase the national debt.

Lithuania (Hitachi – GE)

Summary of main characteristics:

- Who bears the capital expenditures: investors and technology supplier
- Who acts as the guarantor of the electricity price: investors, who are the consumers at the same time
- How the contractor was/will be selected: tender

Detail:

Main aspects of the Visaginas NPP Project:

- Electricity generation deficit in Lithuania
- Political will and simplified permitting legislation in combination with an appropriate investment model/financing create suitable conditions for project implementation
- Complex legislative changes in a number of acts including the creation of the Act on New Nuclear Power Plant
- Investment model composed of power supply companies in the neighbouring countries (Estonia, Lithuania and originally Poland) and completed by a strong co-investor, who finances and delivers the project
- Technology – ABWR - NPP with a boiling water reactor (Hitachi – GE)
- Financing with the use of favourable loan terms and conditions under the PPA

The SWOT analysis for the use of the same model in the Czech Republic is similar to that for Finland. Moreover, there is a strength in bringing together several countries, thus diversifying the risks.

Summary of the SWOT analysis: cannot in practice be used in the Czech Republic.

England – Hinkley Point C Project (EPR1600)

Three consortia are currently preparing their projects:

- EdF Energy (Project Hinkley Point C[18] - EDF /45-50%/, CNNC+CGN /30-40%/, AREVA /10%/, other investors /15%/), project 2 × EPR1600 AREVA.
- Horizon (Hitachi 100%) 5400MW- ABWR GE-Hitachi (boiling water reactor)
- NuGeneneration (60% Toshiba, 40% GdF Suez), 3×1,200MW (AP1000 Westinghouse)

Example of the project at the most advanced stage - EdF Energy - Hinkley Point C NPP - EPR1600

Summary of main characteristics:

- Who bears the capital expenditures: investors
- Who acts as the guarantor of electricity price: all consumers
- How the contractor was/will be selected: subcontractor selected by investor

[18] As declared by the Government of Great Britain, the project shall, after its completion, supply approximately 7% of electricity for British consumption from 2023; during construction, about 25,000 jobs should be created and during a 60-year operation, 900 permanent jobs should be retained.

Detail:

- The rate of return ensured through the CfD by the Government of Great Britain – notification of the CfD with the European Commission like permitted public supports – approval by the EC 10/2014
- Investors should receive the rate of return of 10%
- Strike price 92.5 GBP/MWh = approximately 115 EUR/MWh (indexed with the consumer price index -CPI)
- The project should receive investment guarantees of the Government of Great Britain in the amount of up to 70% of the investment. The construction will be financed by commercial banks up to that amount
- PPL: An exemption from the public procurement law granted by the European Commission for the area of generating electricity (in 2006)
- Commitment that roughly 60% of the investment will be provided by English companies

Informal discussions between the UK and the EC began already in 2012, with the formal notification in October 2013. Investigation undertaken by the European Commission started in December 2013; the UK responded in January 2014. The public consultation was organised by the EC in March 2014, to which the UK responded in June. On 24 September 2014, the DK COMP expressed its proposal for a favourable opinion on the use of the CfD and its compliance with the internal market while **the compatibility of the whole financing mechanism was finally confirmed by the college of Commissioners on 8 October 2014**. The major issues, for which an agreement was reached after concessions by the UK, are as follows:

- The *Contract for Difference* (CfD), combined with a loan guarantee will not lead to over-compensation. The CfD shall ensure the payment of the difference between the *strike price* and the market price. The *strike price* was achieved through hard negotiations between the UK and the EDF, with the use of detailed analyses, which should ensure that the costs and rate of return were determined on a fair basis. It was difficult to find the relevant *benchmark* for comparison. The UK could not and did not abandon the *strike price*. The strike price equals 89.5 GBP per megawatt hour, possibly 92.50 GBP, if the Sizewell reactor is not built (the UK in relation to the EC also argued about the price of onshore and offshore wind energy, which equals GBP 95 and 150, respectively). If the market price is kept below the *strike price*, the difference shall be paid by consumers, but if the market price exceeds the *strike price*, the difference shall be paid to customers by developers.
- The loan guarantee was a necessary element in ensuring the financing of the project. NNBG (EDF's subsidiary) shall pay a market price for it. The guarantee is an instrument, which would not be provided by the market, which was the major concern of the DG COMP. Therefore, the price for guarantee was increased at the last minute, while according to the DG COMP, this price will already be at the market level.
- The HPC shall function 60 years, the CfD shall be in force 35 years. Another key concession was the achievement of an agreement regarding the *claw-back* mechanism for the remaining 25 years.
- It is also important that any increased costs of construction shall be borne by investors at their own risk.

- The UK has also shown that a number of measures are taken in order to avoid a disruption of the market, supports the internal energy market and takes concrete actions to interconnect markets.
- A disruption of the competition shall also avoid an annual reporting of the EDF to the UK and the Commission on trades between the EDF and subcontractors, which shall be carried out at market price.
- The UK sees joint interest, on the basis of which the support could be declared compatible, in the diversification of energy sources, the strengthening of supply security and a contribution to the low-carbon economy and possible obligatory climate targets.

SWOT analysis for the use of the same model in the Czech Republic:

S – strengths	W – weaknesses
• Zero impact on the state budget • High guarantees from the government = possibility of obtaining high commercial loans = higher possibility of involving the domestic industry (than with an export bank) • Support on market principle • High-level control of the state over the energy structure and over the energy security • Already favourable opinion of the DG COMP as well as the college of Commissioners as a unique precedent.	• In the case of low electricity price, the difference shall be paid by consumers, but not earlier than after commissioning, i.e. after 2030 • Purchases of electricity not guaranteed • Higher rate of return required by investors • Acting upon the PPL or obtaining an exemption required, or international agreement with EU Non-member State

O – opportunities	T - threats
• In the case of higher market prices, the EE price is reduced for consumers	• Disapproval of the notification • The Strike Price is today's estimate; if the project becomes more expensive, the losses shall be borne by the investor

Summary of the SWOT analysis: the most suitable model for use in the Czech Republic. Within this model, there are already the first signals from some potential suppliers expressing their interest in negotiating their co-participation in the project as an investor and a supplier. It can be used in the case of the political willingness to defend any future (after 20 years) surcharges on electricity price.

France - Flamanville 3 (EPR1600)

Summary of main characteristics:

- Who bears the capital expenditures: investor
- Who acts as the guarantor of electricity price: selected consumers
- How the contractor selected was/will be: technology subcontractor selected by the investor

Detail:

- Exeltium (over 100 companies) and EDF signed a prepaid long-term contract for electricity consumption to guarantee the low price for Exeltium members and the appropriate rate of return for EDF at the same time
- The contract was signed for:
  - ~13 TWh per year
  - A period of 24 years starts in 2010
  - The price was not published; however, the probable prepaid sum is € 4 billion
- Construction risks (price increase) are borne by project owner (i.e. EDF) and shall be incorporated into a regulated tariff on a long-term basis pursuant to the NOME act

SWOT analysis for the use of the same model in the Czech Republic:

S – strengths	W – weaknesses
• Diversification of costs and risks • Pressure on the contract price • Pressure on the timely completion • Financing through favourable loans under the PPA	• Not applicable under conditions in the Czech Republic – there is a lack of strong investors - EE consumers • Based on consumers' assumption in electricity shortages in the future and the higher electricity price • State guarantees for the rate of return on the project required • Notification of state support probably required • A necessary procedure pursuant to the PPL or obtaining a derogation (the investor is not capital-linked to the contractor)
O - opportunities	**T - threats**
• In the case of higher market prices, competitive advantage for consumers	• Disapproval of the notification • If the project becomes more expensive, the loss shall be borne by the investor

Summary of the SWOT analysis: cannot in practice be used in the Czech Republic.

Turkey (Akküyu 4 × MIR1200)

Summary of main characteristics:

- Who bears the capital expenditures: technology supplier
- Who acts as the guarantor of electricity price: state (through energy distributor)
- How the contractor was/will be selected: contractor (who is the main investor at the same time) was selected by the state in the tender

Detail:

- Rosatom shall build, at its own expense, four units and then shall own and operate them, while it shall sell a 49% share to a strategic investor, probably one of the Turkish utilities
- The total project costs are estimated at 20 billion dollars
- In accordance with the inter-governmental contract, the Turkish distributor undertook to take electricity at the guaranteed price of 123.5 USD/MWh (92 EUR/MWh) (average for all four units) for the first 15 years of operation
- PPL: Turkey is not yet part of the EU and therefore, the relevant directives regarding the PPL do not apply thereto

SWOT analysis for the use of the same model in the Czech Republic:

S – strengths	W – weaknesses
• Risks of construction and commissioning are borne by the contractor	• The risk of electricity prices shall be borne by the state budget or a consumer, but not earlier than after commissioning • State guarantees required to ensure the rate of return on the purchase of a share by a "domestic company" • Notification in Brussels required – probably infeasible under conditions in the EU • The guaranteed purchase of electricity reduces a free electricity market • Low involvement of the domestic industry
O - opportunities	**T – threats**
• In the case of higher electricity market prices – revenue for the Treasury	• Disapproval of the notification • Possible misuse of the source for geopolitical purposes by the investor.

Summary of the SWOT analysis: cannot in practice be used in the Czech Republic due to absolute incompatibility with the electricity market model of the Czech Republic and the EU.

Slovakia (Jaslovské Bohunice)

- 4÷6 billion €/ unit (probably one unit)
- The technology supplier could be a co-investor
- The initially considered support in the form of guaranteed prices (investor's condition – access considered by Rosatom) approximately 65 EUR/MWh was rejected by the Government of Slovakia; other discussions are not yet under way, at least not in public (open discussions).
- PPL: The Slovak Republic considers applying for an exemption from the PPL, but has not yet taken any formal actions in relation to the EC (still at the stage of informal pre-notification)

Summary of the SWOT analysis: preferred model for the Czech Republic – analogy to the Hinkley Poind C Project in Great Britain.

Poland

- On 28 January 2014, the Programme for the Nuclear Energy Sector of Poland was approved by the Polish Cabinet, which shall serve as a basis for the construction of the first nuclear power plant in Poland ever; the estimated costs are PLN 40-60 billion (USD 13-19 billion)

- A decision on the place of completion shall be taken by the end of 2016; construction shall start in 2019; places near the Baltic Sea – Choczewo and Zarnowiec are under consideration[19]
- The first power plant shall be completed / operational in 2024 and its capacity shall equal up to 3,000 MW, the second power plant shall be completed by 2035
- With regard to the requirement for an exemption from the public procurement law pursuant to Article 35 of the new sector Directive 2014/25 (formerly Article 30 of Directive 2004/17); the PL itself applied for an exemption for electricity generation and wholesale on 15 May 2014. The original time limit for the issue of the EC decision was 25 September. However, this time limit was extended by the EC due to EC's request for additional information from PL. The decision is expected on 31 October, i.e. with the existing EC.
- 11/ 09/ 2014 – an agreement was signed between the PGE and the AMEC Nuclear UK on technical support for the investment process leading to the construction of the first Polish nuclear power plant
- PGE EJ 1 Sp. z o.o., should be responsible for the direct preparation of investment, characteristics of the place of construction, adoption of all relevant decisions, licences and permissions for the construction of NPP
- On 3 September 2014, an agreement was signed between the PGE and Enea, Tauron and KGHM, each acquiring 10% in the PGE EJ 1
- The transaction still has to be approved by the Polish Office of Competition and Consumer Protection (UOKiK)
- The companies agreed to finance the whole project by shares; the next step should have the value of EUR 238 million
- The next step is the selection of technical partner directly for construction; the first tender shall take place at the beginning of next year
- In 2017, the partners will agree on further involvement in the construction project

Summary of the SWOT analysis: the SWOT analysis cannot yet be completed because not all details of the project are clear. Therefore, as far as the Finnish model is concerned, which is unrealistic in the Czech Republic, or state guarantees will be additionally provided and the British HPC model will be concerned.

[19] Zarnowiec is a place where a uncompleted nuclear power plant (not completed after the fall of communism) is situated; there is broad support in the city, but traditionally Greenpeace and the opposition party "Law and Justice" (Janusz Piechocinski, want a referendum on nuclear energy) are against it; at the national level, the core is supported by 50% of people and 8% of people are undecided

Annex 2: Analytical Considerations of the Document

Assumption type	Specific assumption	Quantification	Source
Technical qualifications	Installed capacity	1,200 MW	Illustrative example, one type of capacity for GEN III+
	Availability	92%	Expert estimate on the basis of information provided by suppliers
	Number of hours per year	8,059 hours/year	92% of 8,760 hours
	Generation	9.67 TWh/year	1,200 MW *8,059 h/year
Economic qualifications	Specific CAPEX	4,500 EUR/kW	Assumed costs on the basis of the study for the EC (adjusted to prices of 2015)
	Total CAPEX	5,400 million EUR	4,500 EUR/kW * 1,200 MW (in prices of 2015)
		145.8 million CZK	5,400 million EUR at 27 CZK/EUR (in prices of 2015)
	Specific OPEX	25 EUR/MWh	Expert estimate on the basis of information provided by suppliers (in prices of 2015)
	Total OPEX	247.75 million EUR/year	25 EUR/MWh * 9.67 TWh/year (in prices of 2015)
		6.69 milliard CZK/year	27 EUR/CZK * 247.75 million EUR/year (in prices of 2015)
	Decommissioning costs	Included in OPEXs for a period of service life of a facility	Expert estimate
	Depreciation		According to current legislation
	Power electricity	35-99 EUR/MWh	According to the scenario
	CfD	EUR/MWh	Calculation output
Macroeconomic qualifications	Tax	15%, 19%	According to current legislation
	WACC (nominal)	4% to 9.0%	According to the scenario
	CZK/EUR exchange rate	27	Expert estimate

Note: For calculating the impacts on a customer or the state budget, the details for the output of 1,200 MW were used. To quantify the impacts for another installed power or a higher number of units, the impacts on the customer or the state budget may be illustratively multiplied by a relative increase in capacity.

Assumptions used in Calculating the Expected Reference Development of Power Electricity

Modelling the price of power electricity is based on a series of key assumptions, especially:

- Foreseeable development of the prices of bases, i.e. prices of fuels used for electricity generation (see Chapter No. 3.1.1 - 3.1.4 of the document Economic Analysis of Proposed Update of State Energy Policy);
- Foreseeable development of the emission allowance or, more precisely, carbon prices (see Chapter No. 3.2.3 of Economic Analysis of Proposed Update of State Energy Policy)
- Foreseeable structure of the production mix in the Czech Republic and the neighbouring countries (see Chapter No. 5.2.1 of Economic Analysis of Proposed Update of State Energy Policy);
- Presumption of transmission capacity availability, i.e. existence of network restrictions, if any, for cross-border electricity trade - here, the model expects removing the bottlenecks in the transmission system in the region on the cross-border profiles in the mid-term time frame to enable free electricity trade and the full integration of the Czech-Slovak-Hungarian market with the Western European electricity market.

The prediction of the power electricity price development in the context of the Czech Republic was calculated on the level of the full (production) costs of the so-called closing power plant. The power electricity price should approach this fundamental value, although it may fluctuate in the transitional periods based on the development of other factors not affecting the closing price directly. On the liberalised electricity market, this fundamental value (closing price) needs to be set in the context of the Europe-wide market with a detail merit order, cross-border capacities and other market restrictions.

For calculating the price of power electricity in the base load in the time frame by 2030, the whole-Europe market model PLEXOS ® Integrated Energy Model was used along with the preliminary assumptions set forth herein (it is especially the prices of key fuels and of the emission allowance, i.e. Chapters No. 3.1 and 3.2.3. of the Economic Analysis of the Proposed Update of the State Energy Policy + in the tables below). The model includes the production portfolio of the power plants throughout Europe, including the detailed characteristics of their production costs and the network restrictions, if any. In the 2015-2030 time frame, the power electricity price was calculated alternatively in line with the variant EUA scenarios (Chapter No. 3.2.3 of the Economic Analysis of Proposed Update of State Energy Policy); it especially concerns the reference scenario of the EUA development (i.e. introducing the strategic reserve) which is critical for other calculations in this report.

In the time frame 2030-2040, there is significant uncertainty in terms of the further values of the relevant input parameters, details on the European production mix as well as the prices of the bases and of carbon, which make the power electricity pricing significantly difficult. In this time frame, the power electricity price development prediction was drawn-up - without using the model PLEXOS ® Integrated Energy Model - on the basis of the internal analysis of the Ministry of Industry and Trade in compliance with the closing power plant methodology for the reference scenario of the emission allowance price development only. The underlying assumption of the model is the need for the production portfolio renewal as well as convergence of the power electricity price towards the full production costs of the closing power plant. This analysis still has a predictive ability; however, it is necessary to highlight a higher degree of volatility linked with the input parameter development. Consistent with the emission allowance price, the quantified power electricity price is set in fixed (real) prices of 2013, i.e. regardless of inflation.

Table: *Estimate of auction costs and revenues within the EU ETS between 2014 and 2020*

Estimate of auctions in the EU ETS 2014-2020	2014	2015	2016	2017	2018	2019	2020
Emission ceiling of the EU ETS (million EUA)	2,046.04	2,007.77	1,969.51	1,931.24	1,892.98	1,854.72	1,816.45
of which to be auctioned (million EUA)	1,055.46	1,057.16	1,051.90	1,046.24	1,040.13	1,033.61	1,026.55
Volume of backloading in that year (million EUA)	-400	-300.00	-200.00			300.00	600.00
Auctioned quantity in the EU ETS (million EUA)	655.46	757.16	851.90	1,046.24	1,040.13	1,333.61	1,626.55
Share of the Czech Republic (4.53%, million EUA)	29.69	34.30	38.59	47.39	47.12	60.41	73.68
Correction of the Czech Republic for 2014 (surplus of 2013, million EUA)	2.80						
Derogation of the Czech Republic (million EUA)	-23.07	-19.23	-15.38	-11.54	-7.69	-3.85	0.00
Auctioned for the Czech Republic (4.53%, million EUA)	9.42	14.46	22.25	34.54	37.73	54.49	71.24
EUA price (EUR)	6.50	7.50	8.50	10.00	11.50	10.00	9.00
Revenue of the Czech Republic (million EUR)	61.22	108.43	189.15	345.37	433.88	544.89	641.12

Costs of the business sector of the Czech Republic	2014	2015	2016	2017	2018	2019	2020
Emissions from enterprises in the ETS (million t CO_2 eq.)*	84.73	78.64	76.09	73.58	71.11	68.68	66.29
Free allocation pursuant to Article 10a (million EUA)	24.44	23.22	22.11	21.11	20.19	19.33	18.51
Free allocation pursuant to Article 10c (million EUA)	23.07	19.23	15.38	11.54	7.69	3.85	0.00
Additionally purchased volume (million EUA)	37.23	36.20	38.60	40.94	43.24	45.51	47.79
Costs of EUA purchase (EUR EUR)	241.97	271.47	328.10	409.41	497.23	477.89	430.10

** Source: European Commission: EU Energy, transport and GHG emissions - Trends to 2050 (http://ec.europa.eu/clima/policies/2030/models/eu_trends_2050_en.pdf)*

Source: Expert estimate of ME

Table: *Estimate of costs relating to the EU ETS between 2020 and 2030*

Estimate of auctions in the EU ETS 2021-2030

Without stability reserve	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Emission ceiling of the EU ETS (million EUA)	1,768.07	1,719.69	1,671.31	1,622.93	1,574.55	1,526.17	1,477.79	1,429.41	1,381.03	1,332.65
Auctioned quantity in the EU ETS (million EUA)	1,061.74	1,042.79	1,023.84	1,004.89	985.94	966.99	966.59	933.98	901.37	868.76
Of which auctioned for the Czech Republic (4.53%, million EUA)	48.10	47.24	46.38	45.52	44.66	43.80	43.79	42.31	40.83	39.36
EUA price (EUR)	10.00	11.50	13.00	14.50	16.00	18.00	20.00	22.00	24.00	26.00
Revenue of the Czech Republic (million EUR)	480.97	543.24	602.94	660.06	714.61	788.48	875.73	930.80	979.97	1,023.23

Estimate of auctions in the EU ETS 2021-2030

With stability reserve	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Emission ceiling of the EU ETS (million EUA)	1,768.07	1,719.69	1,671.31	1,622.93	1,574.55	1,526.17	1,477.79	1,429.41	1,381.03	1,332.65
Transfer to the market reserve (million	312.00	292.56	257.45	226.56	193.37	164.17	132.47	0.00	0.00	0.00

EUA)										
Auctioned quantity in the EU ETS (million EUA)	749.74	750.23	766.39	778.33	792.57	802.82	834.12	933.98	901.37	868.76
Of which auctioned for the Czech Republic (4.53%, million EUA)	33.96	33.99	34.72	35.26	35.90	36.37	37.79	42.31	40.83	39.36
EUA price (EUR)	12.00	15.00	18.00	21.00	23.00	25.00	27.00	29.00	31.00	33.00
Revenue of the Czech Republic (million EUR)	407.56	509.78	624.91	740.42	825.77	909.19	1,020.21	1,226.97	1,265.80	1,298.72

Costs of the business sector of the Czech Republic	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Emissions from enterprises in the ETS (million t CO2 eq.)*	65.45	64.60	63.77	62.93	62.11	58.85	55.67	52.57	49.55	46.61
Free allocation pursuant to Article 10a (million EUA)	15.87	13.22	10.58	7.93	5.29	2.64	0.00	0.00	0.00	0.00
Additionally purchased volume (million EUA)	50.31	50.00	49.69	49.38	49.09	46.36	44.19	41.44	38.77	36.18
Costs of EUA purchase (EUR million) - without reserve	503.08	574.94	645.93	716.07	785.38	834.41	883.86	911.76	930.58	940.79
Costs of EUA purchase (EUR million) - with reserve	603.70	749.93	894.36	1,037.06	1,128.98	1,158.90	1,193.20	1,201.86	1,201.99	1,194.09

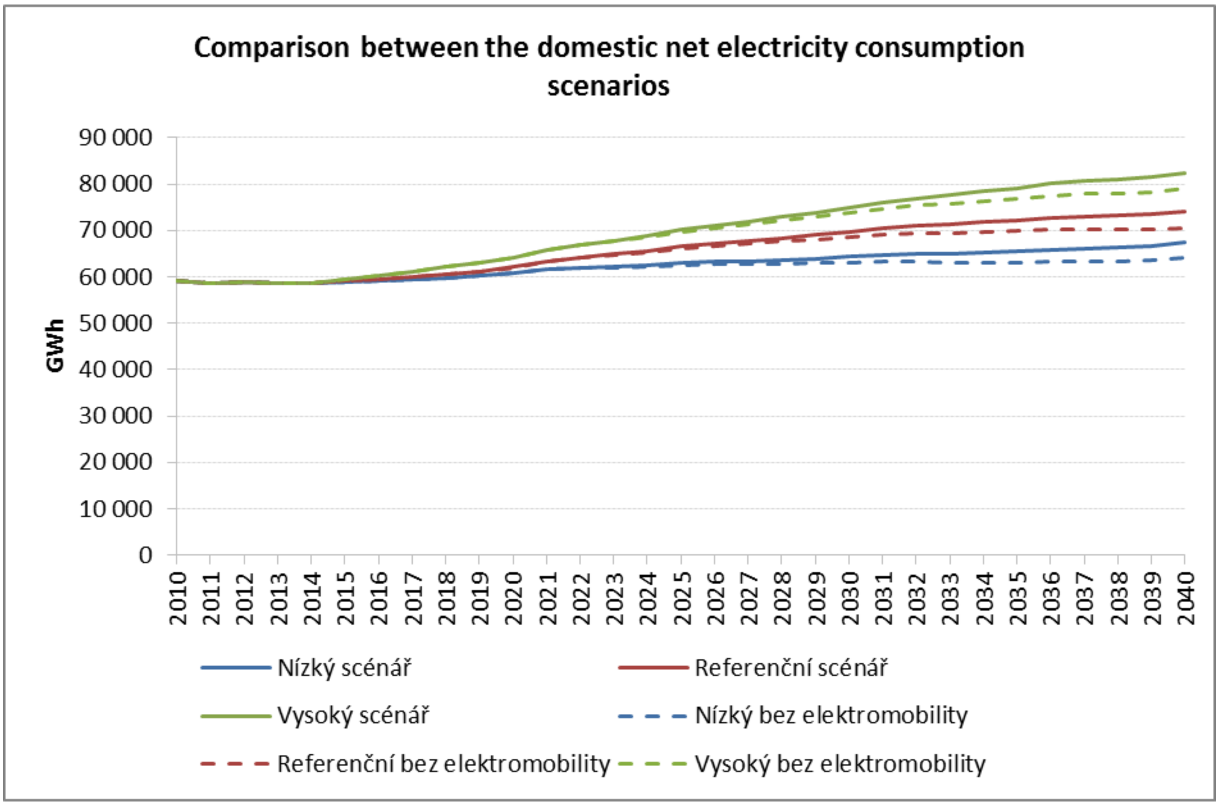
** Source: European Commission: EU Energy, transport and GHG emissions - Trends to 2050 (http://ec.europa.eu/clima/policies/2030/models/eu_trends_2050_en.pdf)*

Source: Expert estimate of ME

Expected electricity consumption

A total of 3 electricity consumption scenarios, namely the low, reference and high, have been prepared; they were based on the macroeconomic input-output methodology model of the Ministry of the Industry and Trade. The development of the net electricity consumption and the electricity consumption excluding consumption within electromobility is shown in the below graph. To create the consumption scenarios, the assumption of the GDP development (or gross value added, GVA) based on the forecasts by the Ministry of Industry and Trade and the Ministry of Finance was used, with the forecast of the former being more conservative. The forecast is based on the reference electricity consumption in 2013 at the undertaking level, with possible fluctuations in this year being eliminated. The electricity consumption development is then linked to the GVA development in the given industry, while respecting the development of the electricity demandingness of the GVA creation.

Graph: *Comparison between the domestic net electricity consumption scenarios*



Srovnání scénářů tuzemské netto spotřeby elektřiny	Comparison between the domestic net electricity consumption scenarios
GWh	GWh
Nízký scénář	Low scenario
Vysoký scénář	High scenario
Referenční bez elektromobility	Reference scenario without electromobility
Referenční scénář	Reference scenario
Nízký bez elektromobility	Low scenario without electromobility
Vysoký bez elektromobility	High scenario without electromobility

Source: Expert analysis of MIT, prediction of MF

Additional Information on the Assessment of the Effect of Investment in Nuclear Facilities within the Nuclear Energy Strategy in the Czech Republic from the Perspective of Impacts on the State Budget

Basically, it is not about securing the return on investment for the investor, but transferring the investor risk to the government. In case of direct building by the government, also the previous measures for securing the ROI can be applied – namely, the CfD, the direct purchase price, green bonuses. Interim payments from the budget or by means of debt financing, i.e. the issuance of sovereign bonds.

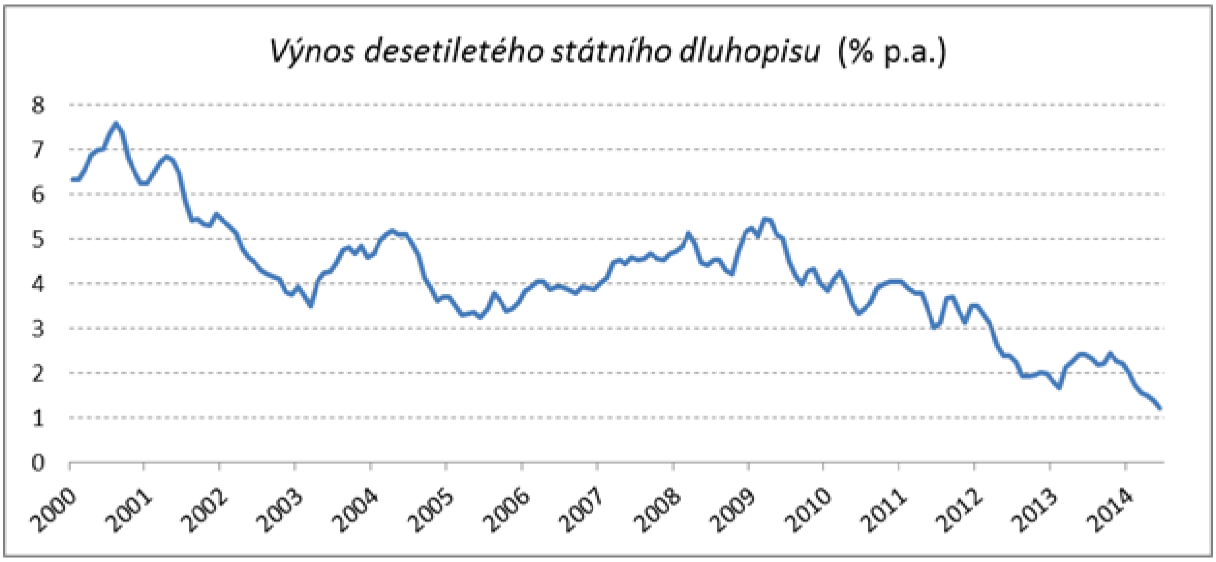
In the event the government is fully involved in making the investment, when the planned expenditure will be, ideally, observed, the financial impact of investment in one nuclear unit can be expected to the maximum of a few units of per cent of the annual state budgets. The investment in the nuclear power plant building will, of course, have an influence on the structure of the state budget expenditure leading to the reduction of other government expenditures. Any change in the budget structure is also associated with the influence of the investment on the amount of a national debt, e.g. in case of the planned deficit of CZK 80 billion, the influence on the level of deficit would amount, in the years of the highest planned expenditure (CZK 11.8 billion), to the tens of per cent and at the total level of the national debt to a few units of per cent.

In case of the investment in nuclear facilities financed by the state budget, the state budget deficit will be influenced, as its amount along with the national debt repayment has an effect on the gross borrowing need of the central government. If the gross borrowing need is positive, it will be financed using the debt instruments, which, in the event the gross borrowing need is higher than a total amount of the national debt repayments, will result in an increase of the gross national debt amounting to the difference between the total national debt repayments and the gross borrowing need.

In case of investments in the nuclear facilities financed by the debt instruments outside the state budget, this funding option needs to be subject to the act on the sovereign bond programme to pay for the investments in the nuclear facilities in order to allow the issuance of bonds to the amount of the planned investment. In case of this option of funding the investment in the nuclear facilities, the national debt will increase by the amount of such an investment. The gross national debt depends on the state budget deficit and on the form of the deficit financing. If the investment plan was financed fully by the debt financing, i.e. the issuance of government bonds, the impact would reach the amount of such an investment. For information only, today's gross national debt amounts to CZK 1,683 billion. In the next year, the stabilisation of the gross national debt at the same level is planned. If the investment was EUR 5.4 billion, i.e. a total of CZK 148.5 billion using the exchange rate of 27.5 CZK/EUR, the increase would be 8.8%.

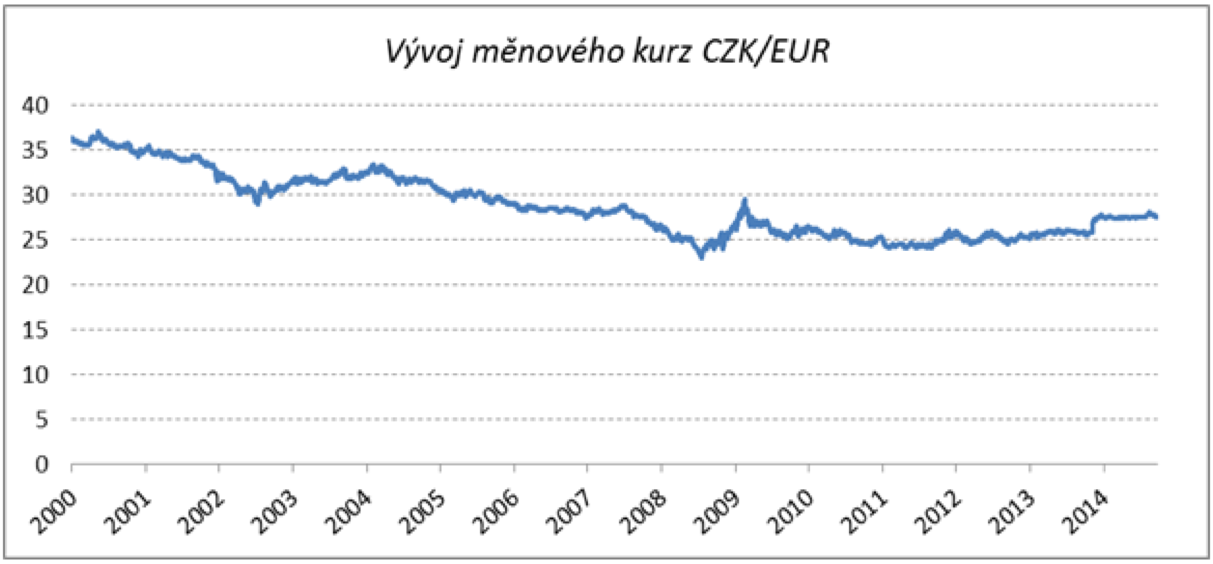
If we consider the investment amounts in individual years as binding, we will assume that the debt financing, i.e. the issuance of sovereign bonds, will be used to cover the investment plan, and we will set the fixed exchange rate of 27.5 CZK/EUR and the average yield of the ten-year sovereign bonds in the amount of 2.4% p.a. in 2015 and the next years (according to the Macroeconomic Prediction of the Ministry of Finance – July 2014). Under these assumptions, it can be concluded that if the expected expenditure to be financed by the issuance of the debt securities is met, the gross national debt will, *ceteris paribus*, increase and reach exactly the amount equal to the given investment in the individual years. The average annual interest costs of debt financing will, then, depend on the situation on the capital market; in this simplified model, they will be around 2.4% p. a.

This simplified scenario of debt financing of the above investment plan would, practically, be the same in the case of different parameters. In other words, if we think about financing the investment by means of debt funding, the gross national debt will increase if the investment happens. The state budget balance will then be influenced by the interest expenditure associated with the bond instruments covering the above cumulative amount of an investment. As a result, if the deficit is increased due to the interest costs of bond instruments funding this investment plan, the gross national debt will increase due to this fact as well. The amount of these impacts, however, cannot be predicted based on a simplified scenario as there is a variety of factors which affect the former. The most unambiguous ones include, for instance, the development of the yield of the ten-year sovereign bonds and the development of the exchange rate. Both of these factors are volatile and hardly predictable in a longer period of time.



Výnos desetiletého státního dluhopisu (% p.a.)	Yield on ten-year government bond (% p.a.)

Source: Czech National Bank - ARAD



Vývoj měnového kurz CZK/EUR	Development of the CZK/EUR exchange rate

Source: Czech National Bank

Based on the foregoing, we can only determine that if the option of implementing the investment plan through the direct investment of the government is chosen, the gross national debt will proportionally increase to the amount corresponding to the investment in the given year. The interest cost will, then, correspond to the debt instrument parameters, the value of which cannot be determined with a sufficient degree of probability in the long-term time frame.