

# The Approaches to Development of New Build Nuclear Projects in the Czech Republic

**Petr Mach**

“ÚJV Řež, a. s.” Company; ENERGOPROJEKT PRAHA Division  
Hlavní 130, 250 68 Husinec-Řež, Czech Republic

[Petr.Mach@ujv.cz](mailto:Petr.Mach@ujv.cz)

## ABSTRACT

The Czech Republic has ambitious plans for the construction of new nuclear capacities. Nowadays nuclear accounts approximately for the 30% of the electricity generation. At the same time the coal phase-out is already ongoing and the use of a coal in energy mix is planned up to 2038 at maximum. Nuclear energy will become the most significant energy source by 2038 as the new nuclear capacities are planned to be put into operation by 2036. Furthermore by 2038 the country would become net electricity importer. To facilitate all challenges associated with the energy sector transformation and expected lack of the electricity the massive nuclear sources build-up is one of the possible answers to such situation. The Czech Republic is on the verge of the possible nuclear renaissance. In new build program the focus must be put on the proper and complex projects preparation. One of the critical tasks in newly developed project is its adaptation to local conditions, its licensing in the specific country conditions and the economic boundaries set up by all parties involved. Author aims on description of the preparatory phase of the new build projects and the boundary conditions set to ensure that the project is viable in specific Czech environment.

**Keywords:** *new build, regulatory processes, design adaptation, nuclear planning*

## 1 INTRODUCTION

The Czech Republic has ambitious plans for the construction of new nuclear capacities. Nowadays nuclear accounts approximately for the 30% of the electricity generation. At the same time the coal phase-out is already ongoing and the use of a coal in energy mix is planned up to 2038 at maximum. Nuclear energy will become the most significant energy source by 2038 as the new nuclear capacities are planned to be put into operation by 2036. Furthermore by 2038 the country would become net electricity importer. To facilitate all challenges associated with the energy sector transformation and expected lack of the electricity the massive nuclear sources build-up is one of the possible answers to such situation. The Czech Republic is on the verge of the possible nuclear renaissance. In new build program the focus must be put on the proper and complex projects preparation. One of the critical tasks in newly developed project is its adaptation to local conditions, its licensing in the specific country conditions and the economic boundaries set up by all parties involved. Author aims on description of the preparatory phase of the new build projects and the boundary conditions set to ensure that the project is viable in specific Czech environment.

## 2 CZECH EXPERIENCE WITH NUCLEAR POWER

### 2.1 Czech Energy Mix

A country's dominant energy source is a coal which is accounted for approximately one third of the total energy supply and about a half of total country's domestic production. Its proportion

within the energy mix was reduced significantly in last decade, however the coal phase-out represents a major challenge for the energy sector transformation in next years.

Renewables are not playing a key role even though their share of the market gradually increased to approximately 16% of the total energy consumption between years 2009 to 2019. It is planned that the share of renewables should rise to 25% of the energy mix.

The Czech Republic has ambitious plans for the construction of new nuclear capacities. Nowadays nuclear accounts approximately for the 30% of the electricity generation. As the coal phase-out is ongoing the use of a coal in energy mix is planned up to 2038 at maximum. Nuclear energy will become the most significant energy source by 2038 as the new nuclear capacities are planned to be put into operation by 2036. Furthermore by 2038 the country would become net electricity importer. To facilitate all challenges associated with the energy sector transformation and expected lack of the electricity the massive nuclear sources build-up is one of the possible answers to such situation.

The list of the completed nuclear energy projects in the Czech Republic is shown in Table 1: Reactors Planned or in Operation:

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<b>NPP</b>	<b>Reactor type</b>	<b>Operation Start</b>
<b>NPPs in Operation</b>		
Dukovany NPP	four VVER440 units, total power output 2000 MW	1987
Temelin NPP	two VVER1000 units, total power output 2000 MW	2002
<b>Nuclear capacities currently in preparation</b>		
Dukovany 5,6	one to two 1200 MW GEN III+ units	2036 Unit 5 Later Unit 6
Temelin 3,4	two 1200 MW GEN III+ units	2040

## 2.2 Electricity in the Czech Republic

The power generation is dominated by the coal and nuclear. They are accounted for 78% of the power generation. The Czech Republic is a net exporter of the electricity trading with all its neighboring countries by 17 grid interconnections. Since year 2000 the use of coal in the generation of electricity slowly declined with prospect of rather more sharp decline in next two decades down to zero coal use by 2038. On the other hand, the nuclear became the stable source of the approximately one third of the electricity generation and there is a prospect of use of renewables up 25% of the mix which seems to be a reasonable amount considering geographic conditions of the Czech Republic. Decline in the coal capacities may be further covered by gas or nuclear. Some of the country's nuclear capacities would have to be replaced by 2045 after 60 years of the operation. Therefore, the need for new capacities would be enormous especially after 2038 when the coal phase-out is planned to be finished. By this year the country would become a net electricity importer. These facts create a big space for build-up of the several large nuclear units supplemented by SMRs that could be utilized for the co-generation of heat and electricity.

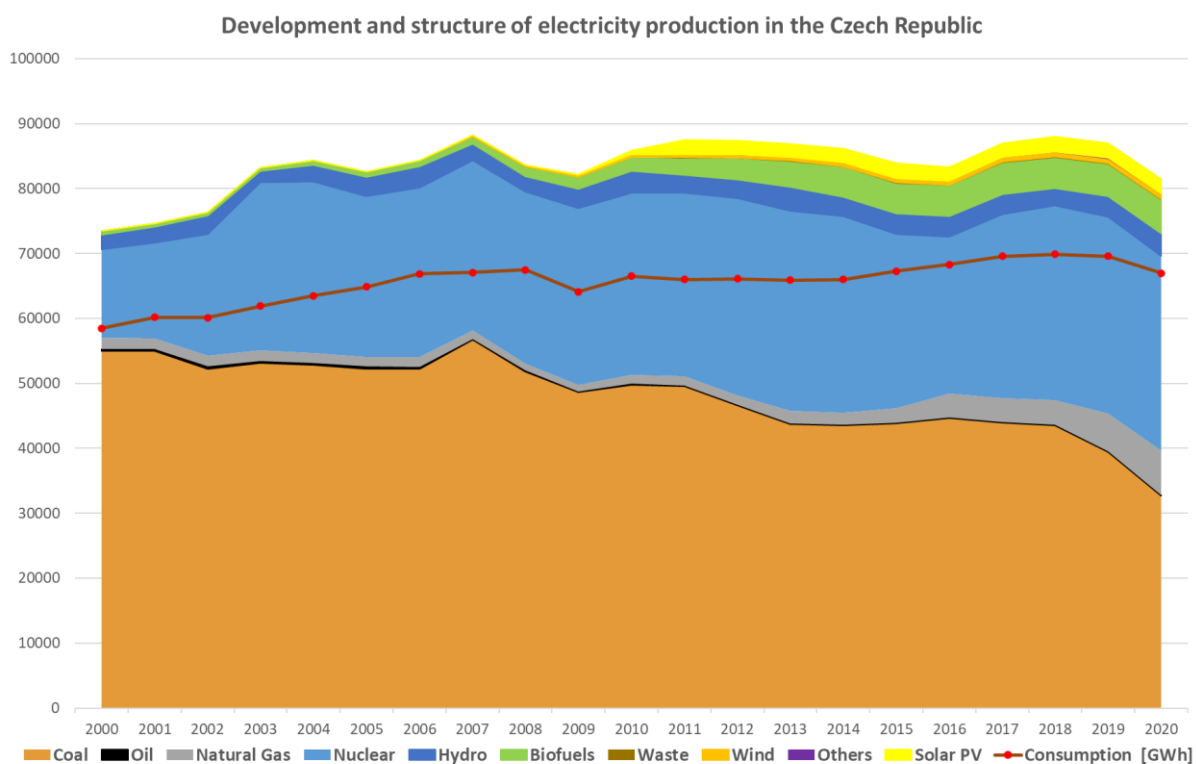


Figure 1: Development and Structure of Electricity Generation in the Czech Republic (Source of data: <https://www.iea.org/countries/czech-republic>)

### 2.3 Czech Energy Policies

NPPs already represent about 30% of the Czech electricity generation. Further expansion of nuclear energy has been identified by the Government in several energy policies as the key priority on the road to achieving carbon neutrality. The main strategic documents that define the development of nuclear energy in the CR are State Energy Policy (SEP) and National Action Plan for the Development of the Nuclear Energy (NAP).

#### State Energy Policy

On 18th of May 2015 the government of the Czech Republic approved the updated version of the State Energy Policy for the following 25 years. The Czech Republic by approval of SEP clearly acknowledged its intention to fulfil all its responsibilities in terms of common European targets and policies and to ensure the stability of investment environment in energy sector and related sectors. This should lead to sustainable energy supply for competitive market prices.

Priorities and strategic objectives in the energy sector are clearly formulated. Their purpose is to give the stability to investors, citizens, and state authorities. Strategic priorities of the Czech energy sector defined by SEP are:

- Balanced energy mix,
- Savings and efficiency,
- Infrastructure and international cooperation,
- Research, development and innovation,
- Energy security.

One of the goals given in the SEP within the Balanced energy mix priority is to strengthen the role of the nuclear energy in electricity generation and maximal use of the waste heat energy from the nuclear power plants. Long term goal is to support the development of the nuclear energy as one of the pillars of the energy sector with share of 50% on the electricity generation and maximization of the heat deliveries from the nuclear powerplants.

Total primary energy supply in the Czech Republic by source was envisioned in the SEP as given in the following Table 2: Total primary energy supply in the Czech Republic by source:

Table 2: Total primary energy supply in the Czech Republic by source

<b>Fuel source</b>	<b>2016 level</b>	<b>2040 target level</b>
Coal and other solid non-renewable fuels	40%	11-17%
Oil and petroleum products	20%	14-17%
Gaseous fuels	16%	18-25%
Nuclear energy	15%	25-33%
Renewable and secondary energy sources	10%	17-22%

### **National Action Plan for the Development of the Nuclear Energy**

NAP follows the SEP and within the limits of its strategic priorities transforms any sub-targets of this document into 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 from nuclear, medicine and industry, and research in the field of nuclear power and education.

NAP addresses priorities of SEP by following means:

- Nuclear generation will gradually replace coal energy in the role of the pillar of electricity generation.
- The target share of nuclear energy in electricity generation ranging around 50% with the maximization 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 (construction of one nuclear unit at the Temelin site and one unit at the Dukovany site with the possibility of the construction of two units at both sites).
- The construction of a unit at the Dukovany site and its commissioning by 2037.
- Ensure the legislative, administrative and social conditions for construction, and the safe and long-term operation of radioactive waste repositories (including spent fuel). Deciding on the nuclear waste repository by 2025.
- Finding other suitable sites for the development of the nuclear energy sector.

### **3 NEW BUILD LICENSING IN CZECH REPUBLIC**

There are three principal laws forming the licensing and permitting of nuclear new build facility in the Czech Republic:

- Law No. 100/2001 Coll. on the Environmental Impacts Assessment (EIA Law)
- Law No. 183/2006 Coll. on Siting and Construction Rules (Building Law)

- Law No. 263/2016 Coll. Atomic Law

All these laws represent parallel processes that are interconnected during the permitting and licensing. By permitting in this context, it is understood the proceedings according to the Building Law and by licensing the proceedings according to the Atomic Law. The important fact is that the Building Permit according to the Building Law can only be obtained after the Construction License according to the Atomic Law and Coherent Stamp from the EIA process are obtained as well.

The subsequent changes during the construction and commissioning shall be permitted as well within the change management process. In case these changes affect the nuclear safety, technical safety, and physical protection the licensing of these changes according to the Atomic Law is required as an input for the permitting. Same if the impact of the changes is affecting the assumptions given in the Environmental Impact Assessment, then the subsequent proceeding according to the EIA Law is required. These principles are visible from the Figure 2: Licensing and Permitting Process in the Czech Republic which includes whole licensing process from siting up to operation of new NPP.

Each of the three branches are represented by different licensing/permitting authorities. In case of the EIA Law, it is represented by the Ministry of the Environment, the Building Law is represented by the Ministry of the Industry and Trade (in case of nuclear facilities) and the Atomic Law Branch is in the gesture of the State Office for Nuclear Safety. There are several other offices entering the whole process via Building Law branch if the areas they govern are affected, such as Railway Office, Forest Office etc.

For the preparation of the Building Permit documentation the engineers performing such job must be authorized according to the Law No. 360/1992 Coll. on the Exercise of the Profession of Authorized Architects and on the Exercise of the Profession of Authorized Engineers and Technicians active in Construction.

As the licensing and permitting process is rather complex and preparation of the relevant documentations require deep knowledge of local regulatory framework the significant involvement of the local consulting engineering may be expected.

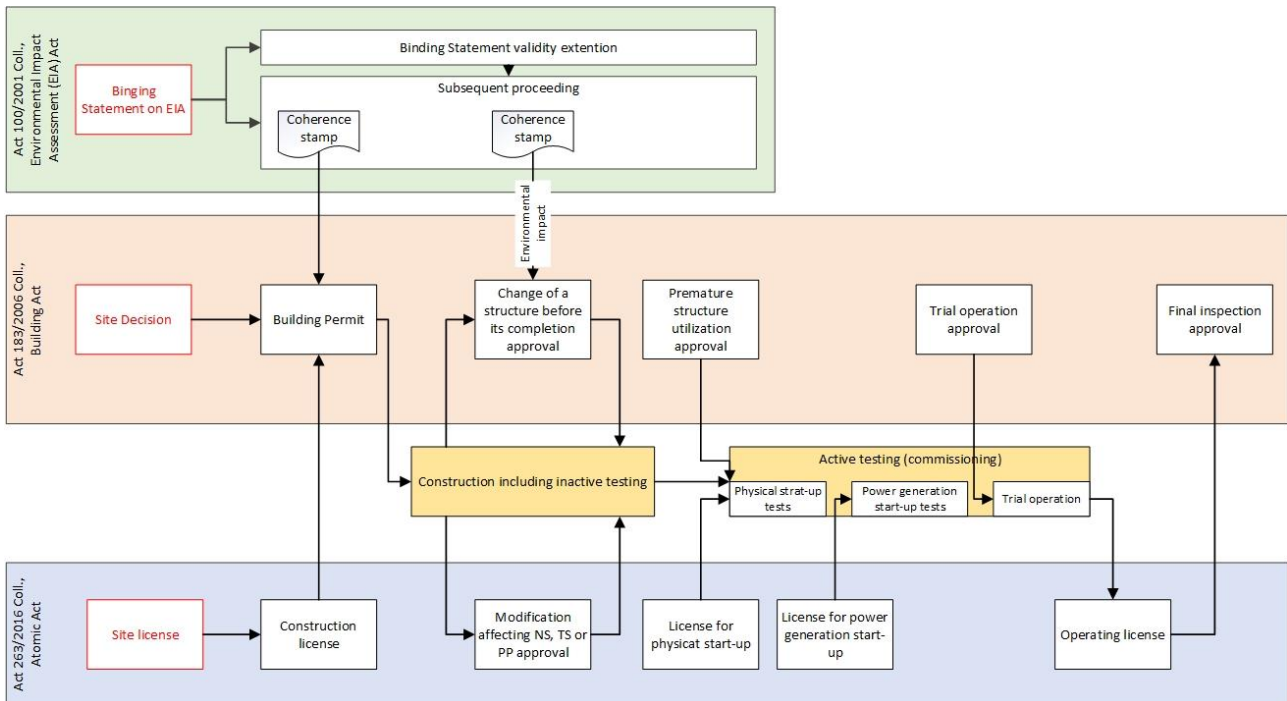


Figure 2: Licensing and Permitting Process in the Czech Republic

## 4 NEW BUILD PROJECT IN DUKOVANY

The Dukovany new build project started around years 2010-2011. At that time Dukovany site was the second option of new nuclear build in Czech Republic as Temelin site was the favorite to build new two reactor units. After the termination of the tender for Temelin the priority was shifted to Dukovany site. Following the conclusions and recommendations of the NAP, CEZ, established a subsidiary - Elektrarna Dukovany II, a. s. (EDU II) in 2015, which implements the project of New Nuclear Power Plant at the Dukovany Site.

The company EDU II obtained the License for the siting of two units of the new Nuclear Power Plant at Dukovany Site from the State Office for Nuclear Safety on 8th March 2021.

The large capital investment usually exceeds the possibilities of full funding by a single utility company via its equity or without jeopardizing its credit rating. This is accompanied by the limited possibilities to seek the partnerships in order to maintain the competitiveness of the procurement process. Market pricing signals are influenced by several factors starting with the political influences such as the development of the renewable technologies that are supported politically within the EU. Nuclear power is also often affected by the security policy of the state, possible shifts in the nuclear safety aspects of the industry and possible political decisions to prematurely decommission the plant. This brings a rather big level of uncertainty for the investment project of 60+ years such as NPP. Conditions of the electricity market are driven far more by policies than market signals. Therefore, such market conditions are considered as a market failure.

State will address the market failure by the state aid to the Project. The notification to the European Commission (EC) is required, i.e. an evaluation whether the aid is coherent with the regulations of the European Union's internal market. The Ministry of Industry and Trade shall obtain the decision of the European Commission by the end of 2022.

The state support may be divided into two main pillars as follows:

- Power purchase agreement
- State Loan

Both mechanisms are described within the Law No. 367/2021 Coll. on Measures for the Transition of the Czech Republic to a Low-carbon Energy Sector. This law is often also called “Lex Dukovany” as it was tailored for this new build project.

The exact conditions of the PPA are being negotiated between the parties. However, it should be aimed to help overcome the existing market failures. The PPA is expected to be signed by 2024.

The project will be funded by the State Loan. The State Loan provides the significantly lower interest rate/financing costs than it would be possible to get on the capital market. Borrowing cost should be based on the minimum 2 % interest rate (or interest based on state borrowing cost plus 1%).

The procurement process was launched in February 2022 by announcement of the tender process for the selection of the supplier of the NPP in Dukovany. The tendering documentation was sent to three possible bidders – EdF, KHNP and Westinghouse. Signature of the EPC contract is expected around the end of 2024.

Publicly stated value of the overnight cost is around 5,400 EUR/MWh. The value is similar with the others stated in other public sources. For instance, the Nuclear Energy Roadmap 2015 states the overnight cost 5 500/kW USD for NPP in the European Union. It may be expected that the tender process will create competitive circumstances between the bidders and the final overnight costs would not differ much from the expectations. In the other hand, post covid era and the current geopolitical conditions brings volatility to the markets, and it is far more difficult to predict the costs on the mid-term or long-term basis.

## 5 CONCLUSION

The Czech Republic is on the brink of the nuclear renaissance which is sped up by the energy sector transformation, planned coal phase-out in the country and current geopolitical conditions causing volatile position of the energy supply in the region.

The effects of major changes on the energy market make the nuclear energy more important than it was in last several decades. The lessons learned by the industry from the recent new build projects in the world will be for sure taken into account during the current nuclear build up and hopefully will help to avoid delays and cost overruns seen elsewhere.

The country prepared itself for the nuclear new build project for last decade. One tender was already terminated for two nuclear units in Temelin due to the lack of financial guarantees to the project. State aid for the Dukovany new build project, detailed preparation for the project and general preparedness of the industry and engineering capacities create solid basis for the successful project implementation.

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